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SYNTHESIS PAPER

Administrative data and methodologies for tax policy

Pierre Bachas and Anders Jensen

This synthesis paper outlines the general value of administrative data for evidence-based policy design, reviews the main research methodologies in public finance which use administrative data, and discusses the best practices and challenges with managing administrative data and developing policy-research engagements.

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Contents

Introduction

The growing literature on state capacity places the ability to collect taxes in an efficient and equitable manner at the heart of how state-building occurs along the development path (Besley and Persson 2013). Governments in developing countries are currently characterised by limited tax capacity — low level of taxes collected, in an inefficient manner, and with limited redistribution. Understanding which policies are effective in alleviating capacity constraints requires an evidence-based approach. Evidence-based policy design is an approach where rigorous methods and high-quality data are combined to identify the policy problems and its underlying failures and, in turn, evaluate policy solutions using experimental and quasi-experimental empirical designs.

In the context of taxation, the rise of evidence-based policy design in developing countries is closely related to the increased use of administrative data in research and policy analyses. Administrative data are the set of microeconomic datasets that governments continuously create for the administration of their tax and transfer programmes. In this review, we outline the general value of administrative data for evidence-based policy design, review the main methodologies in public finance which use administrative data, and discuss best-practices and challenges with managing administrative data and creating policy-research engagements.

Administrative data sources

In Section 1, we provide an overview of administrative data sources and discuss the main ways in which it is a helpful source of knowledge for citizens, firms, and governments. Administrative data are characterised by three features which make it especially valuable. First, administrative data often contains rich information on firms and citizens at the micro-level. Second, administrative data are collected at high frequency (yearly, or, in the case of firm data, quarterly or monthly), and permit tracking over time of individuals and firms. Third, administrative data has comprehensive coverage of the formal sector, which results in much larger sample sizes than survey data. For these reasons, administrative data has seen a rise in usage in public finance research.

This rise is closely related to the growing emphasis in public finance (and empirical work, more generally) on 'identification' — the focus on the quality of the empirical research design and the delivery of robust, causal, and policy-relevant estimates. Before focusing on public finance research in Section 2, we discuss other areas of research in development where administrative data is also helpful to shed light on important questions, including international trade, firm decisions, inequality, and macroeconomic trends.

Finally, administrative data is of high value for descriptive purposes but may not have an immediate research focus. We discuss different innovative ways in which governments have recently made use of tax

data to gain real-time insights into trends in the economy to inform policymaking. These 'just-in-time' economic analyses include ways governments have managed to conduct policies during the COVID-19 pandemic.

Main empirical methodologies

In Section 2, we discuss the main empirical methodologies that make use of administrative data for tax policy analysis. We begin by reviewing some of the main descriptive exercises. The combination of tax returns and audit data have allowed researchers to gain important insights into the 'anatomy of tax evasion'. This simple descriptive exercise relates accurate measures of actual evasion to taxpayer characteristics. One of the most important studies in this area (Kleven et al. 2011) revealed that the extent to which the income-source is covered by third-party reporting (for example, employers and financial institutions) can account for most of the evasion in the population of taxpayers. This insight has subsequently triggered a large set of research papers that study how information coverage impacts compliance and conditions the effectiveness of various tax policies.

Descriptive exercises on the anatomy of evasion are crucial in the context of developing countries, where evasion is widespread. Another highly relevant descriptive exercise in developing countries is the distributional measure of how effective tax rates (the ratio of taxes paid to taxable income) vary across firms and individual taxpayers, and the extent to which the distribution of actual tax burdens differs from the statutory burdens (as defined by the tax code). Finally, in the descriptive context, administrative data can be combined with original survey data to make progress on questions that relate to individual willingness to comply and tax morale.

A second methodology that uses administrative data is randomised controlled trials (RCTs). RCTs randomly expose a subset of taxpayers to a particular intervention that is related to taxation, and withholds exposure for the other subset. As such, the RCT is considered the 'gold standard' from a causal estimation point of view, and the implementation of RCTs in developing countries has seen a large rise in the past decade. There has been a natural progression in the RCT design, where research projects have moved from initially randomising letter messages to more ambitious randomisation designs — including experimentally varying audits and statutory actual tax rates, personnel, and technology.

As such, RCTs are proving to be a strongly relevant empirical tool to guide policy-decisions for many dimensions of tax systems. Moreover, conducting an RCT with a tax authority requires the researcher to build a collaboration with practitioners over the long-term. As such, these collaborations are often the source of new and insightful questions that emerge from the exchange of ideas between practitioners and researchers.

Third, we review the 'bunching' methodology. Similar to RCTs, bunching has also seen a rise in usage in academic research. Again, this rise is closely related to increased availability of administrative datasets. This is primarily because the bunching approach requires large datasets with minimal measurement error. Indeed, the bunching approach ultimately relies on finding graphically compelling evidence that taxpayers respond to discontinuities in the tax system by moving reported taxable activities between specific points in a narrow range.

Bunching relies on the existence of discontinuities in incentives. As these discontinuities are ubiquitous in tax systems, bunching has been used to provide causal evidence on taxpayer responses to many dimensions of tax systems, including tax rates and enforcement environments. Moreover, bunching lends itself particularly well to provide prima facie evidence on the existence of evasion as a mechanism for taxpayer behaviour — which is naturally highly relevant in developing countries.

Challenges with administrative data

In the final section, we review some of the challenges of working with administrative data in practice. National tax authorities have invested heavily in information technology (IT) systems that allow for better registration of taxpayers, processing of electronic tax filings, and aggregating information reported by third parties, among others. The vast amounts of data generated by these systems, however, are often not exploited to their full potential due to lack of capacity. As such, high quality administrative data is both an input and an output of strong tax capacity.

We discuss limitations on research that result from ineffective use of administrative data. These challenges include: coexistence of digitised and non-digitised data for subsets of taxpayers within the same tax base; inability to merge datasets due to lack of unique taxpayer identification numbers; and existence of tax declarations that are incomplete, unclear, or which generate inconsistent information on the same variable across datasets. We discuss recent initiatives undertaken by individual tax authorities to overcome some of these challenges.

Importantly, several developing countries have created special government units that are dedicated to data management and tax policy analysis. One of the roles of such units is to ensure that agencies in charge of administrative data are managing the processing in the most realistically efficient manner; moreover, the special unit focuses on ensuring that datasets can be merged across agencies that otherwise have limited communication with each other. We conclude by discussing these experiences in the context of the creation of the tax data lab in Senegal and the tax policy unit in Honduras.

1. General relevance of administrative data for citizens, governments, and researchers

Administrative data permits more credible research and is increasingly used

Governments create comprehensive micreconomic datasets to assist in the administration of their tax and transfer programmes. In the context of taxation, administrative data contains several categories (Brockmeyer 2019):

- **The tax register** contains the list of registered taxpayers at a point in time (together with their unique tax ID, if it exists), and can include additional information on the time of registration, location, and other items (demographics for individuals; industry classification for firms).

- **The taxpayers' self-assessment forms**, are the declarations about taxable income submitted by the taxpayers themselves (for example, individuals submit personal income tax declarations, while firms submit corporate income tax returns and value-added tax declarations).

- **Information and withholding declarations** are submitted by third parties (including employers, financial institutions, real estate agents) that observe/process transactions with specific taxpayers (and which may be liable to withhold and remit some taxes that arise due to the transaction).

- Relevant in developing countries, **data from customs authorities** include information on cross-border movement of goods (value and quantity); this data should and often does contain information on the unique taxpayers that import or export.

- **Process data** contains records of activities performed by the tax authority — including audits and recovery of fees, and fines due to non-compliance or delinquency.

In principle, tax administrative data may be combined with administrative data that is compiled by other government authorities — including firm outcomes (from commerce agencies and finance regulators), transfers (from social security administrations), labour market outcomes (work and labour ministries), health outcomes (health administrators), and educational outcomes (educational institutions). When combined across sources, administrative data can therefore contain rich information which ultimately covers most aspects of firms' and individuals' activities in society (Card et al. 2010).

In the context of public economics, administrative data is increasingly being used in research papers. Based on textual analysis of papers published since 1975 in the NBER Working Paper Series, Kleven (2018) finds that studies which mention the word 'administrative data' has gone from 2-5% in the early 1980s to 30% in the mid-2010s. The rise of

administrative data appears to go hand-in-hand with the increased emphasis on identification — the use of the word 'identification' in empirical papers has risen from 1-2% in the early 1980s to 45-50% by the mid-2010s.

Identification is at the heart of the 'credibility revolution', the movement which has seen empirical researchers focus more on the quality of their research design, and deliver — through the use of both experimental and quasi-experimental methods — analyses that are robust and policy-relevant (Angrist and Pischke 2010). As Angrist and Pischke argue, the availability of more and better data has been a key factor to establish credible and policy-relevant research. Administrative datasets are often large in size, which permits more precise estimation and richer heterogeneity analysis — thereby increasing the internal validity of results. By virtue of covering the universe of registered taxpayers, administrative data also allow broader conclusions, which helps to increase external validity.

Focusing on publications in leading journals on developed countries, Chetty finds that the increased use of administrative data has largely been accompanied by decreased reliance on existing survey data (Chetty, 2012). The substitution from survey data to administrative data relates in part to the virtues of larger sample sizes (in the US, administrative data is over 2,000 times larger than the most widely used survey data, Chetty 2012). Additionally, relative to survey data, administrative data also permits longitudinal tracking over longer periods. This not only helps with identification per se (by allowing researchers to study within-unit changes in panel models), but also allows research to address questions about long-term impacts, which are often of interest to policymakers.

Figure 1: Research on administrative tax data around the world

Countries (of population above 1 million) with academic papers or policy papers that use micro-level administrative data for descriptive or econometric analysis.
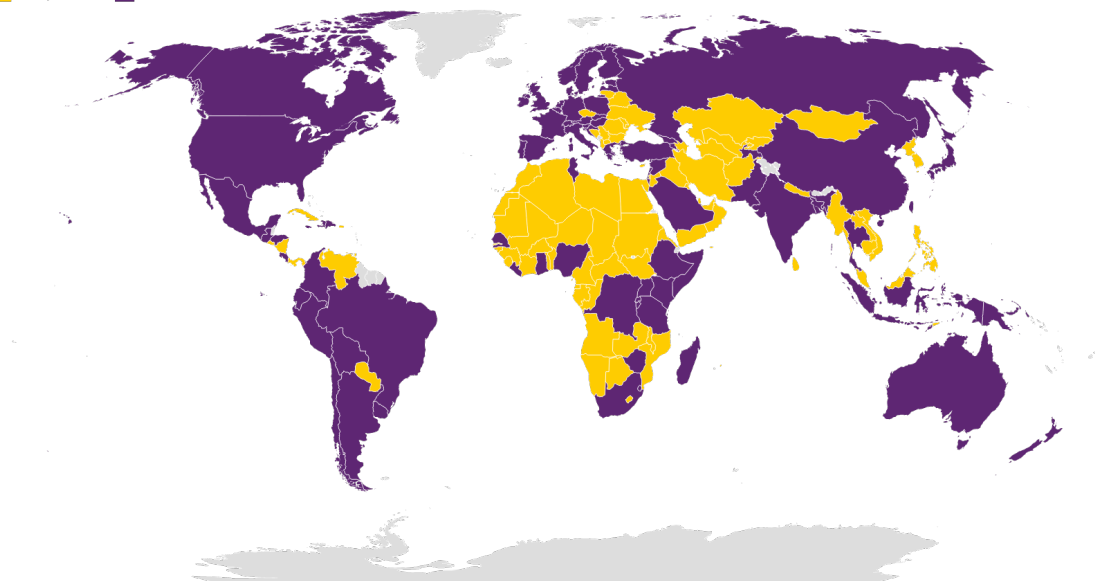
Note: This data highlights publicly available working papers/published papers that use administrative micro-data. This measure represents necessarily a lower bound on usage of administrative data, since it does not include internal papers that also use administrative data. If you know of a study which is publicly available and uses administrative micro-data in a country which currently is coloured in yellow, then please contact the authors.
Source: Authors' research

The use of large administrative datasets in empirical public finance research is not reserved to high-income countries. Advances in information technology, e-filing of taxes and digitisation of data have enabled many countries around the world to generate administrative data that can be used for policy analysis. In the last ten years such policy and research analysis has strongly grown: Figure 1 shows 78 countries with pop over 1 million where, based on our search, academic or research type papers have been produced using micro tax administrative datasets (List of papers in Appendix I). 30% of low and middle-income countries have at least a study that uses admin data, and 26.8 % of all countries (pop > 1M) have at least a study that uses admin data. As can be seen, most countries in Latin America have already produced research, but this is also the case for an increasing share of countries in Africa and Asia.

Administrative data permits real-time insights to guide policymaking

Traditionally, information on economic activity was obtained from surveys, which were expensive and took time to collect and harmonise. The data and digitisation revolution has opened the door to just-in-time economic activity analysis, often termed "now-casting". Obtaining reliable statistics on recent economic activity allows governments to adapt their budgetary plans, adjust fiscal policy, and rapidly insure households and firms against shocks.

In the US, creative usages of micro-data to now-cast economic activity are fast developing. For example, Chetty et al. (2020) aggregate micro-data from finance service providers, such as credit card payments, to measure the impact of COVID-19 on economic activity at the local level. Blanchet, Saez and Zucman (2022) rely on high-frequency employment data, together with assumptions about the distribution of income and wealth, to adjust inequality estimates on a quarterly basis.

In developing countries, data such as shipping volumes and mobile banking usage are also being used for just-in-time economic analysis (Buell et al. 2021). However, administrative tax data arguably presents further advantages: it covers all formal sector activity; it is collected at a low cost (when digitised); and it is generated with a high frequency. This is particularly true for the measure of firms' sales, which are remitted monthly to the government in most VAT systems, or even daily for firms using electronic billing machines. Misch et al (2017) discusses the uses and limitations of such daily fiscal data in Brazil and the US, and argues that given their increased availability, many governments would gain from integrating these data into their economic analysis and building their data analytics capacity.

The usefulness of administrative tax data to inform on economic behaviour with higher frequency was highlighted during the COVID-19 pandemic. For example, Bachas, Brockmeyer, and Semelet (2020) use the most recent firm-level corporate tax returns in a dozen low- and middle-income country to predict firms' survival at the onset of the pandemic in March of 2020. Corporate tax returns are one of the rare sources of panel data on firms' revenue profits and costs, and also

contain several firm characteristics. The paper simulates different scenarios which vary the duration of lockdowns, and the resulting drop in demand as a function of firms' size, industry, and location, to predict firms' drop in reported profits and sales, and their emergency financing needs. This allows for a back-of-the-envelope estimation of the change in the public and private sector's budgetary position at the onset of the pandemic, which can then be compared to the realised economic outcomes reported in VAT returns a few months into the pandemic.

Byrne et al. (2022) present another creative usage of administrative tax data, which goes beyond sales and profits: they extract the price of masks reported in individual receipts in electronic billing machines in Rwanda. They then observe how prices and quantities sold evolved during the COVID-19 pandemic, and responded to mask manufacturing mandates and import tariff changes. In turn, they find that higher production and lower prices led to increased mask usage (in areas with more production) and lower incidence of the virus.

A key limitation of administrative tax data is that it only covers formal firms on the activity they report to the tax administration. Even if the tax administration has estimates of non-compliance, taxpayers might change their behaviour (for example, by increasing non-compliance) precisely at the time of economic shocks, thus weakening the use of such data to predict overall economic activity. Yet, the use of administrative tax data for now-casting should increase as the formal sector expands, more data is digitised and cross-checked, and research highlights the blind spots of the data.

Administrative tax data permits a unique combination of rich information, panel structure and comprehensive coverage which sheds light on many non-taxation questions

Administrative tax data has three features that makes it attractive for research purposes (beyond public finance questions):

1. **Richness of information** – Administrative tax data collects rich information on the activities of firms and individuals in the economy. The richness of the data often comes from the combination of several administrative datasets –for example, by merging the individual domestic tax returns with the registry data.

2. **Panel structure** – Since administrative data serve as an input for governments to implement tax and transfer policies, these data are continuously being collected – at yearly, quarterly, or even monthly frequency. Moreover, the data is organised in panel format – allowing researchers and policymakers to track activities of specific firms and individuals over time.

3. **Comprehensive coverage** – Administrative data are comprehensive in their coverage and are almost always larger in sample-size than survey data. (Administrative tax data can be smaller in sample size than census data, but census records are often only created only once or twice each decade.)

These three features make administrative tax data helpful for many types of research questions that are relevant in developing countries. We illustrate this point with some examples from recent academic studies below.

International trade: Administrative tax data has been used in recent projects on international trade. Adao et al. (2020) combine multiple data sources in Ecuador to study the impact of international trade on earnings inequality. They leverage the fact that the national tax authority has created a tax ID that is unique across all administrative sources. This allows the researchers to track activities across data sources from the universe of tax-registered, formal firms between 2009 and 2015.

- From the corporate income tax data, the authors measure revenues, intermediate inputs and labour costs, as well as total value of exports and imports.

- From the value-added tax (VAT) data, the authors measure firm-to-firm transactions. This is doable, because VAT forms in Ecuador require firms to list the tax ID of each individual seller and buyer for transactions that have occurred during the relevant filing period (typically a month or a quarter of the year). The requirement to list transaction partners on VAT forms is common in many other countries around the world.

- From the social security tax payments data, the authors link individual employees to firms and measure labour payments.

- From the firm registry data, the authors measure firm ownership.

- Finally, the customs data allow the authors to measure firm-level international transactions that can be linked with the full set of domestic administrative data.

This impressive combination of administrative data allows the authors to measure, on the export side, the extent to which individuals across the earnings distribution sell their factor services abroad (either directly through their own firms, or indirectly through the exports of firms supplied by their own firms in the production network); and, on the import side, how changes in import prices affect demand for services of both workers and capital owners.

Alfaro-Urena, Manelici, and Vasquez (2021) use the VAT forms in Costa Rica which allow them to track firm-to-firm transactions and study the impacts of becoming a supplier to a multinational corporation. They combine this network data with the corporate income tax data and registry data to investigate how the entry of multinationals in the country impacts domestic suppliers in terms of firm sales, employment, asset holdings, and input costs. This paper illustrates how the use of administrative data can help provide microeconomic evidence on the impacts of global value chains in developing countries.

Firm-level behaviour: As the papers cited above illustrate, administrative tax data can provide micro-evidence on firm behaviour in developing countries. This insight goes beyond questions in international trade, and extends to many other dimensions of firm choices. Of course, an exhaustive review of such studies is beyond the scope of this thematic review.

One recent example is Chen et al. (2021), who use detailed corporate income tax data in China to show that investment decisions have an extensive margin, in the sense that they are lumpy in their amount and occur at discrete points in time (work on investment behaviour in developed countries using administrative data include Yagan 2015; Zwick and Mahon 2017; Moon 2022). In the Chinese context, Chen et al. (2021) also use administrative corporate tax returns to study how firms make R&D investments. The detailed data, which contains information on many types of reported expenditures, allows them to show that a significant share of reported R&D is driven by re-labelling of other expenses, and they investigate which innovation policies would be most likely to stimulate R&D when re-labelling is prevalent.

Another administrative data-source that holds significant research potential is electronic billing machines (EBM). EBMs have been introduced by governments in many developing countries as a compliance tool. At its core, the function of the EBM is to directly transmit information from individual firms to tax authorities at the transaction-level and in real time. EBMs are meant to increase the information coverage of firms' activities. The actual design of an EBM may vary from context to context, and determines the level of detail that is contained in the electronically transmitted data. EBMs have the potential to creation an administrative data-set with billions of observations in a given country, containing centralised information at the 'barcode-level' on products purchased, prices, and quantities.

Steenbergen (2017) discusses the EBMs in the Rwandan context. As the use of EBM data in projects is still in an early phase, the value of this administrative data-source for research is yet to be determined. It is important to note that similar to the Chinese studies on investment and innovation, since EBMs serve an enforcement purpose, the data captured on the machines is likely subject to misreporting and manipulation on the firm side; moreover, these data will only cover transactions in tax-registered firms.

Inequality: Administrative tax data serve as an important input into creating many aggregate statistics that help shed light on topics and challenges in society. One such area is the study of inequality. In developed countries, the use of administrative tax data has helped to improve the accuracy of inequality measures; importantly, in comparison to survey data, administrative tax data can allow for a more accurate measure of incomes at the top of the income distribution. In fact, administrative tax data may render superfluous the use of survey data if the tax returns cover the population of interest — which is most often considered to be the full active workforce, or the entire working-age population.

With respect to this objective, the relevance of administrative data becomes limited when we compare developed to developing countries. This is primarily because income tax data cover the entire population in developed countries, but, due to legal exemptions and enforcement constraints, the income tax base often covers only a fraction of the active workforce in developing countries (Jensen 2022). Given these constraints, there is a need for more detailed work in developing countries to improve the combination of administrative tax data and nationally-representative survey data to create robust and transparent income inequality measures — including the work by researchers at the World Inequality Lab.

The availability of administrative data which combines information from tax and non-tax forms have also led researchers (primarily in the US and Europe) to take a broader perspective on inequality. This has led to an increasing focus on the concept of inequality of opportunities (which includes income, but also studies topics such as health and education). For example, administrative data linkages allow researchers to study how mobility (movement from one part of the income or wealth distribution to another part) varies, both across space (individuals, locations) and time.

The study of mobility in various forms has had less influence in developing countries — again, due to the limited coverage of administrative data. Given the importance of establishing opportunity trends in these countries, more work is required to understand how limited administrative data can be combined with other information sources. For example, recent work in India (Asher, Novosad, and Rafkin 2018) uses new empirical methods and the combination of administrative data, census data, and survey data to measure intergenerational education mobility.

Macroeconomic statistics: Administrative tax data can help improve the quality of national account statistics. Since the work of Kuznets (1941), macroeconomic policy decisions have been made on the basis of macroeconomic statistics that are calculated in the national accounts framework (including GDP, factor incomes, and value-added by sector). These statistics are crucial to form an understanding of a country's macroeconomic performance, stability, and trends, and are used by researchers to study the macroeconomic effects of government policies.

National statistics data based on surveys has several shortcomings. First, such data typically cannot be used to confidently assess variation across geographical areas or subgroups, due to relatively small sample size. Second, survey-based (or census-based) statistics are typically only available at low frequency, and often with a time-lag to the actual economic changes. Relative to these drawbacks, administrative tax data can significantly enhance the quality of national statistics.

For example, VAT micro-data is increasingly being used by national statistics offices in developing countries (Rivas and Crowley 2018). Due to the high frequency at which VAT data is collected (quarterly or monthly), VAT returns can provide more accurate and timely information on emerging and declining industries. Moreover, the comprehensive coverage of VAT forms can help to measure activity in industries that represent small shares of national income, and where devoting costly resources to surveys may not be justified. VAT forms are also helpful to accurately track intermediate consumption, which in turn improves the measurement of value added.

Corporate income tax records are often helpful to compile financial accounts, which in turn are used to measure national savings, investment, and net lending. Finally, national statistics offices maintain databases to guide data collection and to select samples for economic surveys. The continuous maintenance of these samples is costly and challenging; experiences from several developing countries shows that integrating tax registry databases to the national statistics' data allows for a more comprehensive sampling of firms.

Naturally, there are dimensions of national income that administrative tax data are not helpful to cover - including, importantly, the activities in the informal sector. And, as noted above, since tax bases in developing countries cover only a limited share of economic activities, administrative data are less helpful, at the margin, than in developed countries. Nevertheless, investing in the use of administrative data to improve national statistics is meaningful, to improve domestic macro-policy guidance. Moreover, integrating administrative data may curb governments' discretion in the production of GDP figures (Martinez 2021) and thereby improve citizens' trust and the perceived integrity of governments.

An LIC office building as seen in Kolkata, India on December 12,2021. Photo by Debajyoti Chakraborty/NurPhoto via Getty Images

2. Use of administrative data in public finance research

Administrative data has high informational value, which is helpful to describe taxpayer activities and improve tax collection

Administrative data allows researchers and practitioners to gain important descriptive insights into the tax system. Perhaps one of the most important descriptive capacities of administrative data is to shed light on the 'anatomy of evasion'. In a seminal paper on tax evasion, Kleven et al. (2011) collaborated with the Danish tax authority. They conduct randomised and unannounced audits of a (random) sample of individual taxpayers. The audits were comprehensive and the detected misreported income was subject to penalties under the tax law.

Using this audit data, the authors can describe with great accuracy the anatomy of tax evasion in the Danish context. They find that the overall evasion uncovered represents a modest fraction of taxable income, but they uncover an important source of difference in evasion across taxpayers – namely, the extent to which the taxpayer's income is covered by third-party reporting. They find that the evasion rate is almost equal to zero for income on which a third-party report exists (mainly by employers or financial institutions), but substantial for self-reported income. For taxpayers that mainly earn self-reported income, for which evasion is significant, the evasion rate on the small amount of third-party income is still close to zero.

This striking descriptive finding led to the conclusion that the high degree of overall compliance in developed countries may largely be due to the widespread coverage of third-party reporting on taxable income. The results from this paper set in motion a large subsequent literature which has investigated how information coverage can explain tax collection outcomes, both within countries (Pomeranz 2015; Naritomi 2019; Best et al. 2015) and across countries (Jensen 2022). The descriptive findings were made possible by the combination of two important administrative datasets – the process data from the audit department which permitted accurate measures of evasion and the tax returns data which permitted measures of third-party coverage.

In addition to evasion characteristics, administrative data can be used to describe other important aspects of the tax system. One example is the measure of policy tax gaps: the revenue lost due to legal provisions: special exemptions, credits and reduced rates.[1] Such gaps are particularly relevant for firms: their effective tax rates are the ratio of taxes paid to their income, which represents their actual

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1 These tax advantages, often termed tax provisions, consist of all non-standard claims via which taxpayers reduce their tax base and tax rate. This includes preferential tax rates; exemptions on what income is taxable; special deductions from the tax base such as investment incentives; and deductions from the tax liability such as tax credits.

tax burden. In practice, the effective tax rate can deviate substantially from the statutory tax rate as defined in the tax law.

Measuring the effective tax burdens at the firm levels allows policymakers to investigate how much the actual level of taxes paid differs from the intended tax burden, and how much the distribution of effective taxes paid differs from the intended progressivity of the statutory tax system. In a systematic analysis of corporate tax returns across 14 low- and middle-income countries, Bachas et al (2022) find some striking patterns of effective tax rates (measured as tax liability over profits) and firm size: effective tax rates (ETRs) increase with firm size until the 80th percentile of the size distribution, but then drastically fall for the largest firms (Figure 2 below). This inverse U-shaped pattern of tax rates by firm size implies that medium-sized firms bear a disproportionate tax burden.

Other recent papers investigating effective tax rates include Mascagni and Mengistu (2016), who use corporate income tax returns and customs returns in Ethiopia to measure the effective tax burden faced by individual firms. They calculate effective tax rates as the ratio of taxes paid to sales (thus the gap between effective and statutory rates combines both, tax provisions and overreporting of standard deductions/differential profit margins by firm size).

Figure 2: Effective tax rates and firm size, average across 13 countries
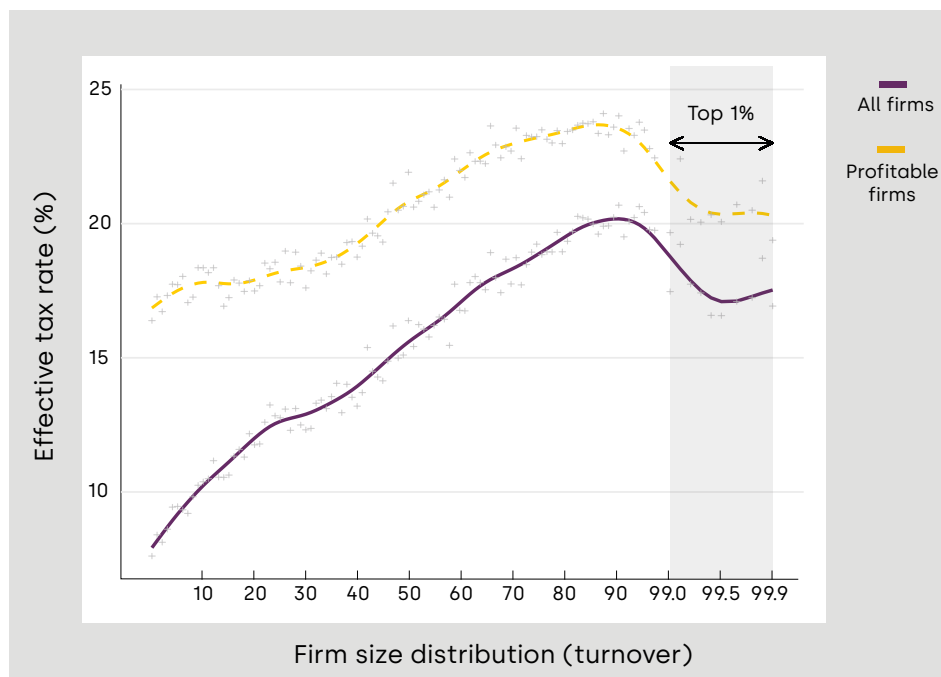
Note: This figure shows effective tax rates (ETR) as a function of firm size quantiles on average across the 13 countries covered in the forthcoming study by Bachas, Brockmeyer, Dom and Semelet (2022). It takes the average ETR at each quantile, weighing countries equally. The purple solid line corresponds to a flexible polynomial fit, where loss-making firms are assigned a zero ETR. The yellow dashed line corresponds to the polynomial fir for profitable firms only, holding the size quantiles fixed. The quantiles correspond to percentiles between the 90th and 99th percentile (white area), to 0.1 percent bins between 99.0th and 99.9th (grey shaded area) .
This graph was adapted from Bachas, Brockmeyer, Dom and Semelet (2022).

As a final example of how administrative data is used for descriptive purposes, recent research has merged original survey data with administrative data. In a recent study involving Danish taxpayers, Hvidberg, Kreiner, and Stantcheva (2021) link survey data on citizens' perceived income positions and views on inequality within reference groups to administrative data on their actual reference groups and income. This unique combination of survey and administrative data allows the researchers to measure how accurate people's perceptions of inequality are in relation to reference groups, and to investigate which elements of people's environments and life events impact their perceptions.

Bergolo et al. (2020) collaborate with the national tax authority in Uruguay and merge survey responses with administrative data. The authors use the under-reporting of wages by individual taxpayers as the main measure of tax evasion. They correlate evasion behaviour with a rich set of (lab and survey) responses to questions which measure individuals' tax morale, values, and beliefs. They find that these rich measures have limited power to predict actual tax evasion. Some measures, such as tax morale, have no association with wage under-reporting. Other measures — including the perceived evasion of firms, and political leaning – have a stronger correlation with evasion. The paper in Uruguay represents an important first effort to link survey-based measures of individual preferences with measures of actual tax/evasion behaviour.

These studies highlight the informational value of administrative data, and how it can descriptively shed light on taxpayer activities. Several papers (see box below) have found that, due to information enhancement, the creation of additional administrative data-sources can directly help increase tax collection.

While many progressive income tax systems around the world feature kinks, the income tax in Pakistan is based on notches: at specified threshold levels, the entire taxable income becomes subject to a higher tax rate. Photo by Aliraza Khatri/Getty Images

New administrative data-sources and their impact on tax collection

In **Ecuador**, Carillo, Pomeranz, and Singhal (2017) conduct an intervention where a subset of firms is notified that the tax authority has access to administrative data (in this case, third-party reports) which have helped them identify a wedge between the value of firm's self-reported activities and the value that is implied by these data. The authors find that firms make significant adjustments and bring their reported activities almost exactly in line with the information contained in the administrative data. Thus, the simple existence of an administrative data-source can be leveraged to change firms' reporting behaviour.

Results from an experiment in **Costa Rica** are similarly encouraging. Here, the authors find that communicating to individual firms the existence of third-party information specific to their activities (including by providing specific examples of the taxpayers' third-party reported sales transactions) lead to a large increase in filing rates and tax payments. (Brockmeyer et al. 2019)

In the **Chinese** context, Fan et al. (2020) study a policy which digitised VAT filings. While administrative data existed prior to the reform, it was in paper format (for example, hand-written tax deduction invoices). The reform led to a digitised administrative dataset by creating electronic versions of tax receipts and by creating a national database which allowed cross-checking of electronic tax receipt. The authors find that the transition to digitised administrative data led to large increases in VAT payments.

Lediga, Riedel, and Strohmaier (2020) study an administrative reform in **South Africa** where the national tax authority merged its tax business tax registry with data from the commercial registry of the Companies and Intellectual Property Commission. Firms that incorporate in the country need to supply information to the commercial registry. The authors find that synchronising this commercial registry with tax data led to the discovery of approximately 300,000 firms that were obliged to register for business tax purposes but had failed to do so.

Londono-Velez and Avila-Mahecha (2021) show that the leak of the **Panama Papers**, and the ability to merge such data with pre-existing administrative tax data, led to increased likelihood that wealth would be reported domestically and increased tax payments.

The informational value of administrative data can thus help shed light on taxpayer activities and directly contribute to tax collection. There are, however, important limitations to the usefulness of administrative data in developing countries. First, when third-party reports only cover part of a firm's activity, firms can adjust their behaviour on the margins that are not information-covered in order to partly offset gains to the tax authority. In the study from Ecuador, the authors find that while third-party information on sales led firms to increase their self-reported sales, the firms also responded by increasing the self-reported value of input costs – to an extent that taxable profits almost stayed constant. Importantly, firms adjusted input values in cost-categories that were not covered by third-party information (for example, 'miscellaneous administrative expenses').

Second, as taxpayers learn about the compliance-value that different activities provide to tax authorities, they may distort their behaviour. In the study from South Africa, the authors find that, after the reform, firms were less likely to register with the commercial registry. This is likely because the reform taught these firms that tax authorities make use of such third-party information for tax compliance. Thus, as the link to taxation becomes salient, firms and citizens may become less and less likely to cooperate in providing information through third-party sources.

Third, most of the research to-date has studied the informational value of third-party sources, but some tax bases in developing countries suffer from an almost complete absence of third-party coverage. One important example is the local property tax. Unlike other taxes, the value of the tax due is known to the tax authority – because the property value is directly assessed by the authorities. However, tax non-compliance remains rampant on this tax base. This is likely due to the authorities' limited information on taxpayers' propensity to pay – including the taxpayers' ability to pay, which is related to income and liquidity. In developed countries, local authorities can have access to third-party reports from employers and financial institutions that provide information on ability to pay, but this information is non-existent for local administrations in developing countries.

In this context, Dzansi et al. (2022) show that technology can help fill the informational void. The authors show that providing tax collectors with technology to help them navigate in the field allows collectors to spend more time interacting with property owners and learn about their ability to pay. As collectors directly build the information that would otherwise have been provided by third-party sources, technology leads to a significant increase in tax collection. In the Democratic Republic of the Congo, Balan et al. (2022) show that outsourcing the property tax collection process to local chiefs also helps to alleviate information constraints and improves tax collection. Future work could focus on investigating additional ways that tax authorities can build relevant information for tax collection purposes when third-party reports are not available.

Administrative data is used in RCTs that are conducted in collaboration with tax authorities

The previous section described how administrative data can be used to gain descriptive but important insights into taxpayer behaviour. In this subsection, we describe how administrative tax data is used in randomised controlled trials (RCTs) to go beyond correlation and establish causal impacts of policy interventions[2].

In an RCT, the researcher creates random variation in the treatment variable. Because the assignment to treatment is random (in practice, this has to be verified), the treatment group and the control group should be identical apart from the receipt of the treatment.

2 This subsection is strongly inspired by Pomeranz 2017.

This comparability implies that any difference in an outcome of interest observed after the RCT is implemented can be causally attributed to the treatment. As such, RCTs are considered the 'gold standard' empirical methodology in the quest to establish causal relationships.

The causality of an estimated empirical relationship is naturally crucial for the policy-relevance of the research. Due in part to this strong policy relevance, RCTs have seen an enormous rise in usage in many areas of development economics research. In the taxation context, the implementation of an RCT requires a strong collaboration with the tax authority. This is both because administrative data is often used to measure the impacts, but also because the implementation of the treatment intervention is either done entirely by agents inside the tax authority or in strong collaboration with them.

Studying the impact of communication strategies

As an early and important example of the value of RCTs in collaboration with tax authorities, Pomeranz (2015) studies VAT non-compliance in Chile; prior to Pomeranz's work, evidence based on RCTs was very limited in developing countries. The author implemented two large-scale experiments, which shed light on the enforcement mechanisms that underpin the relative collection success of the VAT. Since the VAT was already in place in Chile, Pomeranz made indirect use of randomisation designing interventions that interacted with existing policies to test the underlying enforcement mechanisms.

In a first intervention, Pomeranz and the tax authority sent letters to over 100,000 randomly selected firms, which informed them that they had been randomly selected for special inspection and that they might be audited. Studying the impact of receiving this letter, Pomeranz finds a sharp increase in the reported sales to final consumers, but no noticeable change to reported sales to other firms or input costs. This result indirectly shows that when a paper trail is present, as in the case of firm-to-firm transactions, increased audits have less of an effect. In turn, this result suggests that firms were evading more on the transactions that did not generate a paper trail (firm-to-consumer) than those that did (firm-to-firm).

In a second intervention, the research-policy team identified 5,600 firms suspected of evading; after randomisation, half of these firms were sent notifications that they would be subject to an audit in the near future. This intervention led to increased tax payments of the firm that received the notification, as well as by the suppliers of the directly-notified firms. The interpretation is that, upon knowing about the upcoming audit, firms began demanding receipts from their suppliers as proof of their input costs. This demand for a paper trail created incentives for the supplier to increase their own VAT payments, in order to avoid penalties and fees for tax evasion. This second result highlights the self-enforcing mechanism embedded in the VAT, as clients and suppliers have individual incentives to create paper trails on individual transactions that in turn improve

compliance. These RCTs were the outcome of a multi-year collaboration with the Chilean tax authority, highlighting the value of sustained interactions with practitioners to generate evidence-based policy insights.

Since the RCT implemented in Chile, a growing number of researchers have implemented other experiments in collaboration with tax authorities around the world. A significant share of these projects study how communication strategies by the tax authority can impact tax compliance. One of the first letter/message experiments was conducted in collaboration with the Minnesota Department of Revenue in the early 1990s (Coleman 1996; Blumenthal, Christian, and Slemrod 2001). Extensive review of the message experiments in developed and developing countries are provided in Hallsworth (2014), Mascagni (2017) and Slemrod (2019).

Letter experiments usually involve either deterrence messages (meant to increase the perceived enforcement capacity and costs of non-compliance) or tax morale messages (meant to stimulate a taxpayer's non-pecuniary willingness to comply). Some experiments combine both types of messages. In general, deterrence experiments have a positive effect on tax compliance, though there are exceptions. For example, in Rwanda, Mascagni and Nell (2022) find that deterrence backfires and worsens compliance. Relatedly, Krause (2020) finds that a letter which reminds taxpayers of the deadline for payment similarly backfires and increases non-compliance.

More work is required to understand the mechanisms through which deterrence messages have unintended consequences. One possibility, discussed in Benabou and Tirole (2011), is that extrinsic motives for tax payment can crowd-out intrinsic motives to comply, and this crowding out is likely to be larger in settings, such as Rwanda and Haiti, where non-compliance is widespread at baseline.

The results from letter experiments with appeals to tax morale are mixed. Here, more work is required to investigate the possibility that average null effects are driven by significant heterogeneity across taxpayers that differ in tax morale; alternatively, tax morale messages may be perceived as 'artificial' by taxpayers, especially in contexts where trust in government and governance integrity is perceived to be low. For an in-depth discussion of these topics, see the review paper on State Building (Jensen and Weigel 2022).

Varying enforcement and incentives

A smaller set of studies have collaborated with the tax authority to randomise enforcement and statutory tax policies. Pomeranz (2015) randomly varied the audit likelihood; Kleven et al. (2011) also randomised the audit probability in a sample of Danish taxpayers. These papers find that increasing the audit likelihood leads to improved tax compliance — primarily on the income-sources that are not subject to third-party coverage.

In a study implemented in the Democratic Republic of the Congo with the regional tax authority of Kananga, Bergeron, Tourek, and Weigel (2021) randomly vary the tax rate property owners face on their local property tax. The authors find that reducing the tax rate leads to net revenue gains — suggesting the initial property tax rate was above the revenue-maximising Laffer point. Moreover, this study was able to cross-randomise enforcement. By randomising both the rate and enforcement, the authors can investigate whether these two types of policies are complements or substitutes: they find that with higher enforcement, the Laffer-rate that can be implemented is higher. These RCTs provide robust, causal evidence on the effectiveness of policy tools that are used in every tax authority around the world.

Recent papers have also begun to randomise other dimensions of tax administrations. In a set of two papers, Khan, Khwaja, and Olken (2016; 2019) collaborate with the tax authority in the state of Punjab in Pakistan. Their interventions focus on incentives provided to the tax collectors that work in the field to collect local tax payments. In a first experiment, they randomise the financial incentives provided to tax collectors by introducing performance pay. In a second experiment, the authors randomise the availability of postings which transfer collectors between government offices in the region. The authors find that both sets of incentives improve tax collection.

Importantly, by conducting several experiments with the same tax authority (and therefore in the same setting, with the same collectors), the authors can make transparent and insightful comparisons of effectiveness between these incentive policies. The authors find that the posting-scheme generated additional tax revenue that was between two-thirds and equal in magnitude to the collection achieved under performance pay; however, the posting-scheme was virtually costless to the tax authority, while a substantial portion of the taxes collected had to be paid out to the collectors in the form of higher wages under the performance-pay scheme.

A recent study in Kananga in the Democratic Republic of Congo (Bergeron et al. 2021) randomly assigned collectors to work in groups; the authors find evidence of group-level complementarities, in the sense that the tax collection achieved per collector by a team of two high-quality collectors is larger than twice the collection achieved by a team with one high-quality collector and one low-quality collector.

Testing the use of technology

Finally, recent papers have also randomised the use of technology inside tax administrations. Okunogbe and Pouliquen (2022) collaborate with the tax authority in Tajikistan to randomly provide a subset of taxpayers in-depth training and support to use electronic filing (e-filing). E-filing may reduce compliance costs for taxpayers and decrease bribes and collusion due to the reduction of in-person interactions with tax officials. The authors find that technology indeed does substantially reduce compliance costs (15% reduction in total time spent on tax-related activities), but that the impacts on tax

payment are heterogeneous depending on the firm's initial likelihood of evasion. In collaboration with local tax authorities in Ghana, Dzansi et al. (2022) randomise the presence of an electronic tablet at the collector level. The tablet uses geospatial data and navigational tools that make locating property owners easier. The authors find that technology leads to a 27% increase in the number of property tax bills that are delivered during a tax campaign and to 103% increase in taxes collected.

In conclusion, the use of RCTs in combination with tax administrative data is increasing in developing countries. RCTs have moved from randomising letter messages to more ambitious designs that experimentally vary other dimensions of tax administrations and tax policies (including tax and audit rates, personnel, and use of technology).

For the purposes of generating evidence-based tax policy design, the increased usage of RCTs is welcome for at least two reasons. First, when properly implemented, RCTs can estimate causal effects; what's more, when the effects are estimated using administrative datasets with large sample-sizes, these causal estimates can often be obtained with great precision. This is to the benefit of practitioners who can make robust and informed decisions about policy design. In fact, recent work from Brazilian municipalities shows that policymakers do value statistical precision of research and are likely to make actual policy-changes when presented with high-quality research evidence (Hjort et al. 2021). Going forward, the sustained usage of RCTs combined with administrative data is thus likely to strengthen the ties between policymakers and researchers.

Second, conducting an RCT with a tax authority requires the researcher to build a collaboration with practitioners. These collaborations, which can often be long-term over several years, are often the source of new and insightful questions that emerge from the exchange of ideas between practitioners and researchers (Pomeranz and Vila-Belda 2019).

Bunching

Empirical work in public finance has seen a recent surge in the use of bunching approaches[3]. As will become clear in this section, the emergence of bunching methods is intimately related to the increased use of administrative data. The bunching approach leverages the fact that some policies feature discontinuities in incentives at certain points. In the bunching approach, the researcher focuses on observing sharp behavioural responses around those points, which helps to both establish actual policy responsiveness and to estimate parameters which govern optimal policy design (such as the elasticity of taxable income). The approach was initially designed to estimate behavioural responses to the tax and transfer system, but the ubiquity of points

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3 This section follows closely the 2016 review paper by Kleven. A simpler exposition can be found in this blog post.

which create discontinuities in incentives has made bunching a popular empirical tool in many non-taxation areas.

To illustrate the bunching approach, let us consider a study by Kleven and Waseem (2013). The authors use the universe of individual income tax returns in Pakistan, and study taxpayer responses to changes in the tax rate. Importantly, there are two forms of discontinuities: a kink is a discrete change in the slope of the choice set; a notch is a change in the level of choice sets. In the taxation context, a kink occurs when there is a discontinuity in the marginal tax rate, while a notch occurs when there is a discontinuity in the average tax rate.

While many progressive income tax systems around the world feature kinks, the income tax in Pakistan is based on notches: at specified threshold levels, the *entire* taxable income becomes subject to a higher tax rate. These notches create large discontinuities in the tax incentives faced by taxpayers on either side of the threshold where the rate changes. Taxpayers that would otherwise have taxable income above the threshold are incentivised to reduce their taxable income in order to locate below the threshold. This behaviour should create 'bunching' in the frequency distribution of reported taxable income: we expect to see an abnormally large number of taxpayers reporting income just below the threshold, and an abnormally low number of taxpayers reporting income just above the threshold [4]. An excess number of taxpayers just below the threshold constitutes evidence on the existence of taxpayer responses to the change in tax rates. The next page shows the actual bunching in Pakistan's case, and describes how the bunching mass can be used to derive an elasticity of taxable income.

Due to the local nature of the bunching response — moving between specific points of taxable income in a narrow range — the bunching approach requires large datasets with minimal measurement error.

As such, the emergence of bunching approaches is closely related to the use of administrative datasets. Researchers often struggle to find sharp and graphically compelling evidence on bunching in survey data, possibly due to small sample sizes and measurement error (which derives from the self-reported amounts). In contrast, with access to large administrative data, simply plotting the raw frequency distribution of taxable income can often reveal bunching and offer *prima facie* evidence on a causal effect of the tax rate change[5]. One of the advantages of the bunching approach is exactly its ability to offer transparent yet compelling graphical evidence, which can be easily conveyed to policymakers and disseminated.

4 What is considered abnormal can best be thought of as the visual difference between the actual number of taxpayers below the threshold and the number of taxpayers that would be predicted based on a (high-order) polynomial that is fitted to the entire distribution of taxable income.
5 As discussed below, the combined existence of bunching in administrative data and absence of bunching in survey data could be consistent with a mechanism where bunching in the administrative data is primarily due to evasion motives.

Empirical and counterfactual distributions around notches: Self-employed individuals (non-rounder sample)

B   Next four notches

E   Notch at 500 k

$b = 5.52(0.38)$
$a^* = 0.51(0.02)$
$z_U = 540.0(9.9)$
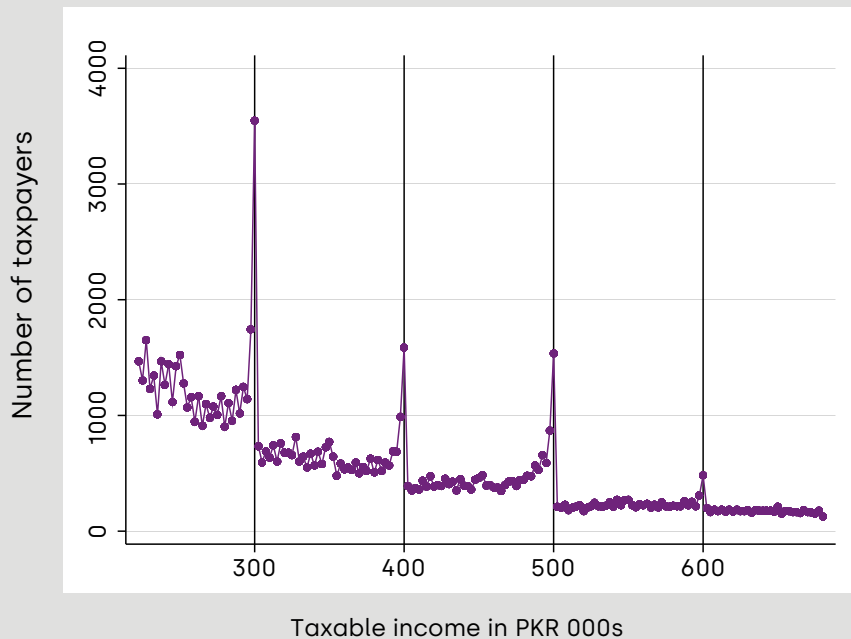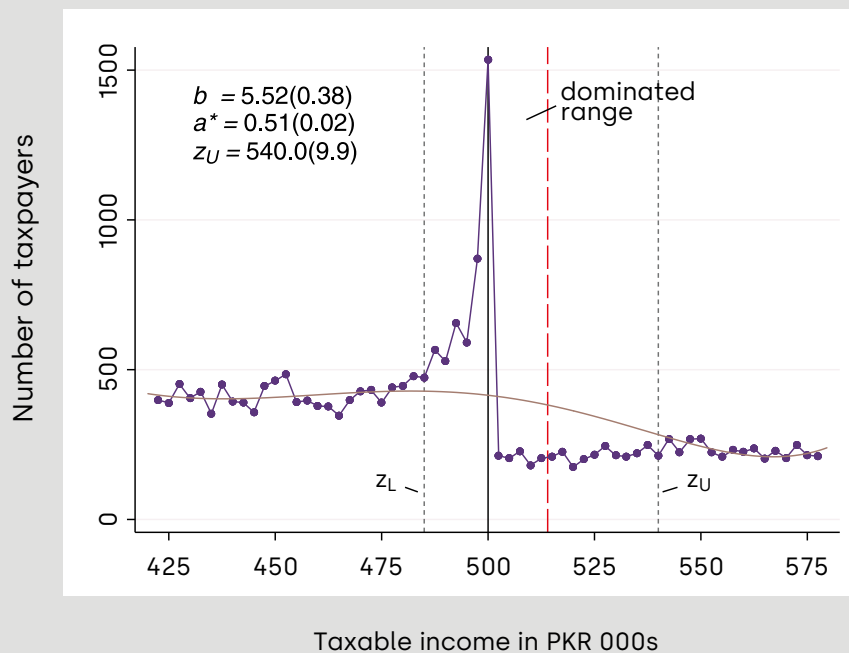
The figure shows the empirical distribution of taxable income (dotted graph) and the counterfactual distribution (solid graph) for self-employed individuals (non-rounder sample) from 2006 to 2009. The counterfactual is estimated for each notch separately by fitting a fifth-order polynomial to the empirical distribution, excluding data around the notch, as specified in equation (13). Notch points are marked by vertical solid lines, upper bounds of dominated regions are marked by vertical long-dashed lines, and excluded ranges [zL, zU] are marked by vertical short-dashed lines. Bunching b is excess mass in the excluded range below the notch (in proportion to the average counterfactual frequency in the dominated range), a* is the share of individuals in the dominated range who are unresponsive, and the upper bound of the excluded range zU has been estimated to ensure that missing mass equals bunching mass. Standard errors are shown in parentheses.

Kink analysis

a Budget set diagram

Type n^*

Type $n + \Delta n^*$ (marginal buncher)

Slope $1 - t - \Delta t$

Convex kink

Slope $1 - t$

Consumption $z - T(z)$

z^* $z^* + \Delta z^*$ Earnings z

b Density distribution diagram

Bunching

Density

Prekink density

Bunching mass

Postkink density

z^* $z^* + \Delta z^*$ Earnings z
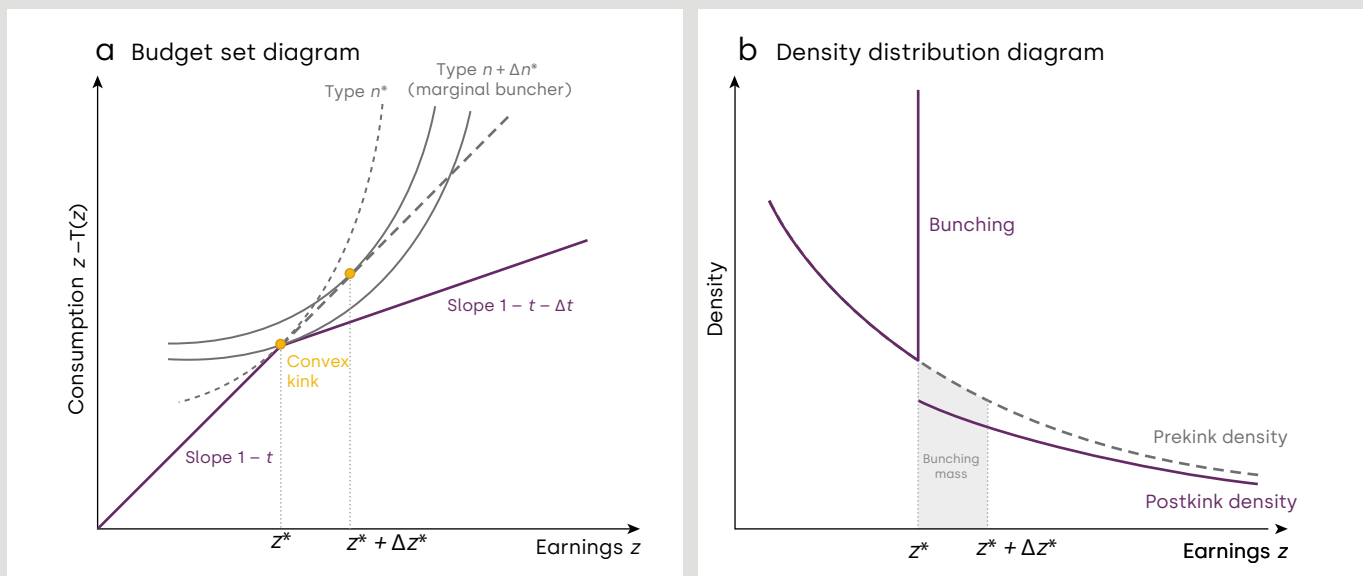
Kink analysis, showing the effects of a convex kink—a discrete increase in the marginal tax rate from t to $t + \Delta t$ at the earnings threshold z^*—in a (*a*) budget set diagram and (*b*) density diagram. In panel *a*, the individual with ability $n^* + \Delta n^*$ is the marginal bunching individual. This individual chooes $z^* + \Delta z^*$ before the kink is introduced and z^* after the kink is introduced. All workers initially located on the interval (z^*, $z^* + \Delta z^*$) bunch at the kink, whereas all those initially located above $z^* + \Delta z^*$ reduce earnings within the interior of the upper bracket. As shown in panel *b*, the implications of these responses for the earnings distribution are sharp bunching at z^* (the size of which is equal to the *gray shaded area* just above z^*) and a left shift of the distribution in the upper bracket.

Notch analysis

a Budget set diagram

Type n^*

Type $n + \Delta n^*$ (marginal buncher)

Slope $1 - t$

Slope $1 - t - \Delta t$

Notch $\cdot z^* \Delta t$

Dominated region

Consumption $z - T(z)$

z^* $z^* + \Delta z^D$ z^I $z^* + \Delta z^*$ Earnings z

b Density distribution diagram: homogenous elasticities

Bunching

Dominated region

Density

Prenotch density

Bunching mass

Postnotch density

z^* $z^* + \Delta z^D$ z^I $z^* + \Delta z^*$ Earnings z
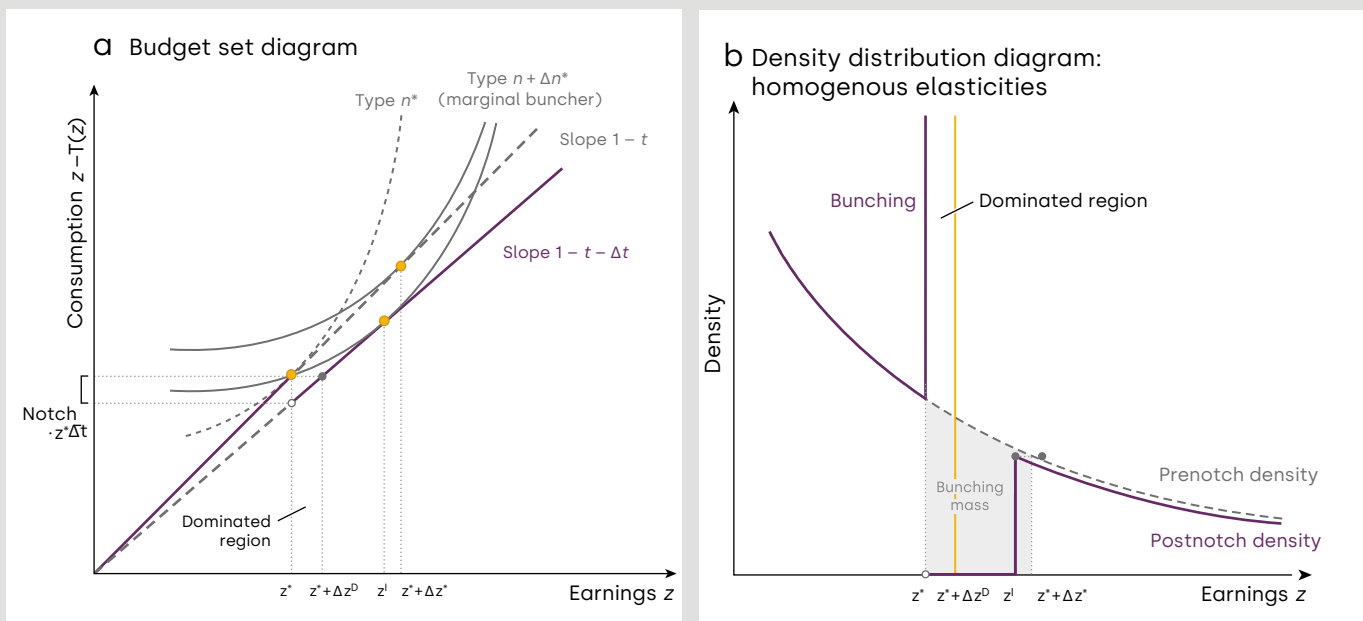
Notch analysis, showing the effects of a notch—a discrete increase in the average tax rate from t to $t + \Delta t$ at the earnings threshold z^*—in (*a*) a budget set diagram and (*b,c*) density distribution diagrams. In panel *a*, the individual with ability $n^* + \Delta n^*$ is the marginal bunching individual. This individual chooses $z^* + \Delta z^*$ before the notch is introduced, and is indifferent between the threshold z^* and the best interior location z_I after the notch. All workers initially located on (z^*, $z^* + \Delta z^*$) bunch at the notch, whereas all those initially located above $z^* + \Delta z^*$ reduce earnings marginally within the interior of the upper bracket. Panel *a* is drawn for a specific elasticity e > 0, and panel *b* shows the corresponding postnotch density distribution, which features sharp bunching at z^* (the size of which is equal to the *gray shaded area* just above z^*) and an empty hole between z^* and z_I.

Understanding the effect tax rate discontinuities through bunching

Bunching approaches have been used in several tax policy settings that are relevant for developing countries. A set of papers, including Kleven and Waseem, studied behavioural responses to tax rate changes. These papers find that, when evasion and avoidance responses are feasible, they likely drive most of the bunching observed (with such behaviour being graphically evident).

For example, Kleven et al. (2011) estimate the importance of the evasion channel, by comparing the extent of bunching of self-employed around rate change thresholds before versus after being exposed to an audit. Consistent with evasion being a primary channel through which self-employed persons are able to report taxable income below the threshold, the authors find that the extent of bunching decreases after the taxpayer has been subject to audits.

Relatedly, Kleven and Waseem (2013) find that bunching in the income tax in Pakistan is much more prevalent for self-employed persons than for employees. This heterogeneity in bunching is also consistent with the interpretation that evasion leads to large bunching responses, because employees are subject to more extensive third-party coverage than self-employed and have less opportunities to misreport their taxable income to the tax authority. Similarly, Fack and Landais (2016) show that the magnitude of bunching responses on deductions for charitable contributions in France are heterogeneous depending on third-party reporting.

Understanding the effect of enforcement and auditing through bunching

While the papers discussed above focus on tax rate discontinuities, other papers have used the bunching approach to study different discontinuities in the tax system. One set of papers focus on discrete changes in tax enforcement. Almunia and Lopez-Rodriguez (2014) study an enforcement notch created by the existence of a large taxpayer unit in Spain. Firms become enrolled in the large taxpayer unit if they have sales above a certain threshold level. In the large taxpayer unit, considerable resources are devoted to enforcement, thus creating a notch in the enforcement intensity on either side of the eligibility threshold. The authors show that firms strategically reduce their sales to avoid being subject to increased enforcement. These responses are stronger in sectors where information coverage is more extensive, suggesting that enforcement and information coverage are complements.

In a randomised field experiment, Dwenger et al. (2016) introduce a notched audit rate and investigate impacts on actual tax payments made. A second set of papers focus on discrete changes in the tax base. Best et al. (2015) focus on a minimum tax scheme in Pakistan, where taxpayers are taxed either on profits or sales, depending on

which tax liability is larger. A lower rate applies to sales since the sales base is broader than the profit base. This minimum tax implicitly creates a threshold level of profits (as a percentage of sales) where the slope of the tax rate changes (that is, a kink). They find bunching at the kink, which additional analysis reveals is likely driven by evasion.

Bachas and Soto (2021) study the corporate income tax in Costa Rica, where the average profit tax rate changes discontinuously at certain threshold levels of sales. Thus, the determination of the tax rate is based on firms' sales, but the tax base is profits. The authors find sharp and large bunching to the left of these threshold level of sales, driven by the strong incentives to face lower tax rates. Similar to the other bunching studies reviewed here, the authors also find strong evidence that is consistent with evasion responses being the primary driver of bunching.

Limitations of bunching

Given the frequency of kinks and notches in tax and transfer systems, the use of the bunching method has become popular to measure taxpayers' responses. However, the method comes with several limitations, and can present challenges for interpretation. First, a set of papers have shown that the extent of bunching (and the resulting elasticity of taxable income) depends strongly on the size and saliency of the thresholds (Chetty et al. 2011). This is an undesirable feature of the design, if the research aim is to estimate stable and structural parameters.

Kleven and Waseem (2013) propose an explanation for the variation in extent of bunching: some taxpayers do not respond due to high friction or adjustment costs, and the elasticity measured is a short-term elasticity. With a notch, we can observe the share of taxpayers reporting a sub-optimal amount of revenue (because if they report revenue just above the threshold, it will lead to lower total revenue after taxes than if they reported just below). This share of non-optimising taxpayers provides an estimate of such friction costs: assuming that all these taxpayers would overcome the frictions in the long-term, one can go from the short to the long-run elasticity. However, the assumption that friction costs can be overcome in the long-term might not be valid, and it will depend on the micro-level explanation for the lack of (information, variability in revenue, norms and reference-dependence). This is an important area for future research.

Another issue that arises with bunching is the precision of estimation. Compared to other methods, bunching is not as well defined "statistically". For example, while a model would predict that taxpayers bunch precisely at the notch, in practice the bunching mass is often more diffuse. In this case, what is the correct bunching window? The best practice for the exact estimation approach is an empirically open question that likely depends on the context. Clever bunching designs often impose additional restrictions to improve precision, either from the model (for example, without extensive

margin response, the excess mass below the notch is equal to the missing mass above the notch, thus allowing for data-driven selection of the window of manipulation), or from additional information (for example, a pre-period before the introduction of the kink or notch to observe the counterfactual).

In summary, bunching is one additional tool that policymakers and researchers can use to learn about taxpayer behaviour. It is particularly well-suited to tax administrative data since it requires large sample sizes to discern stable and precise behaviour. The design also requires sharp discontinuities in budget-sets, a frequent feature of tax systems. The resulting estimates should be extrapolated to other settings with caution, given adjustment frictions that might be specific to kinks and notches, and the very local nature of the estimate (that it is informative for taxpayers with revenue close to the kink). Nevertheless, bunching remains a powerful tool that can provide graphically compelling evidence on the existence of causal responses to tax policies.

3. Challenges in using administrative data and and best practices to overcome constraints

Use of administrative data is constrained by practical challenges

The previous sections presented the advantages of administrative tax data for tax policy analysis. Yet, working with administrative data is often challenging in practice. We discuss here some of the practical aspects of administrative data analysis, both in general and with specific country examples.

High-quality administrative data is both a key output and input of higher tax capacity. Data quality directly depends on investments in technological infrastructure and human capital: the adoption of e-filing, digital IDs, or EBM machines are key technological innovations which permit the creation of high-frequency data that is easy to employ for research purposes. In turn, well-managed administrative data becomes an input into other technologies: it can be used to pre-populate tax returns, develop risk-scoring via algorithmic methods, and now-cast economic activity. Thus, high-quality data is closely linked to technology adoption and management.

In an excellent review of technology and domestic revenue mobilisation, Okunogbe and Santoro (2021) list four key factors which limit the realisation of technology's potential to improve tax collection: unstable internet infrastructure, high adoption costs for users, limited organisational strategy within the tax administration, and a weak legal framework preventing the active use of technology.

The challenges described concern all types of technological innovations, and impact both the quality of the administrative data produced and its usefulness as a tool for policy analysis and compliance management. Users of administrative data in developing countries are thus often confronted with limitations as to what data they have access to and its quality. We highlight below some of the most frequently encountered issues.

Frequently encountered issues with administrative data in developing countries

Some data remains non-digitised: Self-reported tax returns are now filed electronically in most countries, but sometimes only cover large firms, or specific strategic tax offices, thus excluding a large segment of taxpayers. Administrative datasets which do not directly generate a tax liability can still be filed manually: for example, data on audit results, financial statements containing shareholder information, or data on taxpayers' characteristics (year of registration, address, sector of activity).

Different tax returns do not communicate with each other. This can be either because different digital IDs are being used, or because multiple IT systems co-exist in different tax offices. Merging datasets might thus require coordination with different tax offices and agencies (for example, customs versus tax) and consider that some data might only be stored very locally (for example, in Excel sheets at the place where the tax return was filed).

Identifying all existing data sources can be challenging. Even experts of the administration sometimes ignore the existence of data stored into the system, or are unable to understand how it is produced. This often arises in the case of data that does not directly generate a tax liability, and exists for informational purposes.

Tax declaration templates can be incomplete, loose, and unclear. This can arise when there is no automatic verification of the values entered into the system, or no built-in relation across variables; for example, profits might not equal revenue minus costs. Further, some templates can be outdated, no longer corresponding with the current legislation. Working with such data requires identifying which variables are trustworthy (often those that directly generate a tax liability) and cleaning that must be undertaken to make the data usable.

Taxpayer characteristics are inconsistent. Categorical variables are not always stored consistently. This can be the case for example for data on economic sectors, legal status, addresses, etc.

External validity and macroeconomic projections. The sum of values in micro datasets does not always correspond to the macroeconomic statistic. This is often the case, given the skewed distribution of revenue and the outsized role played by a few large taxpayers. Thus, any issues with data harmonisation or deferred payments could produce different aggregates at the micro level compared to government statistics.

Governments can set up dedicated units to maximise the potential of administrative data

Investment in data analytics capacity-building at tax authorities are complementary to investments in IT systems, and have the potential to impact not only domestic revenue mobilisation but also to improve economic policymaking. National tax authorities have invested heavily in information technology (IT) systems that allow for better registration of taxpayers, processing of electronic tax filings, and aggregating information reported by third parties, among others. The vast amounts of data generated by these systems, however, are often not user-friendly and not exploited to their full potential due to lack of capacity.

A potential solution is to establish and strengthen data labs and tax policy units within the tax authority. These units are dedicated to obtaining, cleaning, and analysing the vast amounts of micro-data generated or potentially available with various authorities. Such units already exist in several high-income countries (for example, The Research, Applied Analytics, and Statistics (RAAS) division at the US Internal Revenue Service and the Knowledge; Analysis and Intelligence group at the UK Her Majesty's Revenue and Customs.)

Given challenges with technology adoption, coordination, and data quality, a key role of data-labs is precisely to advise colleagues in IT and field offices on how to generate high-quality data and adopt best practices to minimise taxpayers' compliance costs, and ensure that data are encoded in a consistent manner. Mutual feedback between the data users (tax policy units, tax auditors) and the data generators (IT departments, tax offices) is critical to rationalise the need and quality for detailed taxpayer information.

Once the data is generated, data labs are responsible for merging datasets and obtaining a complete picture of taxpayers' economic activity and history. Data merges should be done with digital IDs; when those are missing, data matching techniques based on observable information can be used. When needed, data labs analysts can also digitise paper-filed data and data in non organised digital formats (for example, Excel spreadsheet) by using recent techniques in automatic text detection and reading.

The role of the data lab is to produce user-friendly final datasets which are harmonised, contain only the needed information for each use case, and have been de-identified. These resulting datasets can then be used for budget projections, tax policy analysis, and economic predictions, as discussed in the previous sections. To maximise taxpayers' privacy, adding noise to variables for specific taxpayers (for example, very large firms) could be considered, especially when the purpose is for research.

A key role for tax policy and intelligence units is also to produce linked datasets — which contain both self-reported and third-party reported data — to monitor tax compliance. Data labs can use such data to cross-check sources and automatically produce letters to notify taxpayers of discrepancies (for example, Brockmeyer et al. 2019), apply machine learning and algorithmic techniques to evaluate the risk of tax evasion, or produce risk flags leading to further investigations by tax auditors. These datasets can then be augmented with further information (for example, arm's length prices for multinationals' transfer pricing, data leaks for wealthy individuals linked to tax havens).

We discuss below two concrete examples of countries setting up new data labs and tax policy units, respectively in Senegal and Honduras. Almunia et al (2019) provide two further examples from data labs at tax administrations in rich countries, namely Finland and the UK.

The examples of Honduras and Senegal highlight recent efforts to set up data labs and tax policy units. Strengthening the capacity and legitimacy of these structures within the tax administration is key to improve administrative data quality and tax policy analysis. The experiences of these two countries also shows that data labs and tax policy units are natural partners for multilateral institutions, civil society, and the academic community. A fruitful manner to collaborate is for any external researcher to partner with an analyst within the tax policy unit. This two-way exchange permits capacity-building for statistical and economic analysis; improves researchers' understanding of the data, tax code and practices; and empowers the policy units.

Data labs allow for statistical codes to be shared within the research team without exchanging sensitive data, which remains on the administration's secured server. Any shared output or meta-data can be first verified such that it does not violate taxpayers' anonymity. A well organised unit then produces a set of guidelines and notes, and shares findings across the different research projects, thereby building capacity and institutional memory. Pomeranz and Vila-Belda (2019,) provide excellent suggestions for how to collaborate with tax administrations while retaining academic independence[6].

South Africa, Johannesburg, O. R. Tambo International Airport. Photo by Jeffrey Greenberg/ Universal Images Group via Getty Images.

6 See section 5 of the paper.
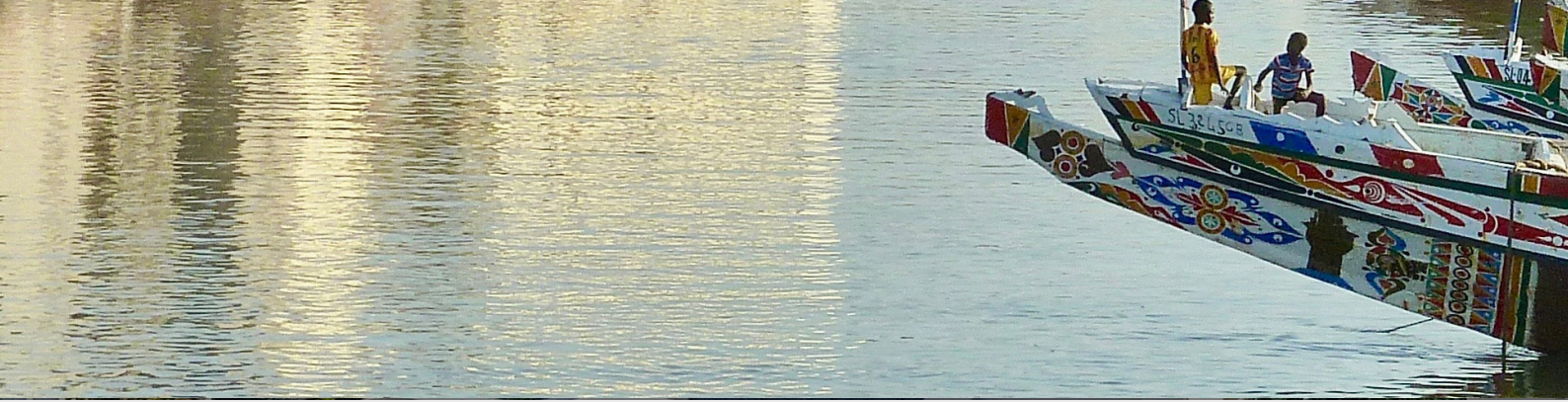
Senegal tax data lab

Since 2015, the Senegalese tax administration (DGID) has been collaborating with researchers on several projects to digitise data, improve audit selection, detect tax evasion by firms, and enforce property tax. All projects relied on administrative data, and faced similar difficulties to find, access, clean, and use the data. As data needs developed, it became apparent that the administration lacked the human resources to exploit administrative data at a large scale, and that this in turn impacted the quality of the information it routinely collects.

Each project initially worked with different tax offices and segments of the taxpayer population (for example, property owners, firms, self-employed), and helped improve parts of the information system by contributing to the conception of tailor-made technological products. For example, an app to register properties in the cadaster, a web app enabling taxpayers to file online a subset of tax statements, algorithms to cross check tax declarations and select firms for audits, etc. The tangible improvements brought by these initiatives convinced the administration of the need to systematise data processing and hire trained data scientists.

Since March 2021, the ad-hoc set of collaborations has been reinforced and institutionalised with the creation of a data lab within the administration. This unit is hosted by the intelligence directorate, where all information collected by the administration converges; it is a dedicated office and currently employs six data scientists. All codes and outputs produced by data scientists and researchers are stored in a common, fully encrypted, data location, allowing everybody to benefit from each other's work. Meta-information about each data source (content, producer, quality etc.) as well as synthetic notes about key fiscal rules are produced collectively. The data lab has also developed a standardised set of practices to digitise manually-filed information, and to deal with non-standard formats of electronic data (for example, ad-hoc Excel spreadsheets).

On the tax policy analysis side, this organisation allows economies of scale for different projects to access and use data. It also considerably reinforces the administration's ability to benefit from research projects, by offering an avenue to transfer knowledge and institutionalise best practices beyond the finite duration of the projects.

In under a year, the data lab has contributed to improve information use in many respects:

- It produced a comprehensive guide to navigate the complex information environment and suggested improvements which were relay to the IT departments and local tax offices.

- It designed a new tool to help fiscal centres better manage their tax registry.

- It revealed data anomalies (missing, implausible or inconsistent values) for which data checking solutions will progressively be implemented.

- It increased the administration's capacity to analyse and cross-check tax declarations and consequently detect non-compliant behaviours at a large scale.

- Data scientists and staff of the intelligence unit share their progress in a weekly meeting where advances and challenges are discussed, sometimes joined by external researchers.

Currently the data lab at DGID is partly funded via research projects. Thus, the unit is temporary, and should be considered as a proof of concept. If it can demonstrate what can be done with data when adequate resources are invested, the administration may choose to fully institutionalise and fund the data lab in the future. Achieving this objective will require, in addition to high-quality data analysis, that the tax administration offers good incentives to hire and retain talented data analysts, and a consideration on the strategic role and evolution of such a structure.

For a longer treatment of the DGID data-lab see (Czajka et al 2022).

Country experiences

Honduras intelligence and fiscal studies departments at SAR

In 2015, the Inter-American Development Bank painted a bleak picture of the revenue mobilisation capacity in Honduras, stating that the main challenge to increase tax collection was the institutional, operational and organisational weaknesses of DEI[7], the Tax Authority. It noted that the taxpayer registry was obsolete, IT systems were insecure and outdated, and that personnel was underpaid and lacking in training. Supported by multilateral institutions, the Government of Honduras extinguished DEI in 2016 and replaced it with the Revenue Administration Service (SAR).

This was far from a simple change of names: the size of the Tax Authority was substantially reduced, including the firing of approximately 1,500 workers and the re-hiring of some of the workforce with support from an international HR company. Since then, SAR has modernised its operations and improved its operational management, including the introduction of a new billing regime and the adoption of technologies for data processing.

An important institutional feature of the new tax authority was the strengthening of the Intelligence department and the creation of the Fiscal Studies department. These are the two areas at SAR directly involved in processing the vast amounts of data available to the Tax Authority, and in producing analytical pieces that inform decision making by other units. The Intelligence department is responsible for creating and managing the risk model that informs a host of interventions by SAR (from electronic communications, to taxpayers, to in-person audits). The Fiscal Studies group, among other tasks, produces data-driven evidence to inform the legal department about

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7 Dirección Ejecutiva de Ingresos, in Spanish

possible effects of tax reforms, and engages with the Central Bank and the Ministry of Finance and Customs on revenue projections.

Given the substantial improvements in its IT systems, the wealth of available data, and the hiring of qualified economists and analysts, SAR is investing in improving its capacity to generate data-driven policy insights. It is introducing experimental methods in its operations to evaluate the impact of policy interventions (such as communication with taxpayers) on compliance. It also uses modern non-experimental methods to understand how taxpayers respond to tax policies, such as how corporations respond to a minimum tax policy, or how individuals respond to changes in marginal tax rates.

SAR is also aware that tax data can inform broader economic policy, and is often the best high-frequency data available on firms and the economy. The Fiscal Studies department produces monthly and quarterly reports on economic activity using VAT data and investigations on topics such as the impact of COVID-19 on firms and income inequality, and organises a yearly conference. Several of these initiatives are being pursued in partnership with academics and international organisations.

In summary, data labs and policy units are increasingly being implemented in developing countries, and can serve three key functions:

1. To coordinate and advise other divisions of the administration on how to produce high-quality and user-friendly administrative data, while minimising the compliance costs of taxpayers.
2. By cross-checking and harmonising tax data to develop a set of tools used to detect non-compliance.
3. To use harmonised and anonymised administrative data to conduct tax policy analysis and inform policymaking.

Conclusion

This review paper has highlighted the increased importance and availability of administrative tax data, the set of microeconomic datasets that governments create through the administration of their tax and transfer programmes. It outlined the general value of administrative data for evidence-based policy design, reviewed the main methodologies in public finance which use administrative data, and discussed best practices and challenges with managing administrative data. It also highlighted experiences with setting up dedicated data labs and policy units within the tax administration to improve data quality, tax policy analysis, and compliance management. These units are then the natural points of entry to create policy-research engagements between external researchers and tax administrations.

Since an increased quantity of data is being generated in a digitised format, we expect administrative data work to continue to expand. This will provide tremendous opportunities to deepen the knowledge of tax policy analysis — and beyond, for example, by being able to now-cast economic activity and more rapidly respond to crises. However, this administrative data revolution comes with several challenges. First, the availability and quality of the data is still limited in many developing countries, which will need investment in both technological infrastructure and human capital to best exploit and manage these data. Second, even improved administrative data will continue to contain several blind spots, for example, the informal sector and illicit activity. Data analysts will engage in a cat and mouse game: as data expands, new manners to hide economic activity will emerge. Finally, issues of data security, confidentiality, and ethics around the collection of large quantity of data, potentially tracking most citizens' activity, will need to be taken very seriously to prevent abuses (Pomeranz 2017).

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Annex 1: Figure 1 list of papers

Country	Papers
Argentina	Alvaredo, F. (2010). The rich in Argentina over the twentieth century, 19322004. Atkinson A., Piketty T. and Saez E. *Top incomes: A Global Perspective*. Oxford, Oxford University
Armenia	Asatryan, Z., & Peichl, A. (2016). Responses of Firms to Tax, Administrative and Accounting Rules: Evidence from Armenia. Proceedings. *Annual Conference on Taxation and Minutes of the Annual Meeting of the National Tax Association*, 109, 1–30. https://www.jstor.org/stable/26816607
Australia	Burkhauser, R. V., Hahn, M. H., & Wilkins, R. (2018). Transitioning from an Historical to a Contemporary Use of Tax Record Data for Measuring Top Incomes in Australia. E*conomic Papers: A Journal of Applied Economics and Policy*, 37(2), 113–145. https://doi.org/10.1111/1759-3441.12209
Austria	Paetzold, J (2017). How do wage earners respond to a large kink? Evidence on earnings and deduction behavior from Austria, Working Papers in Economics, No. 2017-01, University of Salzburg, Department of Social Sciences and Economics, Salzburg
Bangladesh	Social Incentives and Tax Compliance in Bangladesh
Belgium	Buyl, P., Roggeman, A., & Verleyen, I. (2022). An Ex-Ante Assessment of the AGI: Firm-Level Evidence from Belgian Tax Return Data. *CESifo Economic Studies, Volume 68, Issue 1*, Pages 46–72, https://doi.org/10.1093/cesifo/ifab007
Bolivia	Lustig, N., Pessino, C., & Scott, J. (2014). The Impact of Taxes and Social Spending on Inequality and Poverty in Argentina, Bolivia, Brazil, Mexico, Peru, and Uruguay: Introduction to the Special Issue. Public Finance Review, 42(3), 287–303. https://doi.org/10.1177/1091142113506931
Brazil	Naritomi, J. (2019). Consumers as Tax Auditors. *American Economic Review*, 109 (9): 3031-72.
Burundi	Ndoricimpa, A. (2021). Tax reforms, civil conflicts and tax revenue performance in Burundi. *Scientific African, Volume 13*, e00927, ISSN 2468-2276, https://doi.org/10.1016/j.sciaf.2021.e00927.
Canada	Messacar, D. (2017). Big tax data and economic analysis: effects of personal income tax reassessments and delayed tax filing. *Can Public Policy* 43(3):261–283
Chile	Flores, I., Sanhueza, C., Atria, J., and Mayer, R. (2020): Top Incomes in Chile: A Historical Perspective on Income Inequality, 1964–2017. *Review of Income and Wealth*, 66 (4), pp. 850–874.
China	Haichao Fan & Yu Liu & Nancy Qian & Jaya Wen (2018). "Computerizing VAT Invoices in China," *NBER Working Papers* 24414, National Bureau of Economic Research, Inc.
Colombia	Alvaredo, F., & Londoño Velez, J. (2014.). ALTOS INGRESOS E IMPUESTO DE RENTA EN COLOMBIA [Review of ALTOS INGRESOS E IMPUESTO DE RENTA EN COLOMBIA]. Revista de Economía Institucional, 16(31), 157–194. Retrieved August 3, 2022, from http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0124-59962014000200008&lng=en&tlng=.
Costa Rica	Brockmeyer, A., Smith, S., Hernandez, M., & Kettle, S. (2019). Casting a Wider Tax Net: Experimental Evidence from Costa Rica. *American Economic Journal: Economic Policy*, 11(3), 55–87. https://doi.org/10.1257/pol.20160589
Croatia	Bezeredi, S., Bratić, V., & Urban, I. (2022). Tax Burden on Labor Income in Croatia: Calculation and Analysis Based on Administrative Data. *Eastern European Economics*, 60(4), 305–329. https://doi.org/10.1080/00128775.2022.2065305
Denmark	Kreiner, C. T., Leth-Petersen, S., & Skov, P. E. (2017). Pension saving responses to anticipated tax changes: Evidence from monthly pension contribution records. Economics Letters, 150, 104–107. https://doi.org/10.1016/j.econlet.2016.11.011
Dominican Republic	Azuero, R., Bosch, M., Cardoza, M., & Sanchez, D. (2019). Productivity, Misallocation, and Special Tax Regimes in the Dominican Republic. https://doi.org/10.18235/0001888
DR Congo	Weigel, J. L. (2020). The Participation Dividend of Taxation: How Citizens in Congo Engage More with the State When it Tries to Tax Them*. *The Quarterly Journal of Economics*. https://doi.org/10.1093/qje/qjaa019
Ecuador	Carrillo, P., Pomeranz, D., & Singhal, M. (2017). Dodging the Taxman: Firm Misreporting and Limits to Tax Enforcement. American Economic Journal: Applied Economics, 9(2), 144–164. https://doi.org/10.1257/app.20140495
Estonia	Paulus, A. (2015). Tax evasion and measurement error: An econometric analysis of survey data linked with tax records, *ISER Working Paper Series 2015-10*, Institute for Social and Economic Research.

Country	Papers
Eswatini	Santoro, F. (2021). To file or not to file? Another dimension of tax compliance - the Eswatini Taxpayers' survey. Journal of Behavioral and Experimental Economics, 95, 101760. https://doi.org/10.1016/j.socec.2021.101760
Ethiopia	Mascagni, G., Mengistu, A. T., & Woldeyes, F. B. (2021). Can ICTs increase tax compliance? Evidence on taxpayer responses to technological innovation in Ethiopia. *Journal of Economic Behavior & Organization, 189*, 172–193. https://doi.org/10.1016/j.jebo.2021.06.007
Finland	Harju, J., Matikka, T., & Rauhanen, T. (2019). Compliance costs vs. tax incentives: Why do entrepreneurs respond to size-based regulations? *Journal of Public Economics, 173*, 139–164. https://doi.org/10.1016/j.jpubeco.2019.02.003
France	Garbinti, B., Goupille -Lebret, J., & Piketty, T. (2018). Income Inequality in France, 1900-2014: Evidence from Distributional National Accounts (DINA). *SSRN Electronic Journa*l. https://doi.org/10.2139/ssrn.3165058
Georgia	Bruhn, M., & Loeprick, J. (2014). Small Business Tax Policy, Informality, and Tax Evasion Evidence from Georgia. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.2500783
Germany	Schächtele, S. (2020), Tax Responses at Low Taxable Incomes: Evidence from Germany*. *Fiscal Studies, 41*: 411-439. https://doi.org/10.1111/1475-5890.12220
Ghana	Dzansi, J., Jensen, A., Lagakos, D., & Telli, H. (2022). Technology and Local State Capacity: Evidence from Ghana. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4080663
Greece	Saez, E., Matsaganis, M., & Tsakloglou, P. (2012). Earnings Determination and Taxes: Evidence From a Cohort-Based Payroll Tax Reform in Greece. *The Quarterly Journal of Economics, 127*(1), 493–533. https://doi.org/10.1093/qje/qjr052
Guatemala	Stewart, K., Marco, H., Simon, R., & Michael, S. (2016). Behavioral Interventions in Tax Compliance. *Policy Research Working Paper; 7690.* World Bank, Washington, DChttps://openknowledge.worldbank.org/handle/10986/24530
Haiti	Krause, B. (2020). *Balancing Purse and Peace: Tax Collection, Public Goods and Protests.* Working Paper
Honduras	Pineda Pinto, D. F., & Enamorado Irías, R. M. (2021). Taxpayer Bunching Evidence: Responsiveness at Kink Points of the Honduran Personal Income Tax. Studies of Applied Economics, 40(1). https://doi.org/10.25115/eea.v40i1.5598
Hong Kong	Chou, J. T., & Fu, C. H. (2021). Which Families Benefited from the Recent Personal Income Tax Reform in Taiwan: Evidence from the Administrative Data. Journal of family and economic issues, 1–19. Advance online publication. https://doi.org/10.1007/s10834-021-09785-1
Hungary	Benedek, D., & Lelkes, O. (2011). The Distributional Implications of Income Under-Reporting in Hungary. Fiscal Studies, 32(4), 539–560. http://www.jstor.org/stable/24440184
India	Gadenne, L., Nandi, T. K. & Rathelot, R. (2019). *Taxation and Supplier Networks : Evidence from India*, The Warwick Economics Research Paper Series (TWERPS) 1208, University of Warwick, Department of Economics.
Indonesia	Basri, M. C., Felix, M., Hanna, R., & Olken, B. A. (2021). Tax Administration versus Tax Rates: Evidence from Corporate Taxation in Indonesia. American Economic Review, 111(12), 3827–3871. https://doi.org/10.1257/aer.20201237
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