Government Analytics Using Administrative Case Data [*]

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Abstract

Measuring the performance of government agencies is notoriously hard due to the lack of comparable data. At the same time, governments around the world generate an immense amount of data that detail their day-to-day operations. In this chapter we focus on three functions of government that represent the bulk of their operations and that are fairly standardized: social security programs, public procurement, and tax collection. We discuss how public sector organizations can use existing administrative case data and re-purpose them to construct objective measures of performance. We argue that it is paramount to compare cases that are homogeneous or construct a metric that captures the complexity of the case. We also argue that the metrics of government performance should capture both the volumes of services provided as well as their quality. With these considerations in mind, case data can be at the core of a diagnostic system with the potential to transform the speed and quality of public service delivery.

[*] The findings and conclusions expressed are solely those of the authors and do not represent the views of the Italian Social Security Agency.

Lessons for Practice

- **Governments generate an immense amount of data that detail their day-to-day operations. These data can be re-purposed to measure the performance of government agencies.** Such data can provide objective comparisons of agency performance, allowing for an assessment of the quality of public administration across jurisdictions, regions, managers and time.

- **Such operational data provides objective records of bureaucratic performance.** It is important to construct objective measures of organizational performance and/or individual performance rather than only relying on subjective evaluations such as performance appraisals.

- A pre-requisite to construct a comprehensive measure of performance for a public organization consists in obtaining a record of all the tasks undertaken by the organization. This may be difficult in practice because government agencies undertake a wide range of tasks and they may not keep detailed records for all of them.

- **One area of government activity where records are objective measures of performance and frequently relatively comprehensive is that of case management.** Case management data are the records of response by public officials to requests for public service or the fulfilment of public responsibilities. This chapter argues for the use of administrative data on the processing of cases by public officials as a monitoring tool for government performance and as a core input to government analytics. Relevant measures should capture both the *volume* and *quality* of cases processed.

- **To construct an objective measure of performance using case data, one should ensure that cases are comparable to one another.** This could entail comparing cases only within a homogeneous category, or constructing a metric that captures the complexity of the case. For example, a social security claim that clearly meets the requirements of regulation and does not reference other data systems is a less complicated case to process than one in which there are ambiguities in eligibility and external validation is required. A corresponding metric of complexity might be based on the time spent on an 'average' case of that type, allowing for complexity to be defined by the actual performance of public officials.

1 Introduction

In order to implement government policy, the apparatus of the state generates a vast trove of administrative databases tracking the deliberations, actions and decisions of public officials in the execution of their duties. These data are collected in order to coordinate throughout a large, complex organization delivering a host of services to citizens, and to preserve records of how decisions are reached to provide accountability for decisions taken in the name of the public.

These data are not, typically, collected with the express purpose of measuring the performance of government officials, but as governments become more and more digitalized, these records contain ever richer details on the work that is carried out throughout government. This presents an opportunity to re-purpose existing data, and possibly extend its reach, to also achieve the goal of measuring performance. In turn, such data can then be used to motivate government officials, and hold them accountable. Ultimately, a greater ability to *measure* performance can help governments to *monitor* performance. This can improve efficiency in the public sector to deliver more and better services to citizens with the human and material resources the government has available.

Using administrative data has the distinct advantage that the data is already being collected for another purpose. As such, the additional costs of using it to measure performance are largely technical issues surrounding granting access to the data, protecting its confidentiality appropriately, and setting up the IT infrastructure to perform statistical analysis on the data. These are typically much simpler to overcome than the obstacles to launching new surveys of public officials or citizens to measure performance.

Set against that, the primary disadvantage of using administrative data to measure performance is that it was not designed to be used for that purpose. As a result, a great deal of careful thought and work must go into how to re-purpose the data for performance measurement. This involves thinking carefully about what the outputs being produced are, how to measure their quantity and quality, and how to operationalize them within the constraints of the available data. Sometimes, this requires collecting additional data (either through a survey or from external sources) and linking it to the administrative data.

A large share of government operations involve the processing of case files or cases. Case data are the records of response by public officials to requests for public service or the fulfilment of public responsibilities. A case file is typically a collection of records regarding an application. The nature of the applications varies widely. For one, thousands of claimants file applications every day to receive government services such as welfare transfers, access to government-sponsored childcare, or to obtain licences and permits. Public sector organizations around the world initiate auctions to purchase goods and services from private sector suppliers. And millions of citizens and firms all over the globe file taxes every year.

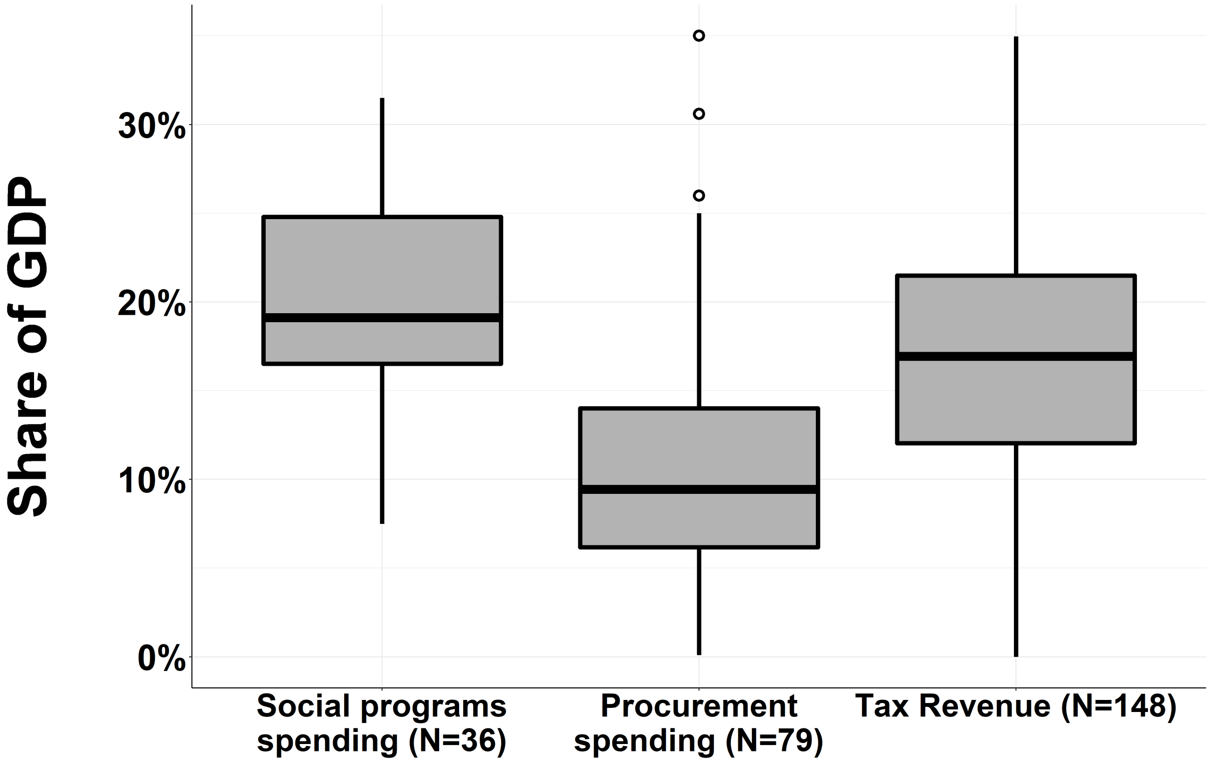
In this chapter, we highlight examples from recent academic work trying to develop new methods to measure performance using administrative data on the processing of government case work. The academic papers provide a window into how similar data from public administrations around the world can be repurposed for analytical purposes.

Our examples cover three important realms of government operations — the delivery of social programs, the collection of taxes, and the procurement of material inputs — that together span a large part of what modern governments do. Figure 1 shows that spending on social programs and procurement and tax revenues jointly amount to more than 30% of a country's GDP on average. While there is some variation in the size of social programming, procurement spending, and tax revenues, these three functions of government represents a large share of government operations in all countries.

Since all governments engage in these activities, exploring potential alternative uses of the data generated in the process is of broad interest. In addition, operations in these areas are usually fairly standardized, which tends to boost the quality of related data, which in turn can be used to generate more accurate insights. In all three cases we highlight the importance of carefully specifying the outputs that are to be measured before undertaking an analysis, and how to conceptualize the data quality.

We also provide some details on the technical methods used to operationalize these concepts and turn them into concrete performance measures, and on how these performance measures are then used in the academic arena. In the conclusion, we discuss how policymakers can use these types of measures in other ways as well as some important limitations to these approaches. The intention of our exposition of these cases is not to argue that the approach taken in the specific papers we overview is optimal for every setting, but rather to showcase a way to approach the analysis of government administrative case data.

Figure 1: Cross-country scale of the three sectors discussed in the chapter relative to national GDP



Notes: The box represents the interquartile range (IQR) - distance between 25th and 75th percentile in the distribution of each variable. The line in the middle of the box represent the median. Whiskers, i.e. the lines extending from the box represent values lying within 1.5 of IQR from the median. Outliers lying beyond that range are represented by dots, where one dot represents a country. Value of N shows the number of country-level observations in each column. Source: OECD (social programs spending), World Bank Development Indicators (tax revenue), World Bank Global Public Procurement Database (procurement spending)

2 Case Data in Administration

2.1 A General Structure for the Analysis of Case Data

Government case work involves a series of standardized elements, each of which can be associated with a measure of the performance of public administration. Case work typically revolves around a set of protocols - perhaps standardized forms that applicants must fill in to apply for social security payments - that makes common measures feasible. Cases are processed by government officials, again frequently in a relatively standardized way.[1] As such, measures of performance can judge how efficiently and effectively public officials worked through the relevant protocols.

Case data is therefore made up of the records of these cases and there processing, including the details of the application or case the characteristics that can be analyzed. For example, in electronic case management systems, time and date stamps record exactly when cases are submitted, acted upon by officials, and then resolved. As such, the speed of multiple stages of case processing can be easily calculated. Similarly, a decision is often made on the case and a response sent to the applicant, such as a confirmation to a taxpayer that they have paid their taxes.

To use the data on the processing of these cases to monitor and analyze government capabilities, we have to overcome two main challenges. Claims are frequently diverse in how challenging or 'complex' the associated case is. A case that involves a claim where a claimant clearly meets the required criteria is less complex than one in which eligibility is ambiguous on one or more margins. In some cases evaluating the claimant's eligibility may be fairly straightforward and may involve verifying the veracity of a few supporting documents provided by the applicant. In other cases it may require the officer to request access to a separate archive to pull the claimant's records.

Thus, first we have to construct a common measure of task complexity that allows us to compare claims of different types. Secondly, we must ensure that any such measure is not easy to manipulate by government staff and is as objective as possible. For example, to minimize the risk of manipulation of these types of metrics, the tracking of claims should be done by a centralized computer system. Allowing employees to self-report their output and log it onto a computer may leave room for opportunistic

[1] Many governments put effort into standardising case data to increase the capacity to undertake analytics. For example, a number of countries have introduced Standard Audit File-TAX (SAF-T) for all taxpayers, a protocol the data collected on each case (OECD 2017).

behavior aimed at artificially inflating the measure of output. Employees may report to have processed a higher volume or more complex claims than they actually did. One way around this is to complement electronic records with field observations of a representative sample of tasks at hand which is regularly updated. This approach minimizes the risk that the performance measures become outdated or disentangled from constantly evolving work environment of public officials.

With these pieces in place, case data can be a source of government analytics. Such data can provide objective comparisons of agency performance, allowing for an assessment of the quality of public administration across jurisdictions, regions, managers and time. Rather than comparing simple output across offices, it is often useful to compare a measure of output per worker (or per unit of time). These measures capture the productivity of the average worker (or the average hour) in each office and are not affected by differences in office size. For instance, larger offices typically process larger quantity of various cases, by virtue of having more workers devoted to back-office operations. However, the fact that larger offices process more cases, does not necessarily imply that they are more productive.

A major limitation of evaluating the performance of public sector offices based solely on output or productivity is that these measures reflect production volumes and do not capture the quality of the service provided. For example, imagine an official who rubber stamped applications for a claim. Only looking at production volumes, the official would seem very productive. However, the officer de facto awarded welfare transfers to all claimants, regardless of their eligibility status. Conditioning on, or including in analysis, a measure of complexity would not adjust for the official's quality of service. Rather, a separate metric related to the quality of decision-making must be constructed to address that concern.

2.2 Extending Analytics Insights

Government agencies can significantly increase the impact of existing administrative data by going beyond basic analysis of the administrative data they hold. First, they can build assessments of the accuracy of their case data. For example, governments can collect additional data on accuracy of tax assessment, say from randomly selected tax units, which will enable them to construct more comprehensive performance measures of tax staff and to establish more credible audit and citizen grievance-redress mechanisms.

Seconly, digitization of case data allows using machine learning and artificial intelligence algorithms to create better valuation measures, such as the detection of clerical and other types of errors, flag suspected fraud cases, or classify taxpayer groups in a (more) automated fashion. More on this topic is provided in Chapter ML/AI and a case study of a similar system is provided in Chapter HRMIS(Brazil).

Authorities can also make anonymized case data publicly available, and this increased transparency can enable the operation of whistle-blowing and peer pressure mechanisms. Referring to one of the case studies that follows, there is a precedent for doing this in Pakistan as the entire tax directory for federal taxes has been published annually for the past decade.

Finally, case data can be integrated with political data to create better measures of politicians' performance at the local government level and thus enhance political accountability. For example, updates to cadastre records, which are crucial for accurate property valuations for tax purposes, were found to be crucially linked to electoral pressures of local officials in Brazil (Christensen & Garfias 2021).

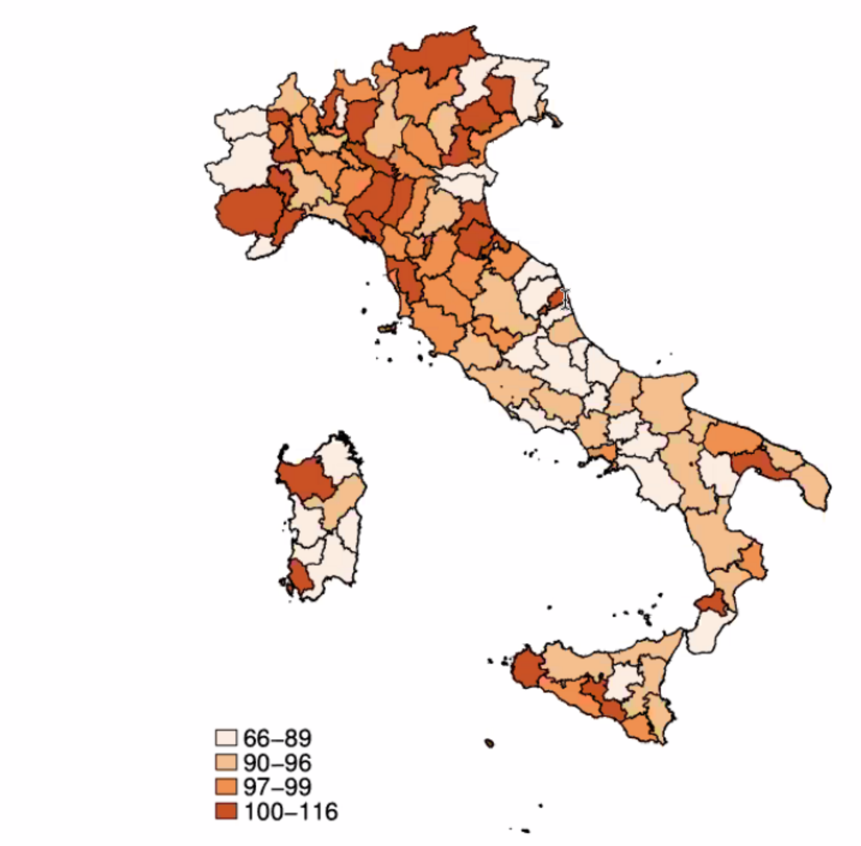
The rest of this paper presents case studies that highlight the analysis and use of case data focusing on measuring case volume, complexity and quality; as well as describing ways to strengthen that analysis by linking to other data sources.

3 Social Security Claims Data

Social security claims data include records relating to old age programs and social welfare programs such as unemployment benefits, maternity leave and subsidies to the poor. Most governments around the world already regularly collect claims data in an electronic format. As such, this data can be repurposed to perform quantitative analysis to better understand the performance of the social security system overall, the challenges facing individual public sector offices, and what design solutions might address them.

In this section we discuss a recent academic paper that uses detailed claim data from the the Italian Social Security Agency (ISSA hereafter) to construct a measure of performance of public offices and evaluate the effectiveness of ISSA managers. Fenizia (2022) exploits the rotation of managers across sites to estimate the productivity of public sector managers. This study finds that there is a large heterogeneity in the effectiveness of these managers: some managers are very productive and improve

Figure 2: Variation in Productivity of Social Security Case Processing



Source*: Fenizia (2022) using ISSA data.* XXX

the performance of the offices they work at, while others do not. The increase in office productivity brought about by talented managers is mainly driven by changes in the personnel practices.

A case in this setting is the process of assessment by a social security officer of the validity of a claim for social security payments to an individual. A key advantage to studying the Social Security Agency is that the tasks that the employees perform are fairly standardized and the agency keeps detailed records of all applications and welfare transfers. This allows us to construct a comprehensive measure of performance that encompasses all the activities that the employees perform.

The obvious volume-based measure of productivity in this context is the number of social security claims of a particular type that are processed by an office in a particular time period divided by the full time equivalent of workers of that office during that time. Figure 2 describes how this measure varies across Italian regions, showcasing how such data can be used in government analytics. The figure indicates which regions are more productive than others, and thus where investments might be needed in the quality of management or staff.

The first concern with analyzing this sort of data is that some cases may be more complex to process than others. In many settings it is possible to measure only the output stemming from a subset of activities rather than the associated complexity. In those settings, the measure of performance only reflect the activities being measured and may be harder to interpret. For example, imagine that an agency performs two types of tasks: task A is observable, but task B is not. If the measure of performance will reflect only the output from task A. If this measure were to decline over time, this could be driven by a worsening of performance in the agency overall or by the fact that resources were reallocated from task A to task B. Section 3.1 discusses how to construct a measure of complexity using the time spent on an "average" case of a particular type.

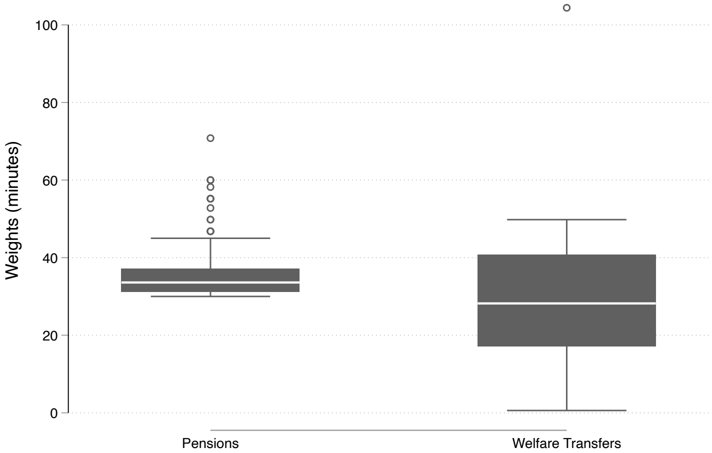
Second, production volumes do not reflect the quality of the service provided. Section 3.2 evaluates the strengths and weaknesses of two proxies of quality of service that can be derived from claims data.

3.1 Complexity

Virtually all government agencies that administer old age programs and welfare programs process a variety of different claims. While it is relatively straightforward to keep track of the number of incoming and processed claims, it is more challenging to construct a measure of performance for public offices that can be meaningfully compared across sites.

A naïve solution might involve counting the number of claims processed by each office. Despite being simple and transparent, this measure suffers from a major drawback: it does not take into account task complexity. Some claims might be very quick to process, while others might require a lot of time and resources. As mentioned above, in some cases the officers have to simply verify that the documentation provided by the applicant is complete and up to date. In other cases, officers may have to acquire further documentation from their internal archives or from other entities. If different offices process a different mix of paperwork, simply counting the number claims processed does not correctly reflect differences in task complexity across sites. The naïve metric would overstate the performance of offices that process sim-

Figure 3: Expected Processing Time for Most Common Types of Claims



Notes: This Figure illustrates the distribution of expected processing time (i.e., weights) for the most common types of pensions and welfare transfers. The box represents the interquartile range (IQR) - distance between 25th and 75th percentile in the distribution of the weights. The line in the middle of the box represent the median. Whiskers represent values lying within 1.5 of IQR from the median. Outliers are represented by circles.
Source: Fenizia (2022) using ISSA data.

pler claims relative to those that process more sophisticated paperwork.

A solution is to use a complexity-adjusted measure of claims processed. For example, ISSA constructs a measure of output for public offices that combines the number of claims processed by each site with a measure of their complexity. Specifically, the ISSA grouped all claim types into more than 1,000 fine categories. Each category is constructed to group highly comparable claims that are equally complex. Each category is assigned a weight representing how much time should take to process that specific claim type.

Figure 3 illustrates the distribution of expected processing time (i.e., weights) for the most common types of pensions and welfare transfers. The expected processing time for most pensions ranges between 31 and 38 minutes, with a median of 30 minutes. The expected processing time is more variable for welfare transfers, reflecting the fact that these products are much more heterogeneous. Most of these claims take between 17 and 41 minutes to process, with a median processing time of 28.

Importantly, the ISSA complexity-adjustment formula uses objective weights as opposed to subjective scores. As part of the ISSA quality control department, there is a team devoted to measuring weights and keeping them up to date. To construct the weight for product v, this team selects an excellent, an average, and a mediocre office and picks a representative sample of product-v claims from each office. Then the team visits each site and records the amount of time each employee took to process each claim. The weight is constructed by averaging all measurements across employees and offices and it represents the time spent processing an "average" case of that type. The same weights apply to all offices at a given time to ensure that all offices are evaluated using the same standards. Weights can change in response to a technological improvement, if the time required to process a specific claim shortens, or when the paperwork associated with a claim changes.

ISSA also ensures that the weights are measured accurately and that there are no opportunities for arbitrage. For example, if processing product b takes on average 10 minutes and the weight associated with it is equal to 20, officers have an incentive to process as many b-claims as possible. By doing so, they artificially increase the output of the office. Similarly, if product b is assigned a weight of 5 minutes when it takes 10 minutes on average to process it, officers may be inclined to give priority to other claim types. To minimize arbitrage, the ISSA tracks backlog by product. If the backlog for a given product increases (decreases) across several offices, this may be an indication that the weight associated to it may be too low (high). Therefore, the ISSA re-evaluates the weights associated to the products that experienced large changes in backlog.

The weights are used to aggregate the number of claims of different types processed by each office i into a single output measure. The aggregation consists in multiplying the number of product-v claims processed (c_{vi}) with their corresponding weight (w_v) and then summing across categories.

$$\text{Output}_i = \sum_{v=1}^{V} c_{vi} \times w_v \tag{1}$$

This output metric reflects the *theoretical* amount of time that it *should* have taken to process the claims that were effectively processed.

Although the procedure described above is largely specific to ISSA and its mandate related to social security, similar measures are used in manufacturing firms across the world. These measures are especially popular in the garment sector where the Standard Minute Value (SMV) has become the standard.

3.2 Quality

In the case of social security claims, a straightforward measure of quality of service provided is the error rate (i.e., the fraction of claims that were processed incorrectly). There are two types of mistakes: a government agency may erroneously give a beneficiary money or may erroneously deny a transfer. Keeping track of the errors found when a denied beneficiary files an appeal only catches the latter type of mistake. That's why, to construct a comprehensive measure of the office error rate and discourage fraudulent behavior, it is paramount to regularly audit a random subset of claim processed by each office.

Agencies may combine the error rate with a second proxy for quality: timeliness in claim processing. While timeliness is an important dimension of the service provided, a drawback of this measure is that it is mechanically correlated with the office productivity. In other words, holding constant other office characteristics, offices that process claims quickly are also those that deliver a high level of output.

3.3 Extending Administrative Data

Alternative approaches to measuring the quality of service provided include using subjective customer satisfaction ratings. The main challenge when using customer rating is that the subset of customers who choose to provide feedback is not representative, as customers with more extreme (either positive or negative) opinions are more likely to provide a review (Schoenmüller & Stahl 2019).[2]

This limitation can potentially be overcome by conducting regular surveys of the representative sample of all customers. The U.S. Social Security Administration (SSA hereafter) implements a range of such surveys both by-phone and in-person, across different groups of customers (online users of SSA services, callers to SSA phone number, visitors to SSA field offices). Although it does not eliminate the possibility that the most (un)happy customers will be more likely to respond to a survey invitation,

[2] To evaluate the performance of government agencies is also important to account for the fact that many government agencies also have front office operations. Measuring productivity in any customer facing setting is challenging. While some agencies use customer rating, the ISSA measures front office output using the inputs—the amount of time employees spend on front office duties. Thus, the measure bluntly captures the value of staffing the office without adjusting for the number of customers served or the complexity of their demands. An agency may also consider constructing a measure of front-office operations analogously to the one used for claim processing. The additional challenge is that allowing front-office employees to self-report their output may incentivize employees to misreport the activities that they undertake.

it does mitigate this concern by targeting a sample of all customers. An indication of average customer satisfaction can also be obtained from surveys conducted by third parties. For example, the different dimensions of services provided by U.S. government agencies are regularly evaluated as one of the topics covered in the American Customer Satisfaction Index (ACSI), which is used to measure general satisfaction of American customers with various goods and services.

4 Procurement Records

Public procurement – governments purchasing goods and services from private sector suppliers – is one of the core functions of the state. Public procurement represents a large portion of governments' budgets, and a sizeable fraction of the economy, representing 12% of world GDP (Bosio *et al.*, 2020). Public procurement also tends to be a highly technocratic, legalistic process generating large volumes of documents recording every step of the procurement purchase in great detail. These data are generated and recorded as part of the government's procedures in order to uphold the transparency and accountability of the procurement process – core goals of a well-functioning procurement system. However, these same data, either by themselves, or in conjunction with additional data, can also be used to measure the performance of the officials and public entities in charge of carrying out procurement.

This section builds on Chapter X (=PROCU) to showcase how the indicators outlined in detail there can be considered as individual case data, as well as showcasing the benefits of complementing administrative data with experimental variation. Here, we discuss two recent academic papers that develop methods to use administrative databases on public procurement to construct measures of procurement performance. Best *et al.* (2020) use detailed procurement data from Russia spanning all procurement transactions between 2011 and 2016 to construct measures of procurement performance. They show that there are big differences across purchases in how effectively the purchase is carried out and that this can be attributed in roughly equal proportions to the effectiveness of the individual civil servants tasked with procurement and the effectiveness of the public entities they represent. They also show how procurement policy can be tailored to the capacity of the implementing bureaucracy in order to offset weaknesses in implementation capacity.

Bandiera *et al.* (2021) use existing procurement data from Punjab, Pakistan and supplement it with additional data collected from purchasing offices to construct performance measures. This paper is an example of how a randomised control trail (RCT) can be used in complement with government administrative data to better understand the impact of personnel policies and other aspects of public administration. By introducing experiments into government, such initiatives amplify the potential benefits of the analysis of public administration data. Bandiera *et al.* (2021) show that granting procurement officers additional autonomy to spend public money improves procurement performance, especially when the officers' supervisors caused significant delays in approvals.

4.1 Complexity

A procurement case may be characterized by a differing number of features of the good or service being procured, and by a wide range of requirements on those features. For example, the procurement of pencils has far fewer features for the procurement officer to assess than a vehicle. As such, when comparing the productivity of procurement agents and agencies, it is important to have a measure of the nature of procurement cases they have to process.

Best *et al.* (2020) use publicly available administrative data from Russia to construct measures of performance based on public procurement. Since 2011, a centralized procurement website (`http://zakupki.gov.ru/`) has provided information to the public and suppliers about all purchases. They use data from this website on the universe of electronic auction requests, review protocols, auction protocols, and contracts from January 1, 2011 through December 31, 2016. The data cover 6.5 million auction announcements for the purchase of 21 million items. However, purchases of services and works contracts are highly idiosyncratic, making comparisons across purchases impossible, so they are dropped from the sample, resulting in a sample of 15 million purchases of relatively homogeneous goods.

To use this data to measure performance there are two key challenges to overcome. First, the main measure of performance uses prices paid for identical items, requiring precise measures of the items being procured. Second, prices are not the only outcome that matters in public procurement and so they use the administrative data to construct measures of spending quality as well.

The main measure of performance used in Best *et al.* (2020) is the price paid for each purchase, holding constant the precise nature of the item being procured. Holding constant the item being procured is crucial to avoid conflating differences in prices paid with differences in the precise variety of item being procured. As described in more detail in an online appendix associated with the chapter, they use the text of the final contracts, in which the precise nature of the good purchased is laid out to classify purchases into narrow product categories within which quality differences are likely to be negligible using text analysis methods.

The method proceeds in three steps. First, the good descriptions in contracts are converted into vectors of word tokens. Second, they use the universe of Russian customs declarations to train a classification algorithm to assign goods descriptions a 10-digit Harmonized System product code, and apply it to the good descriptions in the procurement data. Third, for goods that are not reliably classified in the second step, either because the goods are non-traded, or because their description is insufficiently specific, they develop a clustering algorithm that combines good descriptions that use similar language into clusters similar to the categories from the second step.

Just as in the case of claims data discussed in the preceding section, here it can be similarly seen that the key issue in analysing the case complexity is comparing ’apples to apples’. Although many procedures in public administration come with a set of standardised procedures, the actual complexity of each task is highly variable and therefore its accurate evaluation is the key to understand the performance of public officials. To achieve that a highly detailed metrics might be required. In the case of ISSA claims data, this metric was a continuous weight - time judged as necessary to complete a specific task based on primary data obtained during field observations in various social security offices. In the case of procured goods, the metric used is categorical, but narrow enough to avoid classifying goods of different nature as comparable. It is also not based on field-based measurements but rather on relies on secondary data from descriptions in Russian customs declarations and advanced classification algorithms.

4.2 Quality

Sourcing inputs at low prices is the primary goal of public procurement,[3] but it is not the only outcome that matters. Successful procurement purchases should also be smoothly executed. Contracts should not need to be unduly renegotiated or termi-

[3] Article 1 of Federal Law 94 (FZ-94), which transformed the public procurement system in 2005, declares the aim of procurement as the “effective, efficient use of budget funds". The law also introduced minimum price as the key criterion for selecting winners for most types of selection mechanisms (Yakovlev *et al.*, 2011).

nated, and goods should be delivered as specified, without delays. These outcomes reflect the quality of public spending and may conflict with the goal of achieving low prices. If this problem is severe, then it would be misleading to deem purchases effective if they achieve low prices but this is offset by poor performance on spending quality.

To address this, Best *et al.* (2020) build direct measures of spending quality by combining a number of proxies for the quality of the non-price outcomes of a procurement purchase. Specifically, they use six proxies: the number of contract renegotiations, the size of any cost over-run, the length of any delays, whether the end user complained about the execution of the contract, whether the contract was contested and canceled, and whether the product delivered was deemed to be low quality or banned for use in Russia because it didn't meet official standards.

To summarize spending quality in a single number, they take the six quality proxies and create an index of spending quality y_i as the average of the six proxies after standardizing each one to have mean zero and standard deviation one: $y_i = \frac{1}{6}\sum_{k=1}^{6}(y_i^k - \bar{y}^k)/\sigma^k$ (Kling *et al.*, 2007). This is done because the proxies are in different units of measurement, and because some proxies will be more variable than others. For a deviation in a proxy to be judged as 'large', this approach conditions it on what other deviations we observe for that proxy. For example, there may be many complaints, but very few contract cancellations. In that case, one would want to weight a cancellation more heavily than a complaint, in accordance with how rare and thus significant a cancellation is.

With these measures in hand, Best *et al.* (2020) show that there are big differences across purchases in how effectively the purchase is carried out. They also decompose these differences into the part that can be attributed to the effectiveness of the individual bureaucrats working on the purchases and the part that can be attributed to the agency that is receiving the item being purchased. They show that both contribute roughly equally to the differences in effectiveness, and that together they explain around 40% of the variation in government performance. They also show how these differences in effectiveness contribute to differences in how policy changes manifest in performance outcomes.

They argue that policy that is tailored to the capacity of the implementing bureaucracy can offset overall weaknesses in implementation capacity. The analysis provides an example of how the analytics of public administration can lead to direct implications for the policies that govern it.

4.3 Extending Administrative Data

Existing administrative data can sometimes prove insufficient to measure productivity in public administration, but the required information can nevertheless be obtained by targeted data collection efforts of governments and researchers. Bandiera *et al.* (2021) use administrative data from Punjab, Pakistan to measure procurement performance. In their case, the existing administrative data is not sufficiently detailed to implement their preferred method of performance measured and so they work with the government to design and implement an additional administrative database capturing detailed information about the products being purchased by procurement officers.

The government of Punjab considers that the primary purpose of public procurement is to ensure that "...the object of procurement brings value for money to the procuring agency..." (Punjab Procurement Regulatory Authority, 2014). In line with this, they developed a measure of bureaucratic performance that seeks to measure value for money in the form of the unit prices paid for the items being purchased, adjusted for the precise variety of the item being purchased.

They proceed in two steps. First, they restrict attention to homogeneous goods for which it is possible to gather detailed enough data to adequately measure the variety of the item being purchased. Second, they partnered with the Punjab IT Board to build an e-governance platform—the Punjab Online Procurement System (POPS). This web-based platform allows offices to enter detailed data on the attributes of the items they are purchasing. Over a thousand civil servants were trained in the use of POPS and the departments they worked with required the offices in the study to enter details of their purchases of generic goods into the POPS system. To ensure the accuracy of the data, offices were randomly visited to physically verify the attributes entered into POPS and collect any missing attributes required.

After running the POPS platform for the two years of the project and cleaning the data the officers entered, the analysis dataset consists of the 25 most frequently purchased goods—a total of 21,503 purchases. Dropping the top and bottom 1% of unit prices results in a dataset of 21,183 observations.[4] Figure 4 shows summary statistics of the purchases in the POPS dataset. The 25 items are remarkably homogeneous goods such as printing paper and other stationery items, cleaning products, and other office products. While each individual purchase is small, these homogeneous items

[4] The majority of these outliers are the result of officers adding or omitting zeros in the number of units purchased.

form a significant part of the procurement: generic goods are 53% of the typical office's budget in the sample.

To use these data on prices to measure procurement performance, they again need to be able to compare purchases of exactly the same item. The goods in the analysis are chosen precisely because they are extremely homogeneous. Nevertheless, there may still be some differentiation across items and so Bandiera *et al.* (2021) use four measures of the variety of the goods being purchased. First, they use the full set of attributes collected in POPS for each good. This measure has the advantage of being very detailed, but comes at the cost of being high-dimensional. The three other measures reduce the dimensionality of the variety controls. To construct the second and third measures, they run hedonic regressions to attach prices to each of the goods' attributes. They run regressions of the form

$$p_{igto} = \mathbf{X}_{igto}\lambda_g + \rho_g q_{igto} + \gamma_g + \varepsilon_{igto} \tag{2}$$

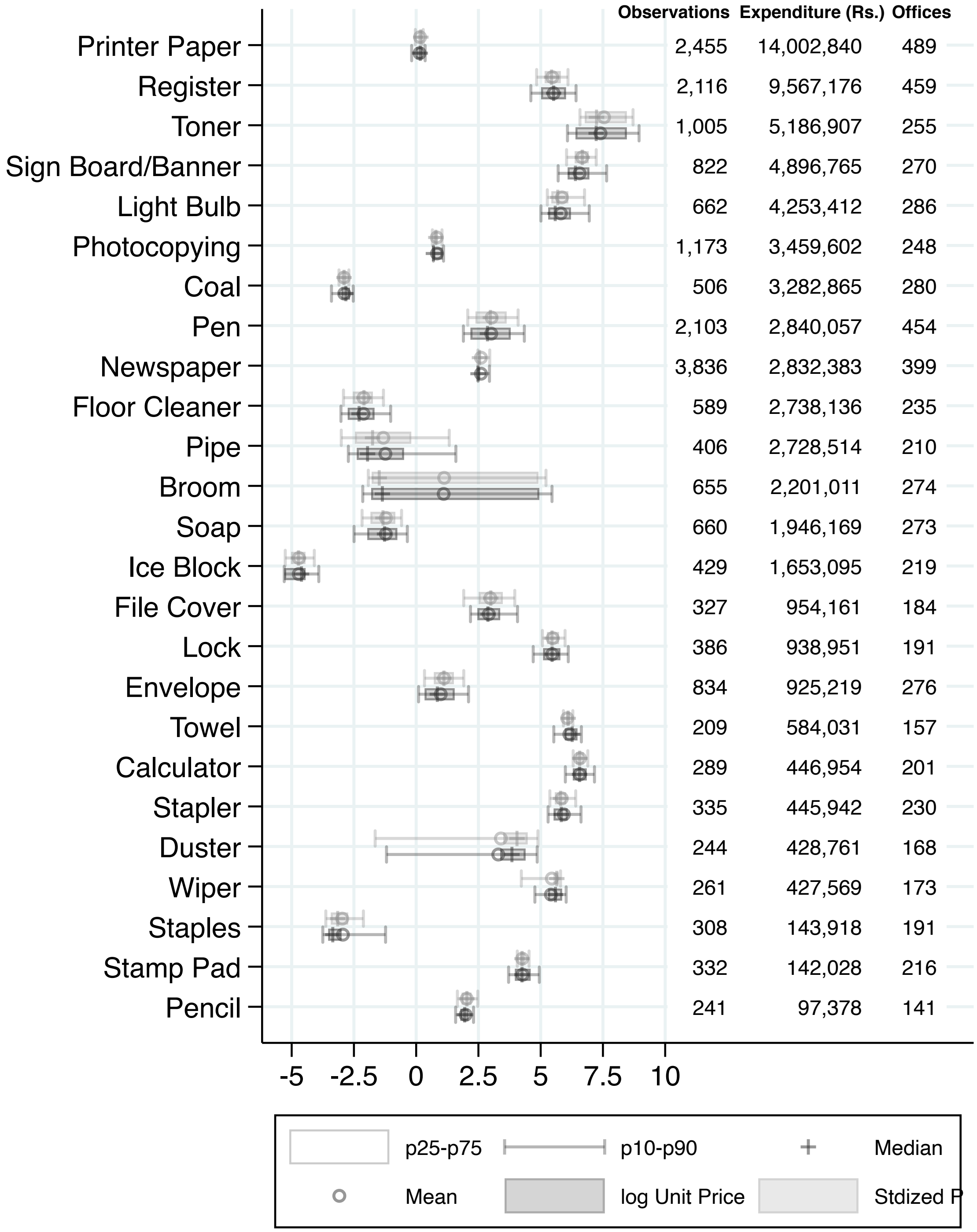
where p_{igto} is the log unit price paid in purchase i of good g at time t by office o, q_{igto} is the quantity purchased, γ_g are good fixed effects, and $\mathbf{X}_{igto}$ are the attributes of good g.

The second, *"scalar"* measure of good variety uses the estimated prices for the attributes $\hat{\lambda}_g$ to construct a scalar measure $v_{igto} = \sum_{j \in A(g)} \hat{\lambda}_j X_j$ where $A(g)$ is the set of attributes of item g. The third, *"coarse"* measure studies the estimated $\hat{\lambda}_g$s for each item and partitions purchases into high and low price varieties based on the $\hat{\lambda}_g$s that are strong predictors of prices in the control group. Finally, the *"machine learning"* measure develops a variant of a random forest algorithm to allow for non-linearities and interactions between attributes that the hedonic regression (2) rules out. The online appendix for this chapter provides further details. This effort provides a way to homogenize the type and quality of goods on which government analytics can be performed.

4.4 Extending Administrative Data

Extending administrative data does not only imply the collection of further data. Rather, it can imply an extension in the methods used for analysis. A particularly powerful extension is to embed a randomized control trial into data collection. In this way, the data collected reflects groups that have received a policy intervention purely by chance. As such, comparing the measures of case processing between these groups

Figure 4: Summary statistics on 25 most commonly purchased goods in the Punjab Online Procurement System in 2014-2016 (Bandiera *et al.* 2021)



	Observations	Expenditure (Rs.)	Offices
Printer Paper	2,455	14,002,840	489
Register	2,116	9,567,176	459
Toner	1,005	5,186,907	255
Sign Board/Banner	822	4,896,765	270
Light Bulb	662	4,253,412	286
Photocopying	1,173	3,459,602	248
Coal	506	3,282,865	280
Pen	2,103	2,840,057	454
Newspaper	3,836	2,832,383	399
Floor Cleaner	589	2,738,136	235
Pipe	406	2,728,514	210
Broom	655	2,201,011	274
Soap	660	1,946,169	273
Ice Block	429	1,653,095	219
File Cover	327	954,161	184
Lock	386	938,951	191
Envelope	834	925,219	276
Towel	209	584,031	157
Calculator	289	446,954	201
Stapler	335	445,942	230
Duster	244	428,761	168
Wiper	261	427,569	173
Staples	308	143,918	191
Stamp Pad	332	142,028	216
Pencil	241	97,378	141

Notes: The figure displays summary statistics for the purchases of the goods in the purchase sample. The figure summarizes the log unit prices paid for the goods, the number of purchases of each good, and the total expenditure on the good (in Rupees) in the sample.

allows us to look for differences that are purely due to the policy intervention and not some other mediating factor.

With the above performance measure in hand, Bandiera *et al.* (2021) perform just such a field experiment in which one group of procurement officers is granted greater autonomy over the procurement process (essentially reducing the amount of paperwork required and streamlining the pre-approval of purchases by government monitors), another group is offered a financial bonus based on their performance, and a third group is offered both. By embedding an experiment into their analysis, they find that granting autonomy causes a reduction in prices by around 9%, illustrating that in settings where monitoring induces inefficiency, granting front-line bureaucrats more autonomy can improve performance.

5 Property Tax Data

Taxation is critical for development; however, tax systems throughout the developing world collect substantially less amount of revenue as a share of GDP than their counterparts in the developed world.[5] Weak enforcement, informational constraints and tax morale provide some explanation. This is also true for property taxes despite their greater visibility and contribution to local public goods. Khan *et al.* (2016) and Khan *et al.* (2019) describe a long collaboration with the Excise and Taxation Department in Punjab, Pakistan on different mechanisms for incentivizing property tax collectors – through performance-pay and performance-based postings. Once again, these papers provide insights into how case data, and in this sub-section case data related to the taxation of individual properties, can be combined with experimental variation to improve the measurement of and insights related to the performance of public administration.

The urban property tax in Punjab is levied on the Gross Annual Rental Value (GARV) of the property, which is computed by formula. Specifically, the GARV is determined by measuring the square footage of the land and buildings on the property, and then multiplying by standardized values from a valuation table that depend only on the property location, use, and occupancy type. These valuation tables divide the province into seven categories (A to G) according to the extent of facilities and infrastructure in the area, with a different rates for each category. Rates further vary by

[5] According to the World Bank data, tax revenue as a share of GDP, stood at 11.4% in low and middle income countries, compared to 15.3% in high income countries

residential, commercial or industrial status, whether the property is owner-occupied or rented, and location. Taxes are paid into designated bank branches.

The Excise and Taxation Department collects regular administrative data. Each quarter, as part of their normal reporting requirements, tax inspectors report their revenue collected during the fiscal year cumulatively through the end of the quarter, which they compile from tax paid receipts retrieved from the national bank. In addition, they report their total assessed tax base before exemptions are granted and after exemptions have been granted. These records are compiled separately for current year taxes and arrears.

In theory, the performance of property tax collectors should be easy to monitor as the key measure of performance, tax revenue, is less subject to measurement issues than other areas of government work. However, in practice, measurement related to the performance of tax inspectors faces many challenges. It is not ex ante obvious how much credibility to give to reported tax revenues at the unit level in Punjab given tax department's internal cross-checks are usually run at a higher level of aggregation. Given multiple reporting templates with slightly varying assumptions being in use in the province, all officers can overstate the revenues they have generated without their misreporting being effectively detected. Similarly, the continuously evolving environment in which tax collectors operate introduces further complications to understanding relative performance. For example, the boundaries of tax administrative units (called tax circles in Punjab) are continuously being changed, and tax circle boundaries do not overlap with boundaries of political units.

As such, gaining a coherent measure of taxes collected and the performance of tax officials and agencies can be a challenging task. Since reported tax revenues are a function of tax base, exemption rate and collection rate, comparing collection alone is not reflective of performance. Finally, given concerns over multi-tasking, performance on revenue collection has to be matched with performance on non-revenue outcomes, especially on accuracy of tax assessments and citizen/taxpayer satisfaction.

5.1 Complexity

Rather than generating novel measures of complexity or clever systems for categorization, as in the social security and procurement cases, complexity was made more homogeneous in this context by standardizing the reporting templates and matching of boundaries. As such, the approach to ensuring a common level of complexity in case data can be relatively simple in some settings.

5.2 Quality

In the work in Punjab, to ensure accuracy of administrative data unit level, an additional re-verification program was instituted involving cross-checking the department's administrative records against the bank records. This entailed selecting a subset of circles, obtaining the individual records of payment received from the bank for each property, and manually tallying the sums from the thousands of properties in each circle to ensure that it matched the department total.

The project found virtually no systematic discrepancies between the administrative data received from the department and the findings of this independent verification; the average difference between our independent verification and what the circle had reported revealed under-reporting of -0.28%, or about zero. In general, if rightly conducted data diagnostics and audits can ensure accuracy of administrative data, help flag issues before policy decisions are based on such data, and align incentives for truthful reporting.

5.3 Extending Administrative Data

Once again, Khan *et al.* (2016) showcase the power of introducing experimentation into government analytics. They run a large-scale field experiment where all property tax units in the province were experimentally allocated into one three performance-pay schemes or a control. After two years, incentivized units had 9.4 log points higher revenue than controls, which translates to a 46 percent higher growth rate. The revenue gains accrue from a small number of properties becoming taxed at their true value, which is substantially more than they had been taxed at previously. The majority of properties in incentivized areas in fact pay no more taxes, but instead report higher bribes. The results are consistent with a collusive setting in which performance pay increases collectors' bargaining power over taxpayers, who either have to pay higher bribes to avoid being reassessed, or pay substantially higher taxes if collusion breaks down. The paper shows that performance pay for tax collectors has the potential to raise revenues, but might come at a cost if it increases the bargaining power of tax collectors vis-a-vis taxpayers.

The paper also highlights the limitations of relying on existing administrative data for areas where multi-tasking can be a concern and where existing systems capture only some aspects of performance - for instance, administrative data usually captures revenue collection but not non-revenue outcomes like accuracy of tax assessments and taxpayer satisfaction. To capture these non-revenue outcomes, as well as owner/property characteristics to examine any heterogeneous effects, Khan *et al.* (2016) conduct a random property survey.

The survey is based on two distinct samples. The first, the "general population sample," consists of roughly 12,000 properties selected by randomly sampling 5 GPS coordinates in each circle and then surveying a total of 5 (randomly chosen) properties around that coordinate. These properties therefore represent the picture for the typical property in a tax circle. The second sample, referred to as the "reassessed sample," consists of slightly more that 4,000 properties (roughly 10 per circle) sampled from an administrative list of properties that are newly assessed or reassessed. These properties were then located in the field and surveyed. The purpose of this survey was to over-samples the (few) properties that experience such changes each year so we can as to be able to examine the impacts on such properties separately.

This survey data is used to determine GARV of the property which is the main measure of a property's tax value before exemptions and reductions are applied and unlike tax assessed, is a continuous function of the underlying property characteristics and hence is much more robust to measurement error. To measure under or over taxation, "tax gap," is determined as

$$\text{TaxGap} = \frac{(GARV_{Inspector} - GARV_{Survey})}{(GARV_{Inspector} + GARV_{Survey})}$$

Taxpayer satisfaction is measured based on two survey questions about the quality and results of interactions with the tax department. Accuracy is measured as 1 minus the absolute value of the difference between GARV as measured by the survey and the official GARV, as measured from the tax department's administrative records, divided by the average of these two values.

Khan *et al.* (2019) in a subsequent project examine the impact of performance-based postings in the same setting and rely primarily on administrative data. It proposes a performance-ranked serial dictatorship mechanism, whereby bureaucrats sequentially choose desired locations in order of performance. It evaluates this using a two-year field experiment with 525 property tax inspectors. The mechanism increases annual tax revenue growth by 30-41 percent. Inspectors that our model predicts face high equilibrium incentives under the scheme indeed increase performance more. These results highlight the potential of periodic merit-based postings in enhancing bureaucratic performance.[6]

6 Conclusion

In this chapter we discussed how public sector organizations can use administrative data to construct measures of performance across three important realms of government operations: delivery of social security programs, the procurement of material inputs, and tax collection.

Agencies whose primary work consists in processing claims can use their existing records to construct a measure of volumes of services provided (i.e., a complexity-adjusted index of claims processed) and proxies for the quality of service (i.e., the error rate and timeliness in claim processing).

Similarly, government organizations purchasing goods and services can leverage their existing procurement records to construct two measures of performance: the price paid for homogeneous goods and an index of spending quality that combines information on the number of contract re-negotiations, cost over-run, the length of delays, complaints, contract cancellations, and whether the product delivered did not meet minimum quality standards. When the administrative data is not sufficiently detailed, governments can choose to develop a platform that standardizes the procurement process and collects the underlying data.

Finally, taxation authorities can construct reliable measures of tax revenue by standardizing the process through which tax collectors report the taxes they collected and instituting a set of automatic checks to ensure the data accuracy.

Better measures of performance may help governments to improve the effectiveness of public service provision. For example, policymakers can use these performance measures to identify the best-performing offices, learn about "best practices", and export them to the under-performing sites. Government agencies can also use these metrics to identify understaffed sites and reallocate resources toward them.

[6] In ongoing work with the tax authorities and the local government, Haq *et al.* (2020) are examining strengthening the social compact between citizens/taxpayers and the government by linking the (property) taxes that citizens pay with the services that they receive at the neighborhood level. Combining administrative data from tax and municipal agencies at the neighbourhood level provides local-level measures of variation in public service provision, tax and fiscal gap, administrative performance, and social/political dynamics.

Moreover, governments can *monitor* the performance of public offices and intervene promptly when a challenge arises. Finally, they can use these measures to design incentive schemes aimed at improving public service provision.

Administrative records typically include large amounts of data and performing statistical analyses on them involves some practical challenges. First, not all public sector organizations employ workers who have the technical skills to "re-purpose" the data for performance measurement and carry out the statistical analyses. This challenge can be addressed by partnering with external researchers experienced in this area. Second, governments should take all the necessary steps to protect data confidentiality when granting access to its internal records. This may involve anonymizing the data to protect the identity of the subjects being studied, transferring the data through secure protocols, and ensuring that the data is stored on a secure server. In some cases, government organizations may also invest in their own IT infrastructure such as a large server to store the data and a set of work-stations through which researchers can access anonymized administrative records.

The approaches described in this chapter have the potential to promote evidence-based policy-making within government organizations and result in more effective public service provision. An example of such impacts come from the tax analytics work described in this chapter. Over the course of the research collaborations discussed, the Punjabi tax authorities began to digitize and geo-code unit data at the property level. This database is now being regularly updated. Tax notices are now issued through an automated process supporting tax staff still responsible for field work and for updating property status – e.g. covered area, usage (residential, commercial or industrial) and status (owner-occupied or rented) - and for providing the information relevant for deciding on exemptions. This reduces the human interface between tax collectors and taxpayers. It allows more sophisticated analysis and data visualization conducted at more granular levels, e.g. at neighbourhood levels, in real-time. The data is now being used by the Urban Unit Pakistan, different government agencies, and by analysts to address a range of policy questions.

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