Public Service Provision and the Virtuous Circle: Evidence from Malawi

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Abstract

Many governments struggle to obtain the resources they need to govern effectively. In the virtuous circle model of state development, tax revenue allows governments to provide public goods and services to citizens, and citizens comply with taxation when governments provide sufficient levels of goods and services. The model, however, also suggests a vicious version of the circle, where citizens do not pay taxes, governments lack revenue to provide public goods and services, and citizens therefore continue to not pay taxes. Under this suboptimal equilibrium, governments cannot deliver on their governing and service provision mandates. We study whether a shock to public service provision in a major city in Malawi can induce citizens to pay taxes, thereby shifting the relationship between the city and its citizens from a vicious circle to a virtuous circle. With a difference-in-differences-style analysis, we show that households exposed to new government-provided waste collection expressed more trust in and better perceptions of the local government. Most importantly, these households were more likely to make tax payments. We find that this increase in tax payments largely came from people paying more of what they owed rather than from new taxpayers entering the rolls.

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Introduction

High-capacity governments bring people out of poverty (Tebaldi and Mohan, 2010; Acemoglu et al., 2015; Asadullah and Savoia, 2018), improve public health (Rajkumar and Swaroop, 2008; Dawson, 2010; Hanson, 2015), provide education (Rajkumar and Swaroop, 2008; Hanson, 2015), reduce the likelihood of civil conflict (Fearon and Laitin, 2003; Hendrix, 2010), and improve human well-being generally (Bjørnskov et al., 2010; Pritchett, 2022). Despite efforts to improve capacity, many governments in poor countries are stuck in low-capacity traps: they lack the resources to govern effectively, and their lack of capacity prevents them from generating resources from citizens (Weigel & Kabue Ngindu, 2023). Specifically, governments in poor countries have limited capacity to motivate tax payments from their citizens using either a credible threat of enforcement or a credible promise of goods and services. Tax collection is a fundamental component of state capacity and a necessary precursor to many other state actions (Tilly, 1975; Skocpol, 1979; Cingolani, 2013; Hanson and Sigman, 2021). When states are unable to extract taxes from citizens, they typically persist in a condition of low-capacity governance (Bräutigam, 2008).

How can governments increase tax revenues in order to escape from this low-capacity trap and enter into a virtuous circle of governance (Schmelzle and Stollenwerk, 2018)? One option is to invest in their enforcement capacities and attempt to extract revenue by increasing the probability or severity of punishment for citizens who do not pay taxes (Allingham and Sandmo, 1972). Alternatively, states can strive to create "quasi-voluntary compliance," where — while citizens do perceive and remain susceptible to a background threat of state coercion — citizens pay taxes because they believe that they are receiving something in exchange for their compliance (Levi, 1989, 2006).[1] Since quasi-voluntary compliance is less expensive than compliance achieved through strict punitive enforcement, states have an incentive to provide public goods and services that taxpayers desire in order to generate tax revenue (Timmons, 2005).

Fiscal contract arguments require that citizens understand that their taxes pay for government service provision (Dom et al., 2022). Even if citizens understand that tax revenues fund government services, they might not fully trust the government to use tax revenue for its intended purposes. And even if they understand the tax-to-services connection and trust the government to provide services, citizens must be willing to forego the potential for free-riding. That is, insofar as citizens can access public services whether or not they pay taxes, they have little material incentive to pay if enforcement is weak; therefore, the tendency toward quasi-voluntary compliance must be strong.[2]

Existing evidence on the connections between service delivery and tax compliance is mixed. On the one hand, a set of studies in which researchers exposed citi-

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[1] Thinking in parallel terms to the concept of quasi-voluntary compliance, Luttmer and Singhal (2014) refer to "reciprocal motivations": "the willingness to pay taxes in exchange for benefits that the state provides ... even though [taxpayers'] pecuniary payoff would be higher if they didn't pay taxes" (150).

[2] Strong social norms of taxpaying are another potential mechanism for generating tax compliance (Luttmer & Singhal, 2014), but in many poor countries, the norm of not paying taxes is actually stronger than any norm of paying taxes (see the discussion of Haiti in (Krause, 2020)).

zens to information connecting tax payments and service provision show that people exposed to such messages are no more likely to comply with their tax obligations than citizens not exposed to messages (e.g., Blumenthal et al., 2001; Torgler, 2004; Castro and Scartascini, 2015; see, however, Hallsworth et al. 2017). On the other hand, some studies show that tax compliance varies with service delivery (e.g., Krause 2020; Kresch et al. 2023; Martin et al. 2025) or with changing perceptions about the specific services financed through taxation (Kresch et al., 2023).

We ask whether a shock to public service delivery can catalyze tax payments and break the vicious cycle in Zomba, Malawi, a context of widespread non-payment, minimal government services, and limited trust in government. Like many other cities in the Global South, most citizens of Zomba do not pay taxes, do not believe their neighbors pay taxes, and do not believe that they should pay taxes. And most citizens we surveyed do not trust the government to use taxes to improve public services — on average, our sample believes 50% of the money they pay in taxes is lost or stolen.

We facilitated an increase in solid waste collection across under-served city wards and simultaneously rolled out an information campaign about taxation and service provision to randomly selected households in these parts of the city.[3] We focus on waste collection because the city government and preliminary interviews with citizens reported that this was a desired but under-provided service in the city;[4] our baseline data confirms that most residents in our study did not have access to government-provided waste collection and that it was the service they most wanted the city to provide.[5] In this context, past literature and the local expertise of Zomba City Council suggested that new service provision might plausibly improve how residents of Zomba viewed the city government and payment of taxes to the city.

We measure attitudes and behaviors using panel survey data and administrative data about tax payments. In terms of new service delivery, we find that 23% of households reported access to government waste collection at endline, up from only 2% at baseline. Using difference-in-differences-style analyses that compare the households most plausibly exposed to the new waste delivery to other households, we find that new access to service delivery predicts improved trust in and willingness to comply with local government tax collection. Although attitudes toward the city government improve, attitudes toward specific incumbent elected officials remain unchanged. Most importantly, we find that new access to public services is associated with an increase in observed tax compliance. This increase seems to come primarily from households paying a larger amount of what they owe and not from households that start to pay taxes after the new service delivery.

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[3] The canvassers in the information campaign identified themselves as acting on behalf of Zomba City Council and provided information to homeowners about the connections between property tax payments and service delivery, as well as information about tax payment methods and the possibilities of tax amnesty for delinquent taxpayers. We randomly assigned households to the information campaign. Whether or not a household received the information campaign, therefore, is orthogonal to our main explanatory variable in this paper: household proximity to the new service delivery. We study the impacts of the information campaign in a separate paper.

[4] Authors' interviews, November 2016.

[5] Krause (2020) studies the relationship between solid waste collection and tax compliance in Carrefour, Haiti, because of similar prevailing attitudes in that context.

Our results provide evidence for the argument that shocks to service delivery can improve perceptions of the government and motivate quasi-voluntary compliance with tax collection, thereby helping governments collect the resources they need to break free from low-capacity traps. Overall, these findings provide evidence that new service delivery can catalyze a virtuous circle of tax compliance and service delivery, even if simple appeals to the fiscal contract cannot.

Theory and Context

While wealthy countries capture around 25% of their gross domestic product (GDP) as tax revenue, low-income countries only capture around 15%, and Malawi captures even less at 11.5–12.5% (OECD et al., 2024). Regressive consumption taxes and personal income taxes make up about equal proportions of tax revenue in OECD countries, but in poor countries, goods-and-services taxes bring in about four times as much revenue as personal income taxes on average (Prichard et al., 2019, Fig. 4). Where tax compliance has been low, scholars and practitioners historically have suggested that governments improve the mechanisms for enforcement of taxation, such as improving audit capabilities, increasing audit probabilities, and increasing punishments for non-payment (see the discussion in Prichard et al. (2019) and Slemrod (2019)).

Enforcement, however, is costly and reduces the revenues available for service provision. Scholars, therefore, have also studied the non-pecuniary drivers of tax compliance: do potential taxpayers believe that they are receiving something in exchange for their tax payments? do they perceive their treatment by taxing authorities as fair? do they view the tax authorities as accountable to citizens? (Luttmer and Singhal, 2014; Alm, 2019; Prichard et al., 2019; Slemrod, 2019). Taking into account these perceptions of the overall governance context, Levi (1989) argues that states need to create the conditions for "quasi-voluntary compliance": while there must be some level of credible enforcement in the taxation process, superior strategies for eliciting tax compliance are "non-coercive strategies that produce a high level of constituent cooperation" (53). Levi argues that states "must create confidence in their credibility and their capacity to deliver promised returns for taxes" and "convince taxpayers that taxpayer contributions make a difference in producing the desired goods" (Levi, 1989, 53).

This emphasis on taxpayers needing to perceive that their tax payments are converted into government services and public goods has come to be known as the "fiscal exchange" model of taxation (D'arcy, 2011).[6] Under the fiscal exchange model, taxpayers who observe the government providing public goods and services will be more likely to pay taxes because they expect that they will benefit from the goods and services that the government provides. This behavior originates in a normative belief that paying taxes is the right thing to do because of the expectation of receiving something back from the state (i.e., it is an intrinsic motivation). In a strictly rationalist model, there is a collective action problem: any individual taxpayer might still

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[6] As noted above, Luttmer and Singhal (2014) use the phrase "reciprocal motivations" for this idea.

expect to receive the public good even if they themselves do not contribute revenue to the government. In the quasi-voluntary compliance model, individuals act out of a sense that paying taxes to the state is the right thing to do, rather than a calculation about whether they can still enjoy the benefits of government services even without contributing to their provision.[7]

Beyond the desire to see that taxes are used to finance material outputs, citizens want to see that taxation is administered fairly, that tax burdens are distributed equitably, and that governments soliciting tax payments are accountable (Prichard et al., 2019). Shortcomings in any of these domains might undermine quasi-voluntary compliance even in the context of effective public goods provision. A potential taxpayer might recognize that the government uses tax revenue for public goods provision, but if that tax revenue is extracted primarily from one group among a set of potential taxpayers, or if citizens did not have any input into which public good would be provided, this might undermine the potential taxpayer's desire to fulfill their half of the implicit bargain.

In line with the implications of fiscal exchange theory, Timmons (2005) finds that there is a correspondence between the tax base of a country and the type of public goods that it provides, suggesting that states and citizens design systems of public goods provision around the implied quid pro quo. In Afrobarometer data from 17 countries, D'arcy (2011) shows a correlation between tax morale and both the perceptions of access to services and the quality of those services. Bodea and LeBas (2016) show that individuals who report more positive state service delivery experiences also report a stronger belief that citizens are obligated to pay taxes.[8] Experiments involving letters reminding tax payers of the linkages between taxation and service delivery have returned mixed results (see Blumenthal et al. 2001; Torgler 2004, 2013; Castro and Scartascini 2015) for null results and Hallsworth et al. (2017) and Mascagni et al. (2017) for positive results.

Several recent studies look directly at the way in which potential taxpayers react to the introduction of new government services, similar to what we do here. Gonzalez-Navarro and Quintana-Domeque (2015) provide evidence from Mexico that new asphalt paving in residential neighborhoods increases property tax compliance. Carrillo et al. (2021) use a natural experiment in Argentina to show evidence that new sidewalk construction inspires homeowners to become taxpayers. Krause (2020) randomizes the introduction of solid waste collection in Carrefour, Haiti, and shows that the new public goods provision both increases tax compliance and offsets negative effects of increased enforcement activity. While Kresch et al. (2023) do not study the

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[7] We note that quasi-voluntary compliance and the fiscal exchange model likely matter most for taxes that require more action from the taxpayer, such as property taxes or income taxes, as compared to a value-added tax (VAT) or other sales taxes, where people are compelled to pay immediately. In a recent paper, Weigel and Kabue Ngindu (2023) argue that quasi-voluntary compliance might originate in updated beliefs about government capabilities even if citizens do not perceive an explicit quid pro quo exchange of taxes for services.

[8] Bodea and LeBas (2016) also show that community provision of public goods can weaken the normative sense that citizens owe something to the state: if the community has found a way to substitute for services that the state might provide, citizens are less likely to believe that there is an obligation to pay taxes to the state.

effects of new service provision, they show that Brazilian citizens who have access to sewerage, a service not factored into their property tax rates, are more likely to pay property taxes than similar citizens who do not have such access. With the exception of Krause (2020), most studies on service delivery and tax compliance took place in middle-income countries; in this paper we assess whether these results replicate among households in one of the poorest countries in the world.

In Malawi, Martin et al. (2025) show that a bundled, "bottom-up" treatment — more public service provision, better communication between market vendors and the local government, and more transparency about revenue levels and spending — increased tax compliance among market vendors. Our study complements the findings in Martin et al. (2025) by examining the contextual bounds for when service provision can increase tax compliance. Martin et al. (2025) examines a very strong intervention with a focused sample (market vendors) who know about available services, want access to particular services, and directly benefit from those services. We focus on a broader sample — homeowners in under-served wards — and introduce a weaker intervention where benefits are widespread and there are more opportunities for free-riding and shirking on tax payments. Finding support for the relationship between service delivery and tax compliance here tells us more about the types of situations in which we may expect service delivery to encourage more tax compliance.

Many approaches that improve tax compliance in wealthier contexts have been ineffective in other contexts (Dom et al., 2022). Several aspects of our study context work against the hypothesis that new service provision will increase tax compliance. We implemented the study in informal areas of the city, some of which were newly incorporated into the city and did not have a history of paying property taxes. These study sites are places where income is low, trust in government is low, tax compliance is rare, neither descriptive nor injunctive norms support tax compliance, and government is only minimally present.

With low incomes (the median income in our sample is approximately USD 2.30/ day, based on 2018 exchange rates), even if citizens appreciate the increased service provision, they may not feel they have the resources to reward the city for service provision. As we show below, trust in government is very low and beliefs that some tax money is stolen are widespread. In a similar context of low trust and high perceived corruption in Nigeria, McCulloch et al. (2021) find no relationship between service provision and tax morale. Bratton and Gyimah-Boadi (2016) show that, throughout Africa, tax authorities and local governments are among the least-trusted institutions, with little variation across countries.

Descriptive and injunctive norms also work against tax compliance in Zomba. Tax compliance is rare: only about 18% of our respondents self-report compliance at baseline. And people know that it is rare: on average, our survey respondents believe that only 3 out of 10 of their neighbors pay property taxes, and over 25% of respondents believe *none* of their neighbors pay property taxes. Moreover, less than 40% of respondents believe citizens *should always* pay their taxes.[9]

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[9] These statistics might be particularly low because some of the study sites were newly incorporated into Zomba and did not have a history of paying property taxes.

As discussed above in the summary of the vicious circle, low baseline levels of service provision can work against tax payment — Gatt and Owen (2018) show that Nigerian citizens cite lack of service provision as one of the main reasons they do not pay taxes. The tax literature suggests that achieving tax compliance in this context is unlikely (Alm, 2019; Dom et al., 2022), but these are the contexts where tax compliance is most needed. If citizens do not respond to service shocks that cities can afford, then it will be very difficult for the city to be the first mover in the fiscal exchange.

Tax Compliance in Malawi

Our setting to study the fiscal exchange model is Zomba, Malawi. Zomba is a city of around 100,000 people, located in the southern part of the country. The fourth largest city in Malawi, it was the seat of the colonial government and continued to be independent Malawi's capital from 1964 until 1975, when the capital was moved to Lilongwe. Zomba remained the seat of parliament until 1994. Like many other cities in the Global South, Zomba struggles with service delivery and tax compliance. Few people pay taxes and the local government can therefore only provide a few services, mostly funded by subventions from the central government. Functioning essentially as a "budget-to-budget" government, Zomba is locked in a vicious circle where services are not provided because taxes are not paid, plausibly at least in part because services are not provided.

By law, Zomba requires that every homeowner pay a property tax, known locally as a "city rate." In planned areas of the city, households are required to pay 0.125% of their property value twice per year; in unplanned areas, households owe a flat rate of between MWK 3,000 and 10,000 (about USD 4 to 14 based on 2018 exchange rates) twice per year, depending on the size of their house. These tax revenues finance waste collection, street lighting, road maintenance, and other city services. The city concentrates its provision of public services in the areas of the city where people tend to pay property taxes — which are areas that developed earlier and where wealthier people live. Despite this connection between taxes and services and despite valuing these services, many households in the city do not pay their property taxes, leaving certain city wards underserved or entirely without some city services. The lack of services has, in turn, affected public health and the quality of life for the thousands of people living in those underserved wards.[10]

Tax compliance within the wealthier wards of the city tends to be high. The city can enforce tax compliance in wealthier areas because the city can more easily identify and therefore punish delinquent property owners. In contrast, other wards contain mainly densely packed informal housing, not all of which are listed in city databases or located on paved roads. The city's enforcement efforts in such areas typically focus on extracting owed taxes from a few easily identifiable taxpayers, rather than on obtaining new revenues from harder-to-identify potential taxpayers. As a result of the challenges of collecting taxes in the informal settlements in the city, the government has prioritized broadening the tax base by expanding into areas just outside the city's boundaries. The city can then register and tax the larger, wealthier properties in these

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[10] Authors' interviews, November 2016 and June 2018

newly incorporated areas, although the city also faces resistance to taxation in these areas.

As described above, quasi-voluntary tax compliance by citizens should be motivated by perceptions of a quid-pro-quo fiscal exchange, undergirded by beliefs that the state has enforcement capacity and that other citizens are making equitable contributions (Levi, 1989). These beliefs seem present, to a degree, in Zomba. Despite the challenges the Zomba city government faces in enforcing tax compliance, many residents do perceive the local government as having strong punishment capacity, as seen in Fig. 1. Residents vary widely in what they believe is the proportion of neighbors who are paying property taxes, as seen in Figs. 2 and 3. While most citizens believe very few neighbors pay, almost one-third of respondents believe 50% or more of their neighbors paid. At the ward-level, there is also variation: Wards B and F have more people who believe their neighbors pay, compared to other wards.[11]

Also in line with the fiscal exchange model, Zomba residents in our sample report a lack of service provision as one of the reasons why they do not pay property taxes while also acknowledging that the local government likely cannot deliver services due to a lack of resources. When asked if the local government would repair a local market damaged by fire, 1,171 out of 1,799 respondents said it would not; when asked why the local government would not, 661 out of the 1,171 (56.4%) felt that it was due to a lack of resources rather than to a lack of will. As this might suggest, very few residents reported access to government waste collection at baseline, as seen in Fig. 4. Yet waste collection was the most desired services of residents, both in our baseline survey and in qualitative interviews in these areas. In sum, these attitudes
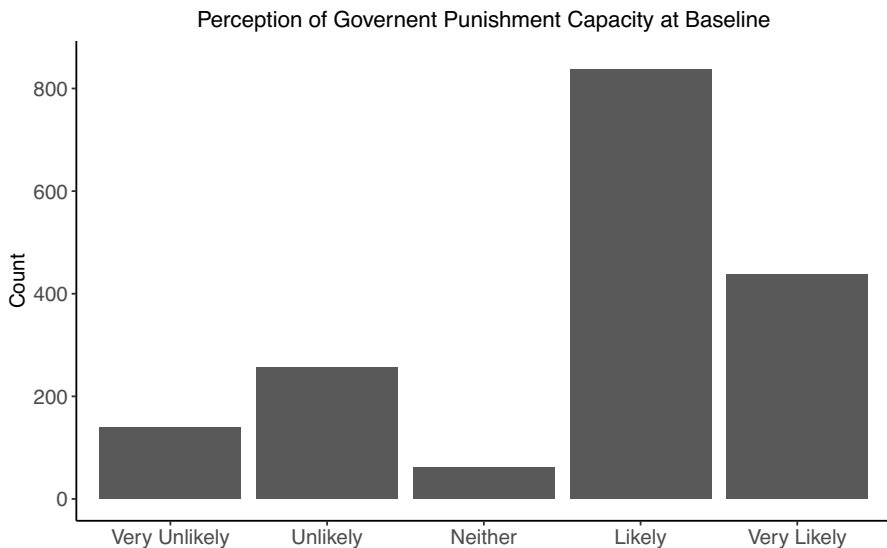

Fig. 1 Perception of Government Punishment Capacity at Baseline: N = 1734 (Total N = 1799, NA = 65). The question asks whether the local government will punish those who do not pay taxes. See Appendix A.1 for question wording

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[11] We do not name the wards to protect the anonymity of respondents.

Perception of Percentage of Neighbors
Who Pay Property Taxes at Baseline
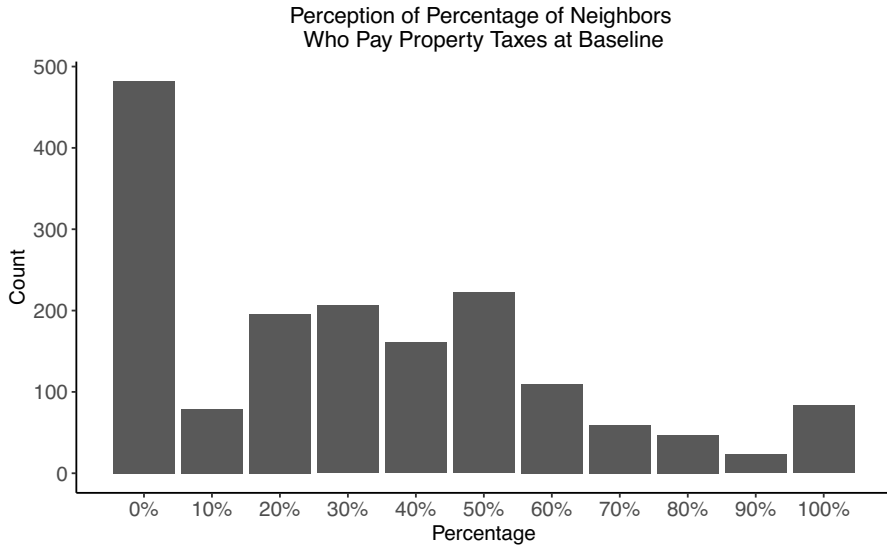
Fig. 2 Perceptions of Percentage of Neighbors Who Pay Taxes at Baseline: N = 1668 (Total N = 1799, NA = 131). See Appendix A.1 for question wording

Perception of Percentage of Neighbors
Who Pay Property Taxes at Baseline
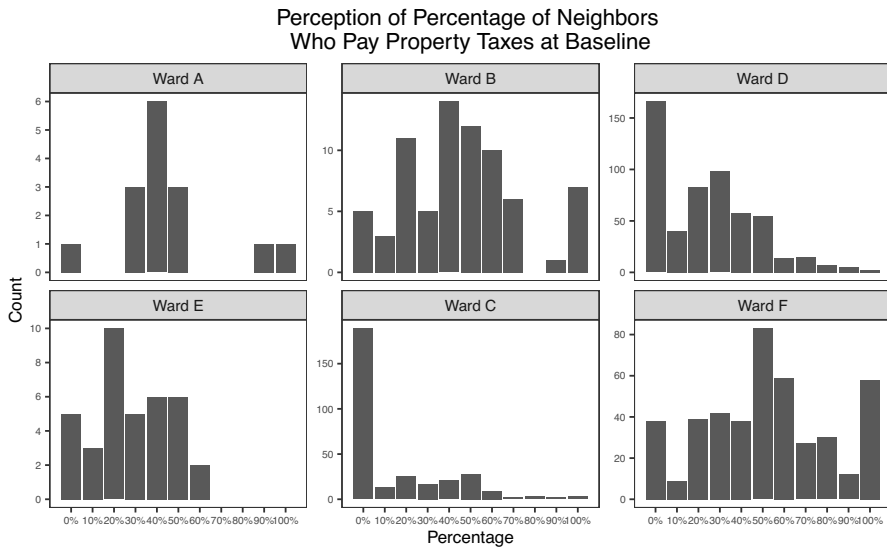
Fig. 3 Perceptions of Percentage of Neighbors Who Pay Taxes at Baseline by Ward: N = 1668 (Total N = 1799, NA = 131). See Appendix A.1 for question wording

Access to Government Waste Collection at Baseline
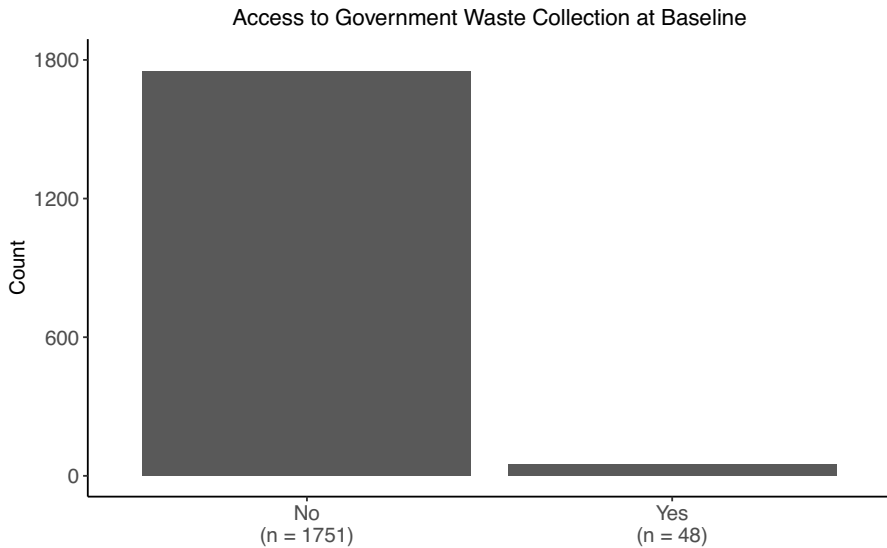
Fig. 4 Self-reported Access to Government Waste Collection at Baseline: N = 1799. See Appendix A.1 for question wording

among residents and the baseline lack of service delivery suggest that new waste collection may bring about increased quasi-voluntary tax compliance.

Research Design, Data, and Methods

We study how residents of Zomba, Malawi, react to an increase in public service delivery from Zomba City Council (ZCC), which began offering new public waste collection services to previously unserviced areas of the city. The city provided waste collection by placing eight waste skips in these areas of the city. A waste skip is a transportable dumpster; they can easily be loaded onto waste-collection trucks called "skip loaders" and transported to and from the city landfill when full. The city placed the skips in locations that maximized the number of residents with access; they also minimized the extra effort necessary for citizens to use this new service by placing waste skips in locations already being used as communal dumping sites. As a result of this system, the proportion of people who self-reported access to government waste collection rose from 2% at baseline to 23% at endline.

This new public service provision occurred as a result of the research team's collaboration with the ZCC, not specifically as a result of lobbying or activism by the people receiving the services. The fact that the impetus for the new service provision occurred without participation by the residents leads us to call this new provision of public services a "shock." We posit that, among residents who experience this shock in public service delivery, we should see improved attitudes toward the government, increased trust in the government, and more tax compliance behavior.

Although this new waste collection service likely would not have happened without the intervention of the research team, to activate the relationships proposed in fiscal exchange theory, residents needed to believe that this initiative was driven by ZCC and not by external actors. Most importantly, city staff operated the trucks, collected waste, and interacted with residents. For these types of services, it is not uncommon for the city to receive gifts, grants, or other forms of external support, yet people typically recognize the city as having responsibility for the realization of the services.[12] Based on our observations during the study period, residents believed the truck was donated to the city, but that ZCC fully owned and operated the truck. Residents interacted with city staff involved in collecting waste, and ZCC conducted public information campaigns to inform citizens about the new waste collection service they were providing. Overall, we are confident that residents understood this new waste collection service as one that was provided by and maintained by ZCC.

We are interested in studying the impact of this intervention to test two hypotheses derived from fiscal exchange theory. First, we expect to see an increase in trust in and the perceived legitimacy of the local government, including support for the incumbent political leaders, among residents who experience new access to waste collection when compared to residents who do not experience new access. Second, we expect to see an increase in property tax payments among residents who experience new access to waste collection compared to residents who do not experience new access.

We expect this shock in service delivery to be associated with more trust in and perceived legitimacy of the government because the government is providing a service that is demanded by residents. By taking the first step to provide this service, the government is showing that — when given the necessary resources — it will deliver services. Thus, the government signals it is a trustworthy partner in the fiscal exchange, which should encourage residents to have greater willingness to comply with the government. This leads to our expectation that increased trust resulting from improved service delivery will also manifest itself as more tax compliance.

Data

We collected both survey and administrative data to study the consequences of the shock to waste service delivery. The survey sampled homeowners in areas underserved by the city government.[13] These areas were selected in collaboration with the city government. They are informal neighborhoods where the city was providing minimal services but wanted to expand service delivery. They are also low-tax compliance areas — at baseline, self-reported payment was 18% across our sample.

Survey data collection occurred at three time points: before the beginning of new service delivery, just after new service delivery had started, and after ten months of

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[12] Even if residents perceived the truck and skips as externally driven, it is likely that they would still give credit to ZCC for facilitating the service, especially in a context where many residents know that ZCC does not have the resources to procure such services themselves. This would be in line with public sentiment found in the Afrobarometer (Sacks, 2012) and parallel to patterns observed in Uganda by Baldwin and Winters (2020).

[13] See Appendix 6.2 for the listing and sample selection protocol.

sustained service delivery. Waste collection has continued from March 2019 to the present, and we collected administrative data for tax payments from 2015–2022.[14] Table 1 describes the timeline of activities.

Exposure to New Service Delivery

We measure citizens' exposure to improved waste collection through their households' proximity to waste skips. We code all houses within 0.35 kilometers (approximately 0.2 miles) of the waste skips as those with meaningful access to new government waste collection. We create a binary measure for households that are "near" to skips (1) and those that are "far" from skips (0).[15] We employ this binary measure in a difference-in-differences-style analysis, comparing the change in attitudes and tax payments of households located near waste skips to households located far from waste skips. In this analysis, households within 0.35km of the skips are the treatment group and households farther than 0.35km are the comparison group. Figure 13 shows a map of the areas in the study and the placement of waste skips in the Appendix.

Attitudinal Outcomes: Trust, Legitimacy, Support for Political Incumbents

We combine survey responses into a trust-and-legitimacy index and a support-for-political-incumbents index. The trust-and-legitimacy index is a mean index that combines answers to questions asking respondents whether the local government has a right to tax, their level of trust in the local government, their expectations that the local government will use revenue to provide services to citizens, their evaluation of the local government, and whether they would attend a local government meeting.

Table 1 Data Collection Timeline

Activity (N)	Time
Baseline Survey (1799)	November to December 2018
Beginning of New Service	Early March 2019
Midline Survey (1586)	Late March to Early April 2019
Endline Survey (1528)	January to March 2020
Administrative Data Collection (443)	–

For each survey, enumerators went to all households enumerated in the baseline survey. There were 213 households included in the baseline survey that we were unable to contact at midline or endline and an additional 58 included in the baseline and midline surveys that we were unable to contact at endline. We collected administrative data covering 2015–2022

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[14] As we describe below, there are 443 individuals for whom we could match administrative records with survey responses. It appears that four households may have moved or transferred their houses after 2019; their tax records become "NA" in the administrative data. For 2015–2018, the administrative records report the yearly account balance of each household; for August 2018–December 2022, we have monthly balances for each household.

[15] We selected 0.35km based on survey responses. People who reported using the waste skips lived, on average, 0.32km from a waste skip, while those who reported not using the waste skips lived, on average, 0.43km from a waste skip. Thus, for the main analysis, we select 0.35km as a cut off between those who have access to the new service compared to those who do not. To show that our results are not sensitive to the 0.35km cutoff, we repeat our analyses for 0.25km, 0.30km, and 0.40km cutoffs as shown in Appendix 6.4.

The support-for-political-incumbents index is a mean index that combines answers to questions asking how respondents evaluate the work of the mayor, how they evaluate the work of their ward councilor, and their level of trust in the ward chair. Both indices are averages of the normalized measures of the underlying variables.[16]

Behavioral Outcomes: Tax Payments

The main behavioral outcome is property tax balance, which is measured using administrative data supplied by Zomba City Council that covers the period from August 2018 through December 2022. Tax balance is recorded at the monthly-level and it includes the net paid and owed taxes through the end of that month for a household, including any previous balances. Households can also own multiple properties; in that case, we aggregate to the household-level by calculating both the mean tax balance per household and the total tax balance per household.

We also calculate a second annual measure for whether the respondent paid during one-year periods covering November to October.[17] We consider any household who has paid at least once during a given November-to-October period as complying
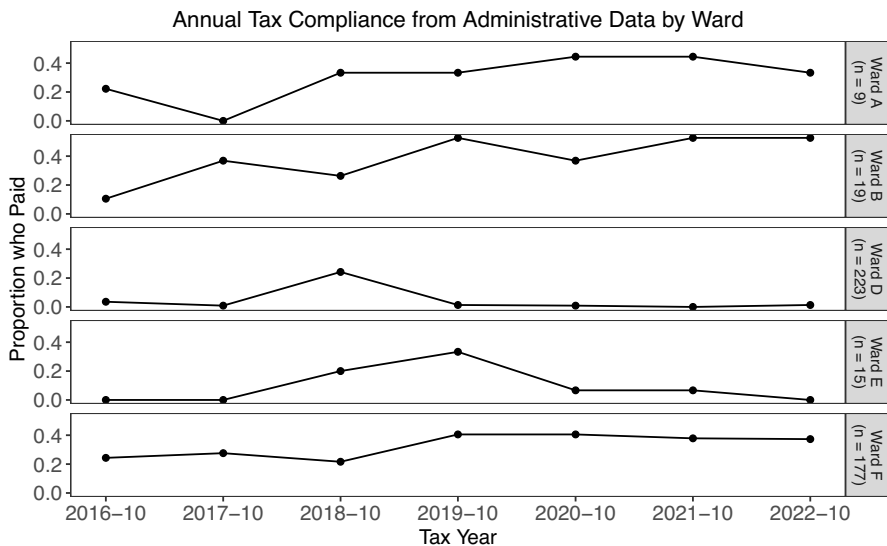
Fig. 5 Tax Compliance by Ward. Households who have paid at least once during a given November-to-October period are considered as complying with tax obligations for that period

[16] A full list of survey questions included in each index is available in Appendix Table 6.1. For both indices, we rescale all component variables to range from 0 to 1, and both indices have a minimum value of 0.

[17] We received annual tax balance data from November 2015 to October 2018 and monthly tax balance data from August 2018 to December 2022. Thus, we use the November–October period to keep the tax period consistent with data prior to 2018.

with tax obligations for that period.[18] Figure 5 shows how this measure breaks down by ward. Specifically, Wards B and F seem to have higher tax compliance than the other wards, which follows survey data showing that households in these two wards perceived that more of their neighbors pay taxes.

Results

Living Near Waste Skips and Attitudes

Figures 6 and 7 show baseline, midline, and endline averages of the attitudinal indices for households we code as either near a waste skip or not. These figures show preliminary evidence that households exposed to new service delivery improved their attitudes toward government but not necessarily toward political incumbents.

For the trust-and-legitimacy index, we see that the relative levels of trust in government across the two groups of households reverse after the beginning of waste collection: households near the waste skips, which previously scored lower on the trust-and-legitimacy index now score higher. Households near a waste skip had an average index score of 0.571 on the 0 to 1 scale while households farther from waste skips had an average index score of 0.583 before the introduction of new waste collection. Immediately after the waste skips arrived in March 2019, households in both groups had the same average score of 0.545. Almost a year later, in January 2020, households near waste skips reported an average trust and legitimacy score of 0.575 while households farther away reported an average score of 0.556.

The trends for the support-for-political incumbent index do not change in the same way as those for the trust-and-legitimacy index. Households near the waste skips had an average index score of 0.537 prior to waste skip placement, 0.568 immediately after waste skip placement, and 0.575 almost a year after waste skip placement. Households farther from the waste skips had an average index score of 0.550 prior to waste skip placement, 0.575 immediately after waste skip placement, and 0.583

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[18] In our analysis, the taxes-paid measures are created from monthly data and we record a household as complying with tax payments if they paid at least once in the 12 months from November to December. For data from 2018 and prior, we record households as complying with taxes if they paid that year. The survey data contain a self-reported measure of tax payment. In a comparison of the two measures, for the administrative data from the September 2019 pay period, 76% of the administrative data responses matched with the survey data responses. Overall, 60% of households for which we could match survey and administrative data did not comply with their tax obligations according to the administrative data and also reported that they had not complied in the endline survey; 21% did not comply with tax obligations according to the administrative data but reported that they had complied in the survey data; 16% complied with tax obligations according to the administrative data and reported that they had complied in the survey data, and only 3% complied with tax obligations according to the administrative data but reported in the survey that they had not complied. We suspect that the administrative data underreports payments. Multiple survey respondents noted the possibility that a resident could have a receipt proving payment of taxes without payment information being reflected in the city records. Because Zomba City Council was re-mapping the city during the study period, administrative data records were incomplete, and there were a number of households in the survey that we were unable to link to the administrative data. Overall, of the n = 1,799 individuals in the study, we were able to plausibly identify administrative data for n = 451 households which were present in the endline data, of which n = 443 had GPS coordinates. We suspect that the survey data overreports property tax payments due to social desirability bias.

Trust & Legitimacy Index
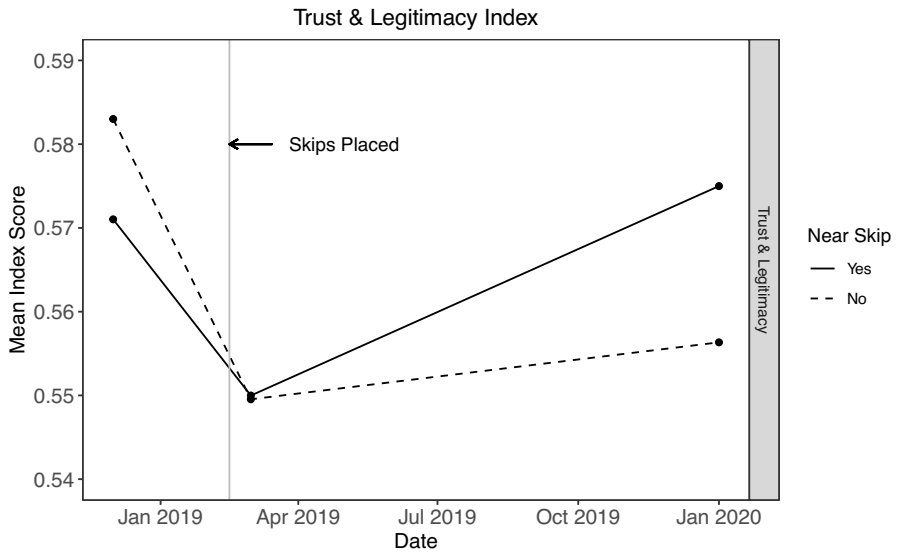
Fig. 6 Trust-and-Legitimacy Index from Survey Data: N = 1131 (Total N = 1528, NA = 397). Mean index scores for households near waste skips or not, where "Yes" are households within 0.35km or less of a waste skip and "No" are households that are farther than 0.35km from a waste skip. Indices are measured at baseline, midline, and endline. See Appendix A.1 for survey questions used in indices

Support for Political Incumbents Index
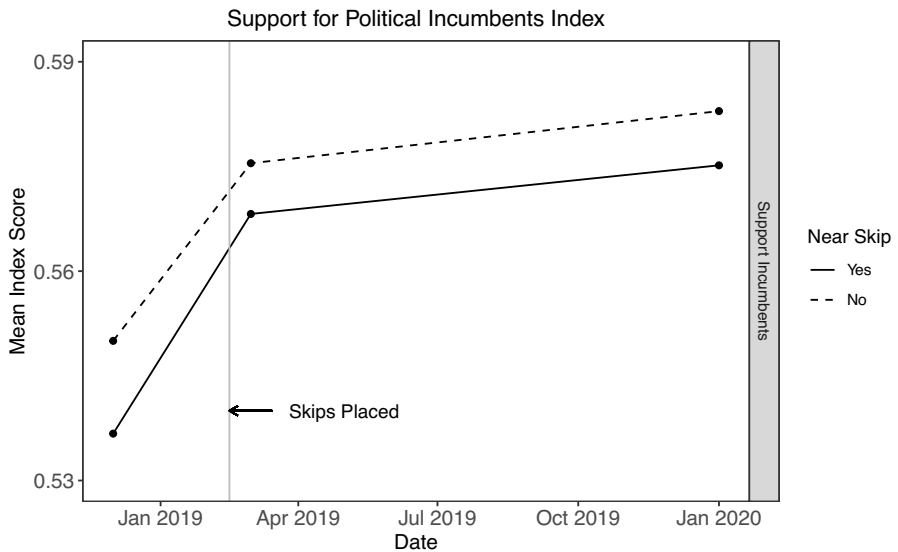
Fig. 7 Support-for-Political-Incumbents Index from Survey Data: N = 835 (Total N = 1528, NA = 703). Mean index scores for households near waste skips or not, where "Yes" are households within 0.35km or less of a waste skip and "No" are households that are farther than 0.35km from a waste skip. Indices are measured at baseline, midline, and endline. See Appendix A.1 for survey questions used in indices

almost a year after waste skip placement. In other words, households farther away from waste skips consistently expressed slightly more support for political incumbents than households near waste skips.

To adjust for differences in responses to the trust-and-legitimacy and support-for-incumbents indices at baseline, and to provide a measure of statistical uncertainty, we calculate differences between endline and baseline values for each index and then use a linear model to calculate the differences in those differences with associated clustered standard errors.[19] We estimate these models using Eq. 1, where $\Delta Y_{i,j}$ is the attitudinal change score outcome for respondent i in primary sampling unit (PSU) j between midline or endline surveys and the baseline survey, and $T_{i,j}$ is a binary indicator of whether the household location of respondent i is near a waste skip (within 0.35km). We used 91 PSUs in this study, and standard errors are clustered at the PSU-level (j).[20]

$$\Delta Y_{i,j} = \beta_0 + \beta_1 T_{i,j} + \epsilon_{i,j} \tag{1}$$

Figure 8 presents the coefficients from this model, summarizing the information from Figs. 6 and 7, and showing that proximity to a waste skip positively correlates with increases in the trust-and-legitimacy index.[21] After almost a year of new waste collection in Zomba, individuals who lived near the waste skips showed improved attitudes toward the local government. We do not find similar results for individuals' support for political incumbents. Individuals who live near waste skips are no more likely to positively evaluate their mayor, councilor, or ward chair than those who live farther away from waste skips.
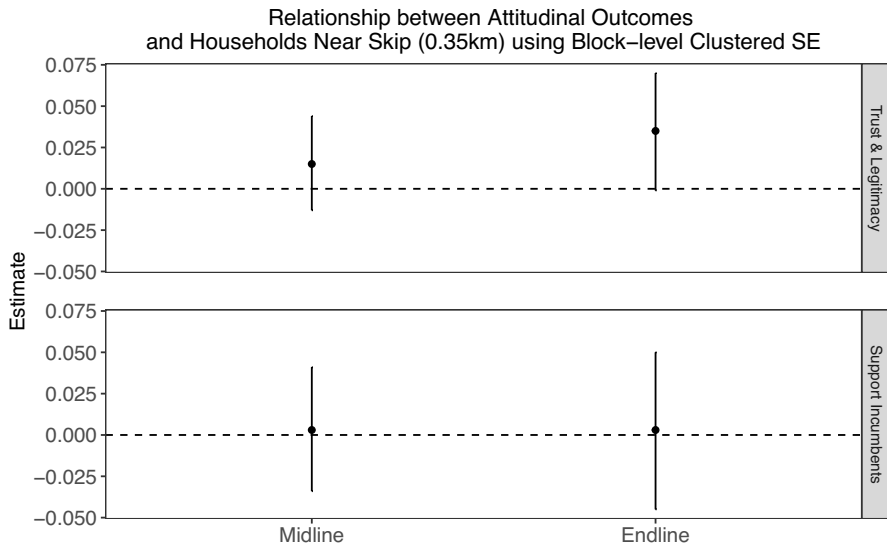
Proximity to Skips and Tax Compliance

Figure 9 shows that households far from waste skips tend to have larger average monthly balances, and thus owe more taxes, than households near waste skips. Prior to waste skip placement, between August 2018 to February 2019, the average monthly difference between the average tax balance of households far from a waste skip and near a waste skip was MWK 24,453. After waste skip placement, the average monthly difference increased to MWK 33,907 from August 2019 to February 2020. The average monthly difference grew more quickly to MWK 48,333 during the period spanning August 2020 to February 2021; and most dramatically to MWK 74,571 during the August 2021 to February 2022 period. This pattern is consistent

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[19] We use the change score rather than including the baseline outcome as a term in the linear model because baseline outcomes were not balanced between near-skip and not-near-skip households (DeclareDesign, 2019).

[20] We chose to cluster standard errors at the PSU-level because this is the level at which we believe the households to be the most similar. We determined PSUs by walking through the city and noting geographical structures like roads, rivers, hills, and other signals that naturally separated one PSU from another. In Table 6 in the Appendix, we report the average ICC at the PSU-level and compare it to the ICC calculated at the skip-level.

[21] We also report results using HC2 robust standard errors without clustering in the Appendix (see Fig. 16).

Relationship between Attitudinal Outcomes and Households Near Skip (0.35km) using Block–level Clustered SE

Fig. 8 Average Differences in Attitudinal Change Scores by Proximity to Skip. "Near Skip" households are within 0.35km or less of a waste skip and the reference group households are farther than 0.35km from a waste skip. Linear regression coefficients shown with 95% confidence intervals using CR2 clustered standard errors at the PSU-level

Average Monthly Balance
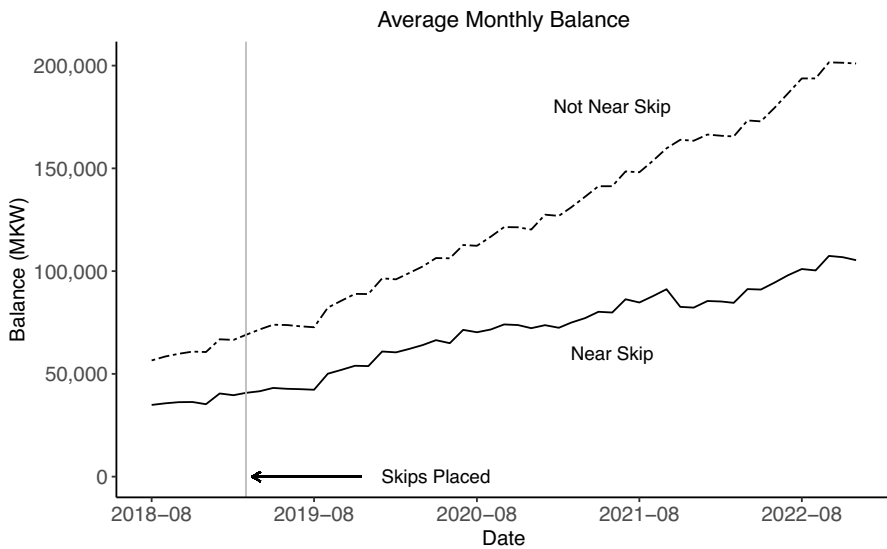
Fig. 9 Average Tax Balance by Month. N = 443 (249 near waste skip and 194 not near waste skip), where "Near Skip" are households within 0.35km or less of a waste skip and "Not Near Skip" are households that are farther than 0.35km from a waste skip. If one household owns several properties, the average tax balance of those properties is recorded

with the explanation that households near waste skips became more inclined to pay their property taxes after waste skip placement than they had been previously.

Figure 10 shows the proportion of households who paid taxes at least once per November–October period. Just prior to waste skip placement, 25.7% of households near waste skips paid taxes at least once compared to 20.6% of households not near a waste skip. By 2019, after placement of the skips, 23.7% of households near waste skips had paid at least once compared to only 16.5% of households not near a waste skip. This difference widens in 2020, where 24.1% of households near waste skips paid compared to 12.4% of households farther away. In 2021, the difference decreased where 20.5% of households near skips paid compared to 15.5% of households farther away, and in 2022, 22.1% of households near skips paid compared to 13.9% of households farther away. Overall, the tax compliance gap grows in the period after waste skips are placed.[22]

We summarize the patterns found in Figs. 9 and 10 using regressions reported in Figs. 11 and 12. These figures show endline-versus-baseline change scores and use a linear model to calculate confidence intervals based on CR2 clustered standard errors at the PSU-level.[23] We analyze tax balances in December of 2019, 2020, 2021, and

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[22] While we include data points for 2016 and 2017 in the figure, the administrative data for these years
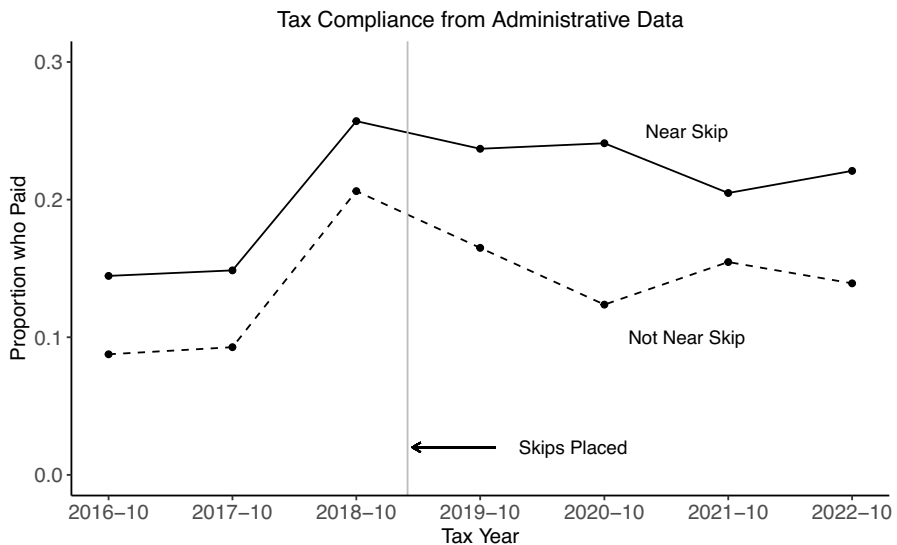
Fig. 10 Tax Compliance. N = 443 (249 near skip and 194 not near skip), where "Near Skip" are households within 0.35km or less of a skip and "Not Near Skip" are households that are farther than 0.35km from a skip. Proportion of respondents who paid taxes at least once per November-October period between 2016–2022

includes substantial missing data; we are less confident about the accuracy of these data but felt it important to provide context for these trends.

[23] For the tax balance results, we also show results using HC2 robust standard errors (see Fig. 17) and ward-level fixed effects (see Fig. 18) in the Appendix.
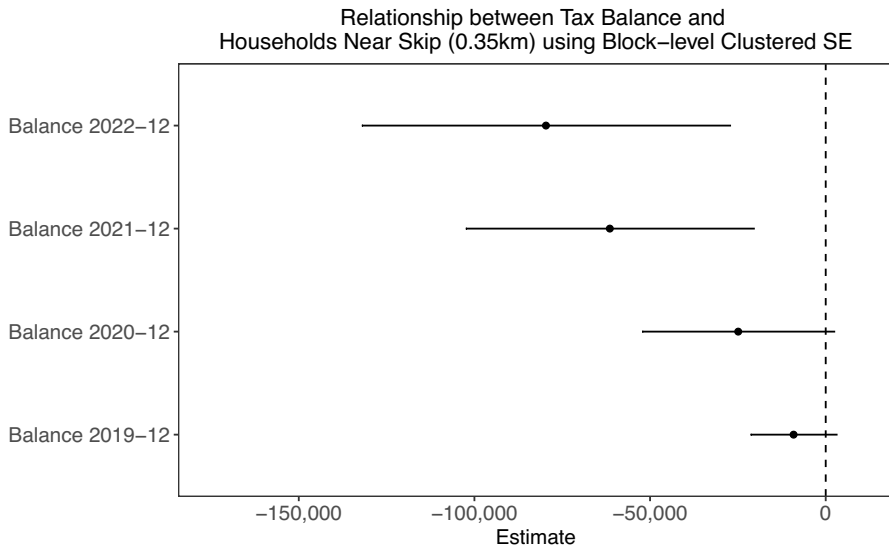
Fig. 11 Mean Differences in Change in Tax Balance. Based on administrative data from households near skip ($\leq$ 0.35km) versus far from a skip. Yearly tax balance is measured as a change score (the difference between the year-end balance for the indicated year and the February 2019 tax balance). "Near Skip" households are within 0.35km or less of a skip, and the reference group households are farther than 0.35km from a skip. Coefficients are shown with 95% confidence intervals based on CR2 clustered standard errors at the PSU-level from a linear model regressing change score on an indicator for being near a skip

2022 separately. To calculate the December 2019 tax balance change score, we use the total tax balance after waste skips were placed in December 2019 and the tax balance right before waste skips were placed (February 2019); we follow the same procedure for the other annual change scores, replacing the December 2019 tax balance with December 2020, 2021, and 2022. We also analyze yearly tax compliance from 2019–2022, calculating the yearly change score based on whether or not any taxes were paid in 2019, 2020, 2021, and 2022 relative to 2018. To estimate these regressions, we also use Eq. 1, where $\Delta Y_{i,j}$ is the tax change score for a certain year for the household of respondent i in PSU j and $T_{i,j}$ is a binary indicator for whether the location of respondent i's household is near the skip (within 0.35km) or not. Again, standard errors are clustered at the PSU-level (j).

Looking at the change in average tax balance, Fig. 11 shows that proximity to a waste skip correlates with increased tax payments, even after accounting for initial differences across the two groups by using the change score. This mean difference increases every year and is statistically significant at conventional levels starting in 2021. In 2019, households near waste skips paid on average an additional MWK 11,455 more than households not near waste skips, but this difference is not statistically significant. The distribution of balances involves both many zeros and very long tails, so we also use a Wilcoxon rank-sum test to examine the null hypothesis that households near waste skips did not have higher or lower tax balance than households far from waste skips (instead of the null hypothesis of no *average* differences
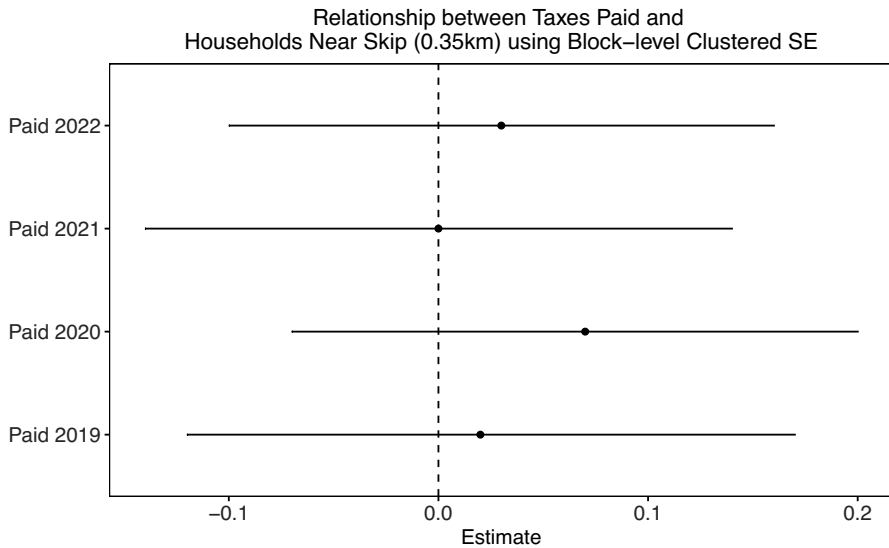
Fig. 12 Change in Proportion Paying Taxes. Based on administrative data comparing households near skip ($\leq$ 0.35km) versus far from a skip. The outcome is measured as a change score (the difference of each year and 2018 payment status). "Near Skip" are households within 0.35km or less of a skip and the reference group households are farther than 0.35km from a skip. Coefficients are shown with 95% confidence intervals from a linear model of difference in any tax payment as a function of nearness to skip, using CR2 clustered standard errors at the PSU-level

between groups). The *p*-value for this test for the 2019 comparison is $p = 0.003$, indicating that, as early as 2019, households near waste skips paid more taxes than households not near waste skips, even if we cannot distinguish the difference in *mean* payments from zero at $\alpha = 0.05$.[24]

In 2020, the implicit additional average amount of taxes paid by households near waste skips relative to those far from waste skips was MWK 26,829, and the *p*-value associated with this mean difference is now 0.07. The Wilcoxon rank-sum test returns $p \leq 0.001$. In 2021, the additional amount was MWK 59,374 (mean difference $p \leq 0.01$; Wilcoxon rank-sum test $p \leq 0.001$), and in 2022, the additional amount was MWK 75,325 (mean difference $p \leq 0.01$; Wilcoxon rank-sum test $p \leq 0.001$). The confidence intervals for each year vary because the variance of the change score increases over time — some households owe more and more over time as they do not pay taxes while other households continue to pay on time. We also note that these balances are cumulative, which means that balance data from 2022 reflects tax payments — or the lack thereof — from 2021, 2020, 2019, and earlier.

The confidence intervals and *p*-values just reported are calculated as if each year were independent, but that is not the case. The Holm (1979) adjustment for test-

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[24] We use a Wilcoxon rank-sum test because tests of mean differences for skewed data suffer from inflated false negative errors. The Wilcoxon rank-sum test does not accommodate clustered standard errors, so we also used a ranked version of each tax balance change score in Eq. 1 and clustered standard errors at the PSU-level. All p-values for these rank-based 2019-2022 outcomes were $p \leq 0.01$.

ing four independent hypotheses inflates all four rank-based test *p*-values to 0.004; it inflates the mean difference *p*-values in 2021 and 2022 to 0.016. An adjustment accounting for the lack of independence of these four tests would inflate them less. The analysis, even after the Holm adjustment, shows clearly that those living near a waste skip paid more in taxes than those living far from the waste skips after the skips were installed as compared to before the skips were installed.

In Fig. 12, we report the results for the analysis of whether there are differences across groups using a binary indicator for any tax payment in 2019, 2022, 2021, or 2022.[25] There is no clear increase in payment in these four years.[26] In combination, the results of these two figures suggest that access to new waste collection did not strongly increase the number of households who paid any taxes. Rather, the new waste collection encouraged households who were already paying at least some taxes some of the time to pay a larger proportion of their taxes.[27]

To explore this interpretation of the results — that is, to assess whether the same households that may have started paying taxes are simply paying more of their taxes — we identified households' tax payment patterns before and after the waste skips were installed. The top row of Table 2 shows that fewer households near waste skips never paid, compared to households far from waste skips (49.0% versus 59.8%). The second row from the top shows that slightly fewer households near waste skips stopped paying after 2018 when they had already been paying before 2018 compared to households far from waste skips (12.4% versus 13.4%).

From Table 2, it seems that households near waste skips went from not paying taxes to paying taxes at a higher rate than households far from waste skips (34.1%

Table 2 Payment Patterns by Proximity to Skip

Group	Near Skip	Not Near Skip
No payment 2018; No payment 2019-2022	49.0% (122)	59.8% (116)
Payment 2018; No payment 2019-2022	12.4% (31)	13.4% (26)
No payment 2018; 1 Payment 2019-2022	10.8% (27)	8.8% (17)
Payment 2018; 1 Payment 2019-2022	3.6% (9)	2.6% (5)
No payment 2018; 2 Payments 2019-2022	5.6% (14)	4.1% (8)
Payment 2018; 2 Payments 2019-2022	1.6% (4)	0.5% (1)
No payment 2018; 3 Payments 2019-2022	4.0% (10)	2.6% (5)
Payment 2018; 3 Payments 2019-2022	2.0% (5)	3.1% (6)
No payment 2018; 4 Payments 2019-2022	4.8% (12)	4.1% (8)
Payment 2018; 4 Payments 2019-2022	6.0% (15)	1.0% (2)

Respondents who paid or did not pay in 2018 and number of times paid from 2019–2022 according to Zomba City Council administrative data; percentages and number of respondents are both reported; n = 443

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[25] We also show results using HC2 robust standard errors (see Fig. 19) and ward-level fixed effects (see Fig. 20) in the Appendix.

[26] Since the outcomes for this analysis are binary, we do not present another auxiliary hypothesis test here. A chi-squared test would not have more statistical power than the difference in proportions/means tests that we present here.

[27] Our examination of the administrative tax data from Zomba City Council reveals that partial payment of taxes is common in Zomba.

vs 24.7%[28]). The table also reveals how sporadic patterns of payment can be: among taxpayers who had not paid in 2018 but did make payments after the intervention, nearly twice as many made only one or two payments relative to the number that made three or four payments. Combined with Fig. 11, this suggests that while more households near the skip are paying at a *higher rate*, this lack of consistency in payments makes it difficult to detect significant changes between the *number of households* that are paying near skips and far away.

Overall, these tax data suggest that households near waste skips seemed to pay a larger proportion of what they owed compared to households far from waste skips after the new service provision. While it appears that households near skips may have also started paying — and may have paid more often — than those far from skips, these patterns are not statistically significant. Thus, the fact that tax balances decreased significantly for those near waste skips compared to those far from waste skips, but there was not significant difference for the proportion of people who paid, provides stronger evidence that households near waste skips who were already paying started to pay more of what they owed.

Finally, we can imagine an alternative scenario that would lead to these same results: if households far from the waste skips feel resentment toward Zomba City Council for not providing waste skips in their area, perhaps they refuse to pay their taxes as a backlash. To explore this possibility, we break down the trust-and-legitimacy index to determine if the attitudes towards the city government become more negative among respondents far from a waste skip after the waste skips are placed. These analyses are reported in Table 4 in the Appendix.

While the overall trend for the trust-and-legitimacy index diverge, most of the components of the index have similar trends. These similar trends would suggest that resentment was not a major factor. Four of the six factors all move in the same direction: Residents' evaluation of ZCC and residents' trust in ZCC increase for both groups, while whether residents would attend a ZCC meeting and whether they refused or would refuse to pay taxes decreased for both groups. Two other components diverge — the share of taxes spent on services and ZCC's perceived right to tax. In this case, those near the waste skips have positive change scores while those far from the waste skips have negative change scores. If residents not near waste skips resented ZCC, we would expect a systematic divergence across every component of the trust-and-legitimacy index, and we would especially expect their evaluation of ZCC and their trust in ZCC to decrease. Instead, residents far from skips trust ZCC *more* and evaluate it *more positively* over time. As a result, we do not believe that resentment explains changes in tax balances or that households further from skips felt resentment towards ZCC for providing trash collection to other areas.

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[28] These percentages are the share of 2018 non-payers who began paying after 2018, by group.

Robustness Checks

We conduct a series of additional analyses, where we alter the definition of what it means to be "near" a waste skip, and report the details in Appendix 6.4. One set of additional analyses use living within 0.25km, 0.30km, and 0.40km of a skip to mean "near" a skip. Another set of analyses use self-reported measures of skip use. We measured self-reported use in two ways: unprompted and prompted. In the unprompted version, respondents told enumerators that they disposed of their trash in waste skips in an open-ended question, where enumerators did not explicitly offer "skips" as a response option. In the prompted version, enumerators asked respondents explicitly about their use of the waste skips.[29]

We also conduct analyses with alternative model specifications. We report estimates from a doubly robust difference-in-differences estimator (Sant'Anna & Zhao, 2020). We also report results from models with a linear and additive adjustment for a baseline socioeconomic index. In all cases, the main findings hold: the trust-and-legitimacy index increases at endline for those who have new waste collection and tax balances increased in the years after waste skip placement.

Conclusion

The results from our study in Zomba, Malawi, show that a positive shock to service delivery correlates with improved trust in the local government, improved perceptions of local government legitimacy, and increased tax revenue to the local government. The increased government trust and perceptions of government legitimacy align with expectations from Levi (1989) and other work on fiscal exchange and quasi-voluntary compliance. When the government shows that it can perform and deliver, residents are more likely to trust the government and evaluate it positively. In line with results from Argentina (Carrillo et al., 2021), Brazil (Kresch et al., 2023), Haiti (Krause, 2020), and Mexico (Gonzalez-Navarro & Quintana-Domeque, 2015) and from another recent study in Malawi (Martin et al., 2025), we show that exposure to public service delivery can improve tax compliance.

Did our intervention really initiate a virtuous circle? A quick analysis suggests that it did — that the increase in tax compliance can fund the new service delivery. We estimate that the service delivery shock generated at least MWK 26,606,078 (approximately USD 33,258 at the time of our study) and as much as MWK 88,443,281

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[29] The unprompted version of the question occurred ahead of the prompted version in the survey.

(approximately USD 110,554).[30] The city reports that collecting waste from the eight skips in our study will cost them MWK 12,612,205 in 2025 (approximately USD 7,277 using the current exchange rate). If we assume that collecting from those skips cost USD 7,277 for each year of our study (2019–2022), this intervention cost the city approximately USD 29,111. The skip loader and skips themselves cost approximately USD 50,000 but were donated to the city as part of the research. At minimum, the new service provision covers all operating costs; at best, it more than covers the full cost of procuring and operating the system (details of these calculations are shown in Appendix section 6.5).

These calculations likely underestimate the total value of the skip system to the city because they ignore downstream benefits of waste collection. For example, the city believes the waste collection reduced (waterborne) disease burden, which in turn improves public health and reduces the cost of city-provided health services. While we do not attempt to model the value of these positive externalities, the city's behavior clearly indicates that they believe the waste collection has been worth the cost — ZCC has purchased 10 new skips since our study ended.

On the one hand, tax compliance almost certainly depends on some basic government ability to enforce tax laws. This study occurred in a context where citizens perceive that the local government has the capacity to punish those who do not pay. This study, however, did not increase enforcement: there were neither additional rounds of tax collection nor additional visits from tax collectors that might have given residents more opportunities to pay. Our analyses therefore suggest that more residents complied with tax payments *voluntarily*, following the introduction of new service delivery. Under the right conditions, increasing service delivery can yield more revenue for local governments, which can help local governments exit from a low-capacity trap.

A Appendix

A.1 Measurement

Table 3 presents all of our measures. All variables are rescaled to the [0,1] interval, and we then take the average value for the index.

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[30] USD 33,258 is a conservative estimate; it assumes (1) we do not miss any households when connecting our survey data with city tax data, and (2) renter-occupied houses do not pay any additional property tax as a result of the new waste collection (renters were not part of our sample). USD 110,554 is likely a high estimate; it assumes renter-occupied houses near the skip respond identically to owner-occupied houses.

Table 3 Measures

Index/Concept	Measures (Response)	Variable Rescaled
Trust & Legitimacy Index	"Have you refused to pay a tax or fee as a way of expressing dissatisfaction with the city government?" (Yes, No) "Would you do this if you had the chance, or would you never do this?"(Would do this if had the chance; Would never do this)	1 = No to both questions, 0 otherwise
	"Please tell me how strongly you agree or disagree with the following statement: ZCC has the right to make people pay city rates." (Strongly agree, Agree, Neither agree nor disagree, Disagree, Strongly Disagree)	0 = Strongly Disagree to 1 = Strongly Agree
	"I am going to name a number of organizations and groups of people. Could you tell me how much TRUST you have in each organization or group?: Zomba City Council" (No trust at all, No trust, Trust, Trust a lot)	0 = No trust at all to 1 = Trust a lot
	"How do you evaluate the work of Zomba City Council?" (Very Good, Good, Neither Good nor Bad, Bad, Very Bad)	0 = Very Bad to 1 = Very Good
	"Imagine that Zomba City Council asked citizens to attend a meeting in your area on an important topic. How likely or unlikely would you be to participate?" (Very unlikely, Unlikely, Neither likely nor unlikely, Likely, Very Likely)	0 = Very unlikely to 1 = Very Likely
	"Now I would like to ask you what you think Zomba City Council will do with the money it receives from City Rates. Imagine that these marbles represent the Kwacha that Zomba City Council receives in City Rates. How many of these marbles will be used to provide services to all its constituents?" (0-10)	0-1
Support Incumbents Index	"How do you evaluate the work of the Zomba Mayor/the local ward councilor?" (Very Good, Good, Neither Good nor Bad, Bad, Very Bad)	0 = Very Bad to 1 = Very Good
	"I am going to name a number of organizations and groups of people. Could you tell me how much TRUST you have in each organization or group?: Your local ward councilor" (No trust at all, No trust, Trust, Trust a lot)	0 = No trust at all to 1 = Trust a lot
Government Punishment Capacity	"How likely is it that Zomba City Council will punish people who do not pay City Rates?" (Very Unlikely, Unlikely, Neither Likely nor Unlikely, Likely, Very Likely)	NA
NA Neighbors Who Pay Taxes	"Out of 10 people in this neighborhood who are supposed to pay City Rates, how many do you think actually pay the City Rates owed to Zomba City Council?" (0-10)	0-100%
Access to Government Waste Collection	"Who collects your trash? How do you currently dispose of your trash?' (City Government collection, Private collection, Respondent Describes Skip, No collection - burn, No collection - river, No collection - rubbish pit, No collection - other)	1 = City Government collection, 0 otherwise

A.2 Listing and sample selection procedure

We created our sample according to the following steps:

First, we worked with Zomba City Council to identify areas of the city that did not currently receive waste collection but where waste collection could feasibly be provided. We then conducted a listing exercise to create maps of households in these areas and identify homeowners. (As only homeowners pay city property taxes, we target only owner-occupied households in order to study individuals who are respon-

sible for paying the tax.) To conduct this listing exercise, we used satellite data and local knowledge to create enumeration areas for the listing survey based on natural divisions (e.g., bridges, major avenues, farm land). We then randomly ordered these enumeration areas and listed households within them until we identified over 2,000 homeowners. To identify homeowners and create maps of households, enumerators approached each household in an enumeration area and inquired whether it was owner-occupied or not, automatically marking its GPS point on their survey tablets. In the event that the residents were not at home, enumerators solicited information about whether the house was owner-occupied from neighbors and local leaders. In the end, we listed over 2,200 homeowners.

Second, we used the GPS coordinates from the listing exercise to demarcate owner-occupied households into 91 PSUs with similar numbers of households (about 25), using natural boundaries where possible.

Third, we randomly ordered homeowners and selected the first 78% of homeowners from each PSU so that we have roughly 1,800 homeowners in the study. By selecting a percentage and not an absolute number, we ensured that larger PSUs are not underrepresented and smaller PSUs not overrepresented in the individual level data. Ordering homeowners before selection allowed us to randomly replace respondents who do not consent or who were not eligible for the study with the next homeowner in the non-consenting homeowner's PSU.

We attempted to survey all households in the sample at baseline, midline, and endline. Surveys were confirmed with daily random backchecks, specific backchecks based on survey data quality checks, GPS data, demographic data, and metadata that stores the time spent on each survey question.
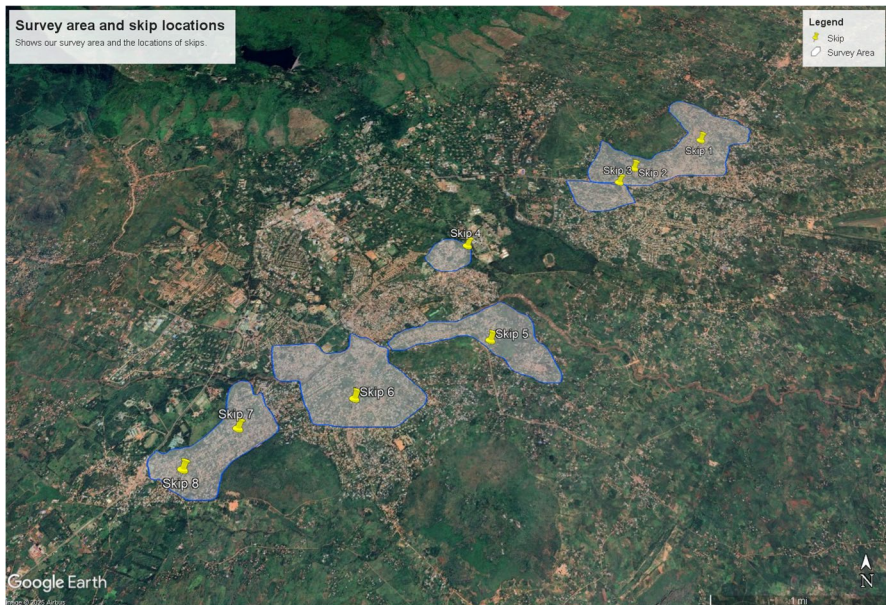
Fig. 13 Map of areas with households in study and waste skip placement

A.3 Additional Tax Compliance Measures

Figure 14 shows the total taxes owed ("balance") from households near and farther away from skips per month. This total is the sum of all tax balances by month These trends are similar to those from average monthly balance, shown in the paper.

We also show the average of the total balance by households near and farther away from waste skips in Fig. 15.
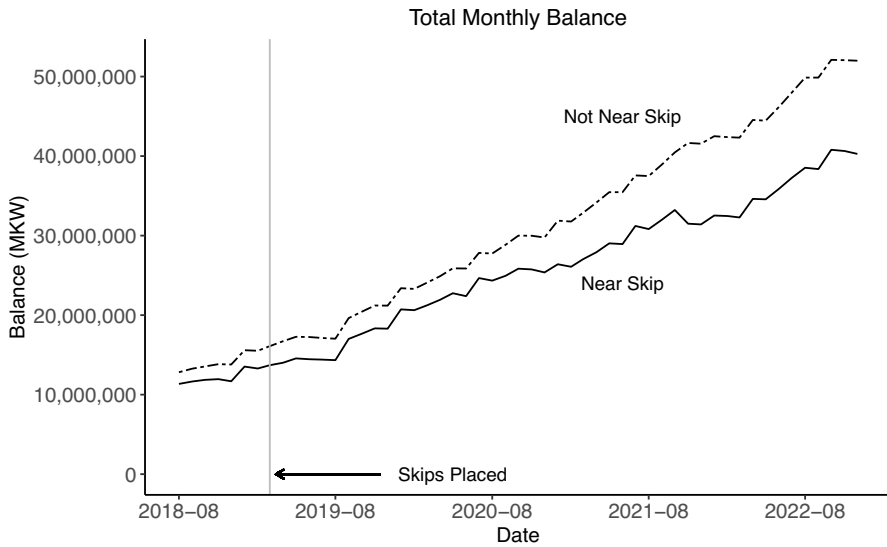

Fig. 14 Cumulative total balance by month. N = 443 (249 near skip and 194 not near skip), where "Near Skip" are households within 0.35km or less of a skip and "Not Near Skip" are households that are farther than 0.35km from a skip. If one respondent owns several properties, the sum of those properties is recorded

Mean Total Monthly Balance
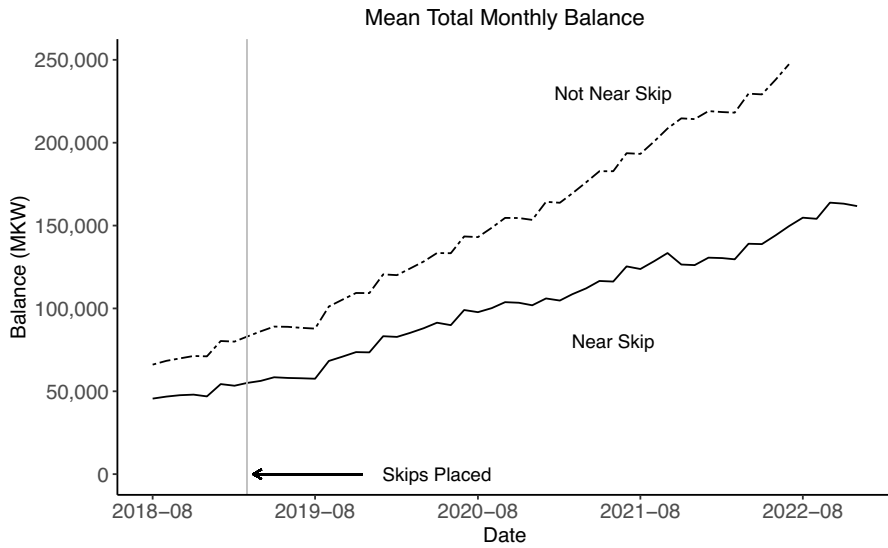
Fig. 15 Average total balance by month. N = 443 (249 near skip and 194 not near skip), where "Near Skip" are households within 0.35km or less of a skip and "Not Near Skip" are households that are farther than 0.35km from a skip. If one respondent owns several properties, the sum of those properties is recorded

A.4 Robustness Checks

A.4.1 Additional specifications for attitudinal outcomes
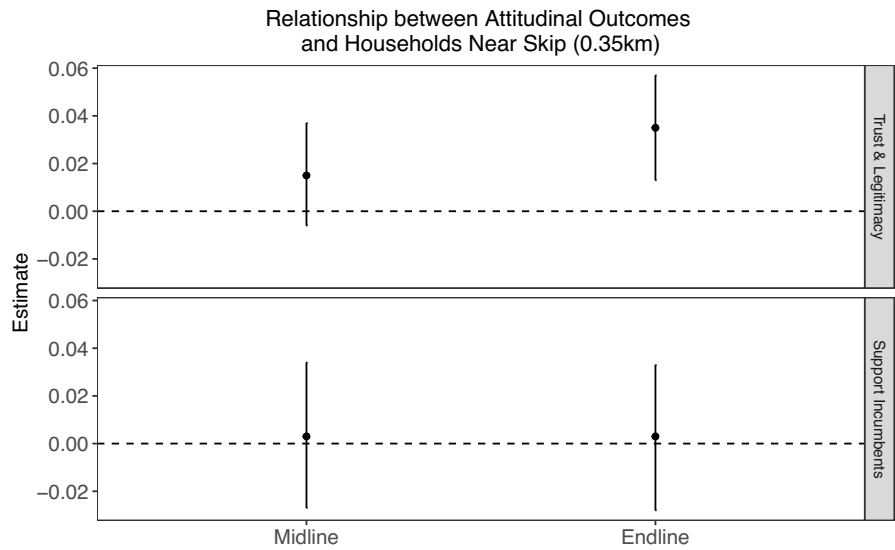
Fig. 16 Average Differences in Endline-vs-Baseline Differences in Attitudes by Proximity to Skip. "Near Skip" households are within 0.35km or less of a waste skip and the reference group households are farther than 0.35km from a waste skip. Linear regression coefficients shown with 95% confidence intervals using HC2 robust standard errors

A.4.2 Additional specifications for tax outcomes
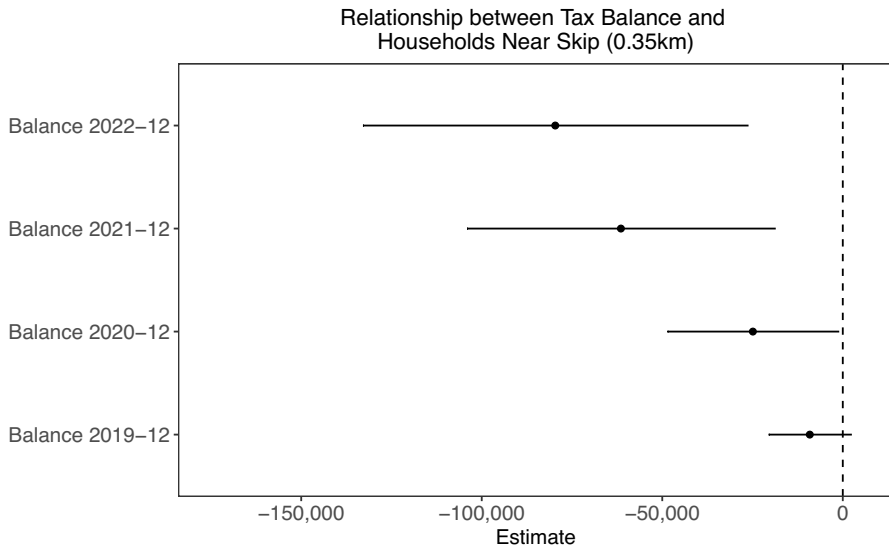
Fig. 17 Relationship between Tax Balance and Household Near Skip, using HC2 robust standard errors

Fig. 18 Relationship between Tax Balance and Household Near Skip, using fixed effects at the ward-level

Relationship between Taxes Paid and
Households Near Skip (0.35km)
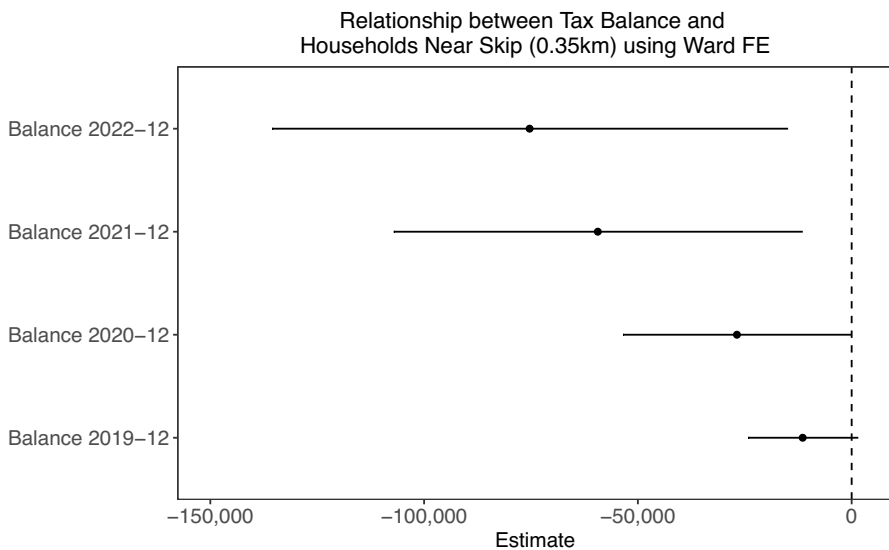
Fig. 19 Relationship between Taxes Paid and Household Near Skip, using HC2 robust standard errors
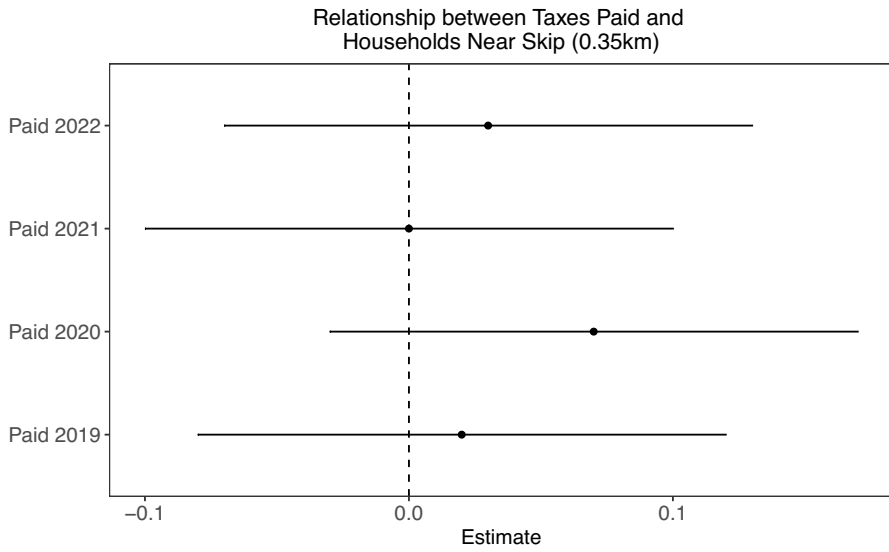
Relationship between Taxes Paid and
Households Near Skip (0.35km) using Ward FE
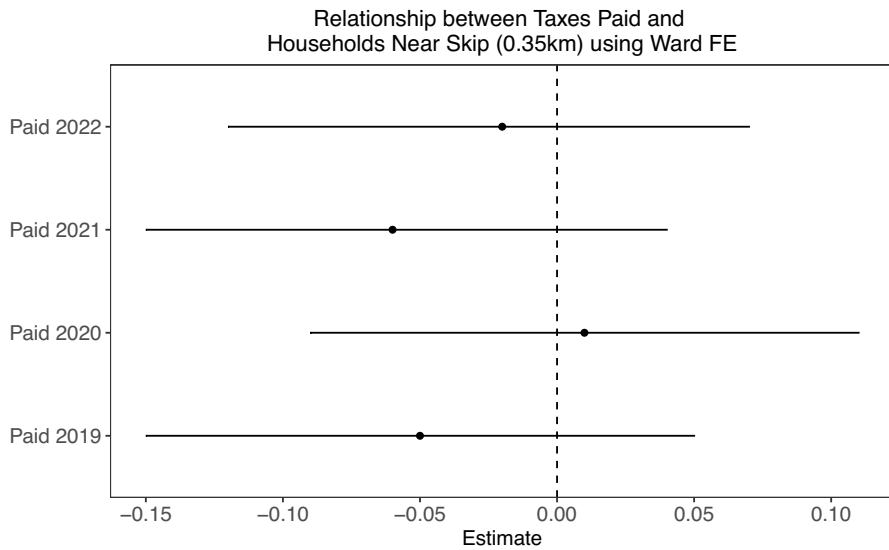
Fig. 20 Relationship between Taxes Paid and Household Near Skip, using fixed effects at the ward-level

A.4.3 Multiple specifications for Attitudinal and Tax Outcomes
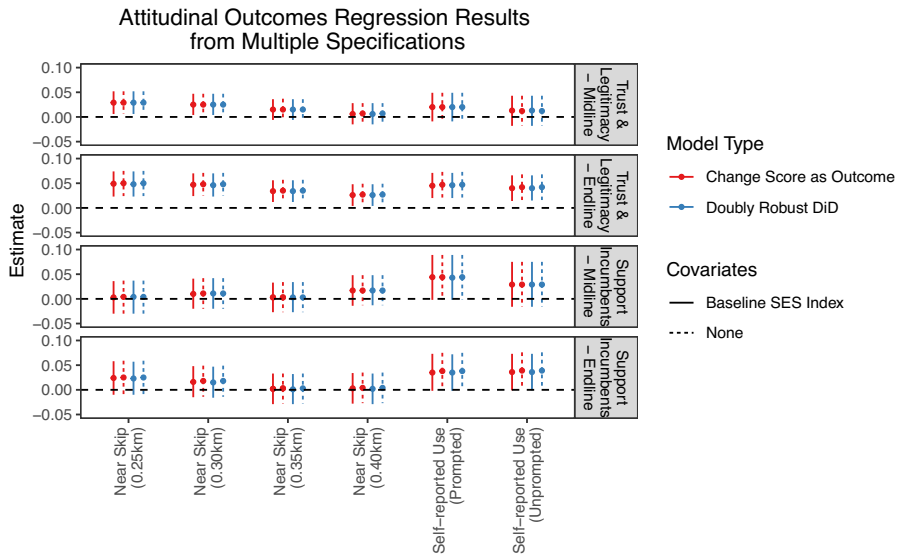
Fig. 21 Regression results from multiple specifications for attitudinal outcomes
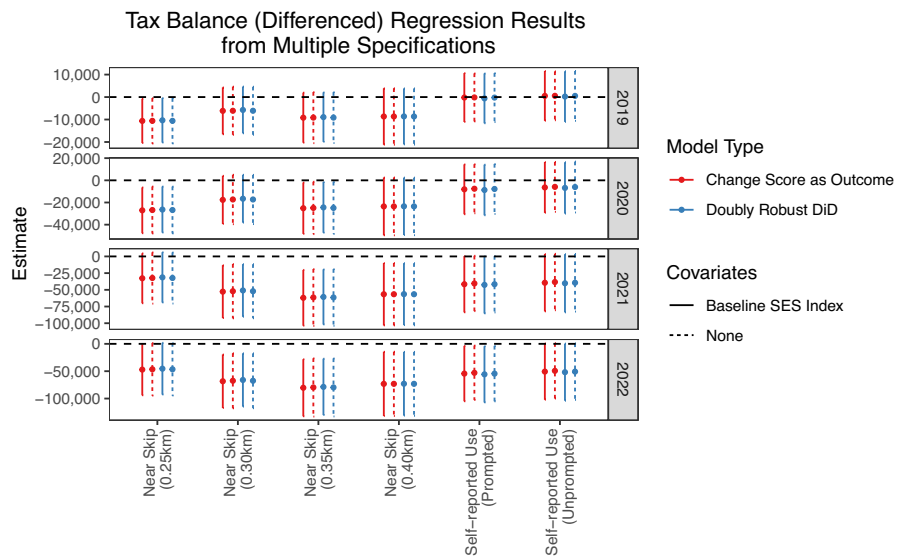
Fig. 22 Regression results from multiple specifications for tax compliance

A.4.5 Attitudes Around Resentment Toward City

Table 4 Results from the Trust and Legitimacy Index and the components of the Trust and Legitimacy Index at endline

Measure (Change Scores)	Not Near Skip	Near Skip	Estimate	*p*-value
Trust and Legitimacy Index	-0.03	0.01	0.03	0.00
Share of Taxes Spent on Services	-0.04	0.11	0.16	0.26
Would attend ZCC Meeting	-0.03	-0.01	0.02	0.21
Did/Would Refuse to Pay Tax	-0.18	-0.11	0.08	0.03
ZCC's Right to Tax	-0.02	0.03	0.05	0.04
ZCC Evaluation	0.02	0.04	0.02	0.14
ZCC Trust	0.04	0.07	0.03	0.05

This table shows that while the Trust and Legitimacy Index increases for those near the waste skips, the two groups tended to move in the same direction for four out six components

Multi-Level Models

We estimate multi-level models to account for dependence at both the PSU and skip levels. Note that these models generate a singular fit warning implying that some of the variance components are essentially zero. Our results remain that households near skips tend to pay more taxes.

Table 5 Mean Differences in Change in Tax Balance by year

	Tax Balances (Differenced)			
	2019	2020	2021	2022
Near Skip (0.35km)	−10979.83	−25818.50*	−61374.21**	−78967.92**
	(5763.04)	(11832.54)	(21141.87)	(26723.64)
(Intercept)	30042.17***	73667.71***	133235.30***	183325.00***
	(5027.22)	(8891.75)	(16491.37)	(22764.18)
AIC	10943.22	11588.82	12115.53	12306.05
BIC	10963.69	11609.29	12136.00	12326.52
Log Likelihood	−5466.61	−5789.41	−6052.77	−6148.03
Num. obs.	443	443	443	443
Num. groups: PSU	73	73	73	73
Num. groups: Skip	7	7	7	7
Var: PSU (Intercept)	13701661.50	210904608.18	0.00	0.00
Var: Skip (Intercept)	34474323.15	61.68	97108713.81	600679817.68
Var: Residual	3308384916.87	14247725745.42	47613871149.68	73086091636.31

Multi-level models include varying intercepts at the PSU and skip levels, shown by year. Results show that households near skips pay more taxes that households far from skips. ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$

In addition to our expectations that the PSU-level is appropriate for clustered standard errors because of how we identified PSUs, we explore whether the PSU-level or the skip-level is the right level to cluster standard errors intraclass correlation coefficient (ICC) and adjusted R^2. On average across the 4 years of study, the PSU-level has slightly larger ICC. We also estimated models that predicted tax balances from either PSUs or skips. We that found on average across the 4 years of study, that the models using PSUs had a larger R^2 than those using skips.

Table 6 Average ICC and adjusted R^2 at the PSU-level and skip-level

	ICC	$Adj\,R^2$
PSU-level	0.006	0.004
Skip-level	0.005	0.003

A.4.6 Revenue and Cost Calculations

In order to understand whether the revenue raised following the introduction of the new waste collection service has been sufficient to sustain the service — which would indicate the presence of a virtuous circle — we run some simple calculations about the likely tax revenues resulting from the new service delivery and the costs of the waste collection.

Revenue We calculated the gain in city revenue as at least MWK 26,606,078 (approximately USD 33,258 at the time of our study). We also calculated the lower bound, the upper bound, and a less conservative estimate.

We use the effect of being near a skip to calculate these estimates. At the end of 2022, households near the skip owed an average of MWK 82,547 less than households far from the skip. We thus take MWK 82,547 (approximately USD 103) per household as the average effect of the new waste collection services on city revenue. To generate estimates, we multiply that amount by the number of households who might be impacted by the skips.

Our **lower bound** only counts households we surveyed who (1) we could identify in the tax data and (2) reside near a skip. This is 249 households × MWK 82,547 (USD 103), equaling MWK 20,554,380 (approximately USD 25,692). The lower bound reflects how much less money households *in our data* near the skips owed at the end of the study, compared to how much they would have owed if they had remained on the same trajectory as the far-from-the-skip group. This amount is strictly what we observe in our data and therefore represents a lower bound for additional city revenue — far more households are likely affected by the skips than those we surveyed and can identify in the tax data.

To generate our **main estimate**, we generalize from our sample to the population: owner-occupied households in our initial listing. We listed almost 7,700 houses, identifying 2354 as owner-occupied and therefore eligible for the study. We did not include renter-occupied houses in the sample because renters do not directly pay property taxes; the landlord pays. We randomly selected 1848 households to be in the

study, but we expect the effect to generalize to other owner-occupied houses in our study area. Of those 2354 total households, 1092 are near the skips. Of those 1092, we expect 29.5% to have tax data (the percentage of our survey respondents we identified in the tax data). Thus there should be 322 owner-occupied households near skips and in the tax data, generating an additional MWK 26,606,078 (approximately USD 33,258) for the city.

Our main estimate is conservative; it assumes (1) we do not miss any households when connecting our survey data with city tax data, and (2) renter-occupied houses do not pay any additional property tax as a result of the new waste collection. We relax that second assumption for our **less conservative estimate**, which generalizes to renter-occupied households the effect of being near a skip. In our initial sample of 7669 households, 3630 are near a skip. If 29.5% of those households are in the tax data, we expect the skips to effect 1071 households. 1071 households each paying an additional MWK 82,547 in tax revenue equals a city revenue gain of MWK 88,443,281 (approximately USD 110,554).

Lastly, we calculate an **upper bound**. The upper bound assumes the effect of MWK 82,547 applies to every household near a skip in our intervention area. Of the 7669 households we listed, 3630 are near skips. If 3630 households all increased tax payment by MWK 82,547, the intervention would have generated an additional MWK 299,648,191 (USD 374,560) in city revenue. This amount represents how much revenue the city would have gained if every household near skips paid MWK 82,547 more than they would have paid had the city not provided waste collection. This number is a logical upper bound — we do not believe every household near skips would have increased their tax payment as much as homeowners we could identify in our tax data: the tax records do not support this.

Costs The total cost of the skip loader and eight skips was approximately USD 51,000 . The skip loader (truck) cost about USD 31,000 at the time of the study. Each skip cost about USD 2500; the total for eight was USD 20,000. These costs included the cost of transporting them to Zomba.

The city reports that the total annual cost of operating the skip system (staff salaries, fuel, maintenance, etc) in 2025 is MWK 39,413,140 (USD 22,742 — note that the exchange rate today is USD 1:MWK 1733, whereas it was about USD 1:MWK 800 at the end of our study). That is the cost to collect waste from the 18 skips the city now owns — they have purchased 10 new skips since the time of our study and located several of them in markets, which require more frequent collection than skips used for residential waste. The city estimates that the cost of collecting the eight residential skips in our study is MWK 12,612,205 (approximately USD 7277) per year. The residential skips are collected and emptied once per week, so they account for 8 of the 25 runs the skip loader makes per week (32%); 32% of the total cost (USD 22,742) is USD 7277.

We also expect the expanded waste collection to reduce disease burden in Zomba, especially waterborn disease burden. This would likely reduce the cost of providing health services from the city. We did not attempt to model cost declines in other portions of the city's budget.

Declarations

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