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UPDATING THE STATE: INFORMATION ACQUISITION COSTS AND PUBLIC BENEFIT DELIVERY

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Abstract

Delays in government to person payments limit their protective value. In a field experiment span- ning the entirety of two Indian states, we randomized bureaucrats' access to a mobile phone based e-management platform for India's flagship workfare program. We randomized which levels of the administrative hierarchy received access to the app, called PayDash. PayDash provided real-time updates on the status of pending payments, identified responsible officers, and enabled immediate follow-up via WhatsApp and phone calls. We have three main findings: first, processing times were reduced by 11% of the pre-intervention control mean in treatment areas, with gains concentrated in high payment delay areas. Second, we observe substitutability in providing PayDash at different levels of the bureaucratic hierarchy, suggesting reduced infor- mation frictions, not simply improved monitoring, underlie performance gains. Finally, officer transfers - a costly form of incentivizing bureaucrats - declined by 23% in treatment areas.

JEL Codes: D73, I38, M59, O15, C93

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1 Introduction

Social protection programs are a ubiquitous element of government policies to tackle poverty and economic vulnerability. Gentilini et al. (2020) documents 1,841 such programs across 214 countries in 2020, with digital government to person (G2P) transfers comprising a substantial proportion: for example, 63% of Covid-related transfers in low and middle-income countries were made through digital infrastructure (*ibid*).

Yet weak implementation in low state capacity settings - reflected, for instance, in poor targeting and substantial funds leakage - often limit the reach and protective potential of G2P payments. Reflecting this, an important research focus has been on how digitizing identification and payment infrastructure can strengthen state capacity for G2P payments (e.g., Muralidharan et al. (2016); Banerjee et al. (2020)). One often overlooked factor in designing digital payment systems is the continuation of human agency - state actors remain involved in program oversight and activity verification. And, the monitoring of monitors, in turn, means that multiple actors within a hierarchical governance structure are involved. Increased automation of some processes may make it harder for these actors to know when processes are delayed, and why.

In this paper, we examine how leveraging the digital payment infrastructure to provide program administrators real-time program updates impacts G2P payment delays. We focus on, arguably, the world's largest rural workfare program – India's Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA).[1] Digitizing payments *per se* has not solved the challenge of payment delays for this program.[2] In the year prior to our intervention, the median payment in our study states occurred more than one week after the stipulated period (23 days, with a 75th percentile at 30 days and a 90th percentile at 46 days.) Delays undermine the protective premise of the program by making it more difficult for workers to align income and expenditures (Basu and Sen 2015; Muralidharan et al. 2018), leading them to return to relying on alternative, largely negative, coping strategies and making them vulnerable to exploitation (Dréze 2020).[3]

[1] In the 2019-20 fiscal year, more than 50 million rural households participated in the program at a cost of approximately US $10 billion. Multiple studies have documented MGNREGA's positive impact on rural households' well-being (Deininger and Liu 2013; Imbert and Papp 2012; Klonner and Oldiges 2014; Muralidharan et al. 2018).

[2] Banerjee et al. (2020) find transitions to e-governance in internal funds transfers actually increased payment delays from a worker perspective. The government has taken multiple approaches to expedite these digital MGNREGA payments. These tend to be punitive, focusing on negative performance incentives and include: (i) issuing warnings to officers, publicly highlighting poor performance, and mandating they pay penalties in case of delays; (ii) delayed payment compensation to workers (which rarely occurs in practice (Deininger and Liu 2013)), with costs recuperated from those responsible for delays; and (iii) social audits to increase accountability.

[3] Local leaders often "front" payments to MGNREGA workers awaiting their wages, only to take a disproportion-

We report on a large-scale experimental evaluation of a mobile-based management platform for MGNREGA, known as PayDash. PayDash leverages "digital exhaust" generated by timestamps that log user activities in the MGNREGA administrative system, allowing us to track when each of the eight bureaucratic steps of the worker payment process is undertaken for every workspell. By packaging existing information in a more readily accessible and actionable format for officials, PayDash reduces the time costs incurred in learning about wage payment processing status. Officials can quickly view both where a delay is occurring and who is responsible for the current step in the payment process.

We randomized officer access to PayDash across the entirety of the states of Madhya Pradesh and Jharkhand, spanning a population of approximately 120 million, of which approximately 40 million are poor.[4] By varying the level of administrative hierarchy (district and/or subdistrict) at which PayDash access is provided, we examine the relative importance of lowering information costs for monitoring versus direct performance efficiency. Finally, we examine whether improved information access affects other dimensions of bureaucratic effectiveness in MGNREGA, and whether it reduces reliance on more costly performance incentives - specifically, officer transfers.

We leverage multiple data sources in this study. Our primary outcome of interest - overall processing time - derives from daily-level data on all payments initiated in our study states over the evaluation period, covering more than 17.7 million payrolls. We utilize usage data captured by the mobile app itself to measure who uses PayDash, and we conducted surveys with the full populations of officials in four primary bureaucratic postings across all localities in our study area. Finally, we worked with local officials to compile records of all transfers of officers in these postings.

We have three main findings. First, access to PayDash reduced the average time taken for payment processing by 11% of the pre-intervention control mean. Variability in processing times was also lessened. These impacts were driven by large improvements in areas with above median delays prior to the intervention. Second, providing PayDash to *either* level of the hierarchy led to large and lasting reductions in payment processing times. We observe substitution – in particular, providing PayDash to two levels of the bureaucratic hierarchy led to no greater improvements in processing times than giving access to only a single level of the hierarchy. Supporting evidence suggests that a primary channel of influence – and a reason underlying the substitutability – is that senior officials passed information they received through the hierarchy, rather than solely utilizing

ately large share in return once wage payments arrive.

[4]Author's calculations using RBI population and poverty estimates from 2011.

PayDash to monitor and incentivize staff performance. This leads to our third finding - PayDash reduces reliance on transfers of lower-level officials as an incentivization strategy.

Our study contributes to the growing body of evidence on how the inner workings of government administration can influence the quality of public service delivery (Finan et al. 2017), and highlights the importance of bureaucratic information acquisition costs for social protection delivery to poor households. While the potential costs of asymmetric information in bureaucratic hierarchies for governance outcomes are widely recognized (Tirole 1986; Dixit 2002), to the best of our knowledge, this study is the first to experimentally vary access to information at multiple hierarchy levels.[5] A recent related paper finds government-initiated monitoring of bureaucrats improved the delivery likelihood and speed of time-sensitive benefit payments to Indian farmers (Muralidharan et al. 2021). Other recent work shows that mid-level supervisors hold information unobservable to higher-level principals in government that can be valuable when leveraged appropriately (Dal Bó et al. 2021). Our study also demonstrates the potential importance in a multi-tiered bureaucracy of sharing information as part of cross-level cooperation, connecting to work which considers the value of mission in aligning incentives across levels, where bureaucrats act as motivated agents that serve the needs of citizens (Besley and Ghatak 2005; Prendergast 2007).

The remainder of the paper is organized as follows. Section 2 describes the context and administrative environment. Section 3 describes the research design, and section 4 describes data and the empirical strategy. Section 5 presents the results, section 6 explores potential mechanisms, and section 7 concludes.

2 Context and Intervention

2.1 MGNREGA and study states

MGNREGA, arguably the world's largest ongoing social protection program, is available to all rural Indian households, and it disproportionately supports vulnerable and marginalized groups. In 2019-20, for example, 38% of workers belonged to historically marginalized Scheduled Caste or Scheduled Tribe groups, compared to 28% in the rural population overall.

Access to MGNREGA work is important for the poor in our study states of Jharkhand and

[5] Deserranno et al. (2020) vary financial incentive provision at multiple levels and find effort complementarities. Dal Bó et al. (2021) explore knowledge differences across the hierarchy but do not vary access to information at different levels.

Madhya Pradesh. In the 2016-2017 fiscal year, prior to PayDash roll-out, the two states together processed more than 25 million payments for workers. And while both states have increased the delivery speed of worker wage payments in recent years, workers waited an average of 27 days (with a standard deviation of 20 days) from the day they finished a workspell until they were paid in the fiscal year prior to the start of our intervention. While some of this time was taken in steps outside the control of MGNREGA officials in the states - notably, the period between a bank receiving a funds transfer order and releasing wage payments to workers' accounts - on average, more than half the time was spent on steps over which they had responsibility.

Oversight and completion of MGNREGA work verification and payment processing occurs within a multi-tiered bureaucratic hierarchy (see Figure 1). Following completion of a roughly week-long workspell on a MGNREGA project in a gram panchayat,[6] multiple administrative steps must be completed before workers receive their wage payments.[7]

First, GP-level bureaucrats enter MGNREGA worker names on an attendance list, which the elected GP leader must then approve. Alongside, technical assistants visit the project site and measure the work completed, and an engineer verifies that the measurement was correct. Once these steps are completed, the register of workers and output (the "muster roll") is uploaded to the online management information system (MIS) by GP officials. Next, junior officials at the block (subdistrict) office examine the submitted materials and generate a funds transfer order. Following two further approvals by higher ranking subdistrict officials, the funds transfer order is submitted to the central government's electronic funds management system (the Public Financial Management System, or PFMS) and routed to a private bank that disburses payment into workers' bank accounts. Our focus is on the time taken to complete the steps of the payment delivery process that fall under the purview of MGNREGA officials (versus, e.g., private banks).[8]

District officials are a step removed from the work verification and payment processing tasks, but play an important overarching management and monitoring role. Subdistrict officers are directly involved in completing some steps in the process, such as providing digital sign-off for wage lists to be sent for processing. They also have primary responsibility for overseeing and coordinating with junior employees and other officials working on GP-level steps.

[6] A gram panchayat is a cluster of villages, and commonly referred to as a GP.

[7] We describe here the payment process as it occurs in our study states. Other states follow very similar processes.

[8] The range of steps we consider is officially referred to by the government as "Stage 1" of the process, with a mandated completion time of eight days. The subsequent steps are referred to as "Stage 2" and have a mandated completion time of seven days.

2.2 The intervention: PayDash

In 2012, MGNREGA transitioned to a fully digital payment infrastructure, accompanied by electronic payments into worker bank accounts. While a primary impetus was to expedite payments, the use of e-payments has proven to be complicated and reduced the scrutability of the payment process to government officials. Since officials still hold responsibility for multiple steps in the payment process, delays have persisted.

For an official working to process MGNREGA payments, government websites that can be used to monitor payment processing are complicated to parse. Subdistrict officials, for example, typically need to access fifteen or more separate GP-specific webpages to understand which musters rolls in their jurisdiction are pending at a single step. Calculation of aggregate statistics must be done manually. Websites are harder to access in rural areas, where internet and mobile outages are common. The time cost required to gather information may prevent officers from obtaining information they need or force them to reduce the time they spend on other important tasks.

Created in collaboration with India's central Ministry of Rural Development (MoRD), PayDash is a mobile- and web-based tool intended to make it easier for government officials to acquire information relevant to monitoring and managing the MGNREGA work verification and payment process. At the development stage, we conducted interviews with more than 75 MGNREGA officials. This qualitative work, coupled with our analysis of administrative data on wage payment processing times, showed that: (i) delays frequently occur during the early steps of payment processing, when local government employees are verifying work quality and uploading data and documents into the MGNREGA management information system (MIS); and (ii) district- and subdistrict-level officials are capacity constrained in identifying and addressing delays occurring below them in the administrative hierarchy.

The subdistrict officer version of PayDash identifies how many muster rolls are currently delayed and the documents holding up processing for each delayed muster roll. It also links those documents to the contact details of the responsible local or subdistrict official, as relevant. Within the mobile version of the platform, users can directly contact the relevant subordinate via a call or a WhatsApp message pre-filled with relevant muster roll details. PayDash further includes a performance dashboard where officials can view their jurisdiction's current and historical processing time performance, both overall and by step. Users can also drill down to view these metrics at the GP level (see Figures A1 through A4 in the Appendix). The version of PayDash provided to

district officials is similar, providing district- and subdistrict-level summaries of processing times at different steps and the number of documents delayed at each step, along with in-app ability to contact block officials via phone or pre-filled WhatsApp message.

An important innovation is that PayDash is built on payment processing timestamps, rather than user-entered data, since officers may prefer not to enter accurate information (Muralidharan et al. 2021). This process is automated – the time-stamps are metadata collected as officials log in to the management information system to complete payment steps – so data cannot be altered. Payment processing information is channeled to PayDash through APIs that capture the date each step of the work verification and worker payment process has been completed for each muster roll. PayDash is offline-compatible, allowing officers to log on and access information even in areas with poor mobile connectivity. Logins are user-specific, so officers access daily-updated information only for areas under their jurisdiction.

2.3 Administrative environment

The officers eligible for PayDash access, even when competent and motivated, generally work in an overstretched environment similar to that described by Dasgupta and Kapur (2017). The bureaucrats overseeing MGNREGA wage payments are familiar with computer and smartphone use in their everyday work: our baseline survey of district and subdistrict officials, described in section 4.1, shows that 93% of officers accessed data from the MGNREGA MIS on a daily basis, and 82% of officers reported a high level of comfort using information technology. Smartphone ownership was nearly universal in this sample, and 87% reported using WhatsApp for work daily, suggesting communication and coordination with others are important components of their jobs. 73% of all officers in our study sample hold a postgraduate degree, and those in the higher-level positions overwhelmingly are part of India's elite Indian Administrative Service or a similar state-level service. Officers have worked in their current position for an average of 7 years.

The median officer in our surveys reported working more than 70 hours per week. While self-reports may be generous, a more objective measure of workloads could be the share of officers that hold additional postings: More than 30% of all officials reported holding responsibility for an additional job or location outside of their primary roles, often covering for the many vacant positions in the local administration. Across both states, for example, district officials reported that one-quarter of subdistrict program officer positions were vacant. Thus, many officers were

doing "double duty" to cover locations without officials posted there.

District officers' reported perceptions of their subordinates further suggests that work overload is common: 77% of the district officials we interviewed at baseline agreed or strongly agreed with the statement that subdistrict program officers in charge of MGNREGA work are overworked. In contrast, evidence is weaker that inadequate monitoring by upper-level officials was a relevant constraint to the quality of service delivery. At baseline, only 14% of district officers felt that subdistrict program officers were dishonest, and 24% did not think subdistrict CEOs were honest. The last is consistent with the fact that mission motivation is an oft-cited reason for having joined the civil service: the type of work done (42%) and serving India (19%) are mentioned most frequently, followed by the prestige of the role (17%) and career path opportunities (14%).

Finally, once in their positions, how are officers incentivized (beyond their mission motivation)? In our officer baseline surveys, bureaucrats reported on whether a set of listed positive and negative incentives were used with others who held their same rank. Their responses highlight how incentives are used to manage officers' performance. Only 3% report others in their rank receive bonus pay for good work, and 14% that promotions are used; in contrast, punitive financial incentives are more common: 32% report salaries are sometimes withheld on purpose from officers. Similar to most bureaucracies, non-pecuniary incentives are more widely used (Finan et al. 2017): 70% report public recognition given to good performers, and 50% that officers are nominated for special trainings. On the negative side, 61% report show cause notices are issued to officers for poor performance, 33% report officers' performance is publicly criticized, and 24% that officers are suspended for poor performance. Transfers are also a common strategy: 25% of officers report others in their rank have been purposely transferred to a better location, and 22% that officers have been purposely transferred to a worse location.

3 Experimental Design and Conceptual Framework

3.1 Study design

We randomized access to PayDash across the entire states of Madhya Pradesh and Jharkhand, covering 73 districts and 561 subdistricts.[9] Districts were randomly assigned to one of four treatment arms:

[9]Excluding one pilot district in each state. The average district population in these states is 1.6 million.

1. TD – PayDash provided to district-level MGNREGA administrators only (17 districts);
2. TS – PayDash provided to subdistrict-level MGNREGA administrators only (16 districts);
3. TC – PayDash provided to both district- and subdistrict-level MGNREGA administrators (20 districts); and
4. Control – neither district- nor subdistrict-level MGNREGA administrators provided access to PayDash (20 districts).

We assigned treatment arms in approximately equal proportions in Madhya Pradesh's 50 districts, and one-third each to control and TC, and one-sixth each to TD and TS in Jharkhand's 23 districts, stratifying within state by above/below median values of average muster-roll-by-worker payment processing time and average per-subdistrict volume of person-days worked over roughly the 2015-16 fiscal year.[10] Subdistrict access to PayDash was clustered by district due to the high potential for within-district spillovers – e.g., it is common for district officials to hold regular district-wide video-conference meetings with subdistrict officials regarding MGNREGA. In contrast, subdistrict officials across different districts do not systematically interact as part of their duties, nor do district officials have regular combined meetings with state officials.

Within each treated level of the hierarchy, PayDash was provided to two officers. The first of these officials is the Chief Executive Officer (CEO), the highest ranking bureaucrat at the district or subdistrict level, who is responsible for overseeing a number of other schemes in addition to MGNREGA. The second is the Program Officer (PO), who is the highest ranking officer solely responsible for oversight of MGNREGA and reports to the CEO.[11]

PayDash was rolled out across Madhya Pradesh in February and March 2017 and Jharkhand in October 2017.[12] We coordinated with the Rural Development Department in each state to bring district and subdistrict officers to district-specific surveying and training sessions so that in-person attendance was feasible. Both treated and untreated officials underwent a basic refresher session on existing MGNREGA MIS tools and completed a baseline survey. Sessions for treated officials also involved installing the mobile-phone app and small group-based trainings on the platform. The survey and training sessions for untreated officials were conducted at different times than those

[10] Appendix Section B.2 provides additional details on variable construction.

[11] The official titles described here and used throughout the paper are those used in Madhya Pradesh. In Jharkhand, the corresponding bureaucratic titles are District Development Commissioner (District CEO), Block Development Officer (Block CEO), District Assistant Program Officer (Program Officer), and Block Program Officer.

[12] In the subsequent analysis, all districts in Madhya Pradesh are assigned a February rollout month.

for treated officials. Overall, sessions were completed with more than 1,200 senior- and mid-level government officials.[13] The evaluation period concluded in August 2018.[14]

Given that officer transfers are common in our study context, we contacted relevant officials in each district to identify position changes and adjust PayDash access accordingly.[15] Officers newly assigned to treatment areas were provided PayDash access for that region and in-person or remote training, depending on logistical feasibility. Officers transferred between treated areas had the region-specific information available to them via PayDash updated accordingly, while those leaving treated areas entirely had their login access deactivated.

3.2 Conceptual framework

MGNREGA work verification and payment processing occurs within a multi-tiered bureaucratic hierarchy. District officers manage and monitor the performance of subordinate district officials. These subdistrict officers complete the later verification and processing steps themselves and in turn manage and monitor local-level officials, who are responsible for carrying out the earlier steps.

Both district and subdistrict officers must exert costly effort to gather the information necessary to identify delays, determine who to hold accountable, and take action to address problems. We assume that officers choose their effort levels to equalize marginal benefit (which may be influenced by factors including extrinsic performance incentives and intrinsic motivation) and marginal cost. In this setting, a technology that reduces the costs of information acquisition has the potential to reduce payment processing times when provided at either the district (upper) or subdistrict (middle) level.

First, mid-level officers may have easy access to the information they need to perform their duties well, but be weakly incentivized to make the effort of collecting and acting on that information. In this case, outcomes may be improved by reducing the costs for upper-level officials of acquiring information relevant to monitoring the performance of the mid-level officers.

Alternatively, mid-level officials may be strongly incentivized, but face high information acquisition costs that limit their gathering of information needed to implement the program effectively. This suggests the potential of reducing information acquisition costs at the middle level of the

[13] These trainings are described in more detail in Appendix Section B.1.

[14] State assembly elections took place in Madhya Pradesh in November 2018. In the months immediately prior to elections, district and subdistrict officers can be shifted and deputed to help with election preparation. We therefore concluded the evaluation before this period.

[15] No regularly updated rosters of district and subdistrict officials' postings exist at the state level.

hierarchy to achieve improved program performance.

It may also be that performance improvements cannot be achieved without addressing both issues, so that complementarities exist in concurrently reducing information acquisition costs at the upper and middle levels of the bureaucratic hierarchy. On the other hand, if mid-level officials are already well incentivized and their superiors understand that they are information-constrained, reducing information acquisition costs for higher-level officials may result in their sharing the new management-relevant information with their subordinates, yielding a substitute relationship in addressing information constraints for officers at the middle and upper levels.

In this context, the direction of the potential interaction of PayDash provision with baseline performance is ambiguous. First, the reduction in processing times achievable with a given increase in effort could be smaller in areas that were initially performing better (e.g., if easier problems have already been addressed) or worse (e.g., if they are a more challenging environment in which to achieve gains in general). Second, the behavioral response of officers in terms of changing their effort level for a given reduction in information acquisition costs may differ depending on initial performance. In worse performing areas, for example, because officials tend to be farther away from the central government's desired processing time cutoff, there may be a larger range of improvement over which there are weak returns (in terms of reward) to effort – dampening officials' responsiveness. It could also be, however, that officers in better performing areas are in the first place more likely to be meeting the desired performance threshold, giving them little incentive to improve further.

4 Data and Empirical Strategy

4.1 Data sources

We obtained information from MGNREGA administrative data about each of the more than 17.5 million muster rolls issued in the states of Jharkhand and Madhya Pradesh between April 2015 and August 2018. This administrative data includes the gram panchayat in which each muster roll was issued, the start and end date of the associated workspell, and the date on which the associated payment request was submitted by the subdistrict office to the central electronic funds management system. This information allows us to determine the total length of time spent on the work verification and payment processing steps for each muster roll. We also collected administrative data

on the universe of submitted payment requests in our study states over this time period, allowing us to observe whether requests were accepted or rejected at the subsequent PFMS step.[16]

Given that PayDash is an Android mobile-phone application, we can also access Google Analytics data on officer-level usage of the platform.[17] We use this data to generate user-month level measures of the number of distinct user sessions, the total duration of usage, and the number of WhatsApp messages and calls placed from within the app. In addition, we tracked officials' posting changes by intermittently completing a series of calls to government offices in each district. This allows us to generate locality-posting level measures of transfer occurrence at different cross sections in time.

The populations of district and subdistrict CEOs and POs in the states of Madhya Pradesh and Jharkhand were surveyed at baseline (February-March 2017 in Madhya Pradesh, October 2017 in Jharkhand) prior to their above-described training sessions. The surveys collected information on sociodemographic characteristics, personality traits and mental aptitude, work and management practices, and MGNREGA administration. The baseline survey coverage rate of the 1,268 officer positions is 91.4 percent, with no significant differences between treated and untreated officers for any of the four officer types.[18] Between May and December of 2020, we conducted a follow-up survey with the set of baseline subdistrict and district POs in Madhya Pradesh. We have a coverage rate of 77.1 percent for these 358 officers, with insignificant differences by treatment status.[19] These surveys collected additional information on work practices, MGNREGA administration, and treated officials' PayDash usage.

4.2 Experimental balance

As a check of experimental validity, in Table 1 we examine a set of pre-treatment district level characteristics related to MGNREGA administration in the year prior to PayDash launch in each state: average muster roll "Stage 1" processing time (our focus), standard and absolute deviations

[16] Section 5.4 discusses this step in greater detail.

[17] We observe that, in practice, officers almost exclusively use the mobile version of PayDash, so we focus on mobile usage measures in our subsequent analysis.

[18] The coverage gap is largely due to positions that were empty at the time of baseline (i.e., the previous officer had vacated the position and the replacement had not yet been posted). Officers unable to attend the initial survey and training sessions were later followed up with individually for training and onboarding.

[19] The lower completion rate reflects the challenges of shifting to phone-based surveying with a population of bureaucrats who were heavily involved in managing the government response to COVID-19 in this period.

of processing time,[20] number of muster rolls processed, monthly average number of persons requesting ("demanding", in program parlance) work, total person-days worked, and total MGNREGA expenditure. We also consider variables related to district composition: percent rural population from the 2011 census and number of subdistricts.

Column (1) presents the means and standard deviations of each variable for districts receiving only District PayDash. Column (2) gives this information for districts assigned only Subdistrict PayDash, while column (3) does so for districts receiving both District and Subdistrict PayDash and column (4) for control districts. Columns (5) through (7) present the coefficients and standard errors from a single district-level regression of each variable on separate indicators for assignment to each PayDash treatment arm, controlling for randomization strata. Of the 27 differences considered, none are statistically significant at conventional levels.

We additionally consider a variety of sociodemographic, work-related, and personality characteristics of the district and subdistrict officers working at the time of intervention roll-out (shown in appendix tables A1 through A4), as collected in the baseline surveys. Of 228 differences considered across the four officer types and four treatment arms,[21] 24 are statistically significant at the 10 percent level, close to the value expected by chance.

4.3 Empirical strategy

Given the random assignment of districts to treatment arms, our identification approach is straightforward. We use the following primary empirical specification:

$$Y_{sdt} = \beta_1 TD_{dt} + \beta_2 TS_{dt} + \beta_3 TC_{dt} + \alpha_s + \alpha_t + \theta_{dt} + \varepsilon_{sdt}, \tag{1}$$

where s is a subdistrict in district d in month t, α_s and α_t are subdistrict- and month-level fixed effects, and Y is an outcome of interest.[22] TD is an indicator variable equal to 1 if only District PayDash has been provided to the district in which subdistrict s falls and 0 otherwise, TS is an indicator taking a value of 1 if only Subdistrict PayDash has been provided to all subdistricts in district d, and TC is an indicator taking a value of 1 if both District and Subdistrict PayDash

[20] Similar to Muralidharan et al. (2016), we calculate the absolute deviation as the average absolute value of the difference between muster roll processing time and median processing time in a given district over the specified timeframe.

[21] Due to their particularly senior standing, District CEOs were asked fewer survey questions than the three other officer types. As a result, there are 16 rather than 20 characteristics included in their balance table.

[22] Randomization strata are absorbed by the subdistrict fixed effects.

("combination") have been provided to district d. When considering processing time outcomes, we additionally include controls for district-specific linear time trends, θ_{dt}, to adjust for the chance occurrence of differential pre-trends.[23] Standard errors are clustered by district, the level of treatment assignment. As a robustness check, we also run analogous regressions at the GP-month level. Unless otherwise noted, regressions are weighted by the number of muster rolls beginning processing within the locality-month so that estimates are interpretable as the intent-to-treat effects on the average muster roll.[24] This design allows us to evaluate the impacts of district- and subdistrict-level provision of PayDash, as well as to test for complementarity or substitutability that may exist between them (against the null, $H_0 : \beta_3 - (\beta_1 + \beta_2) = 0$). Our time range of analysis is from July 2016 through August 2018.

We additionally examine how treatment effects vary with districts' pre-existing performance. Specifically, we allow for heterogeneity in treatment effects between districts with above- versus below-median "pre-period" average payment processing times for muster rolls, defined over the April 2015 to June 2016 period prior to the time range of analysis.[25] The corresponding regressions take the form:

$$\begin{aligned} Y_{sdt} = {} & \theta_1 \left[TD_{dt} * HighPre_d\right] + \theta_2 \left[TS_{dt} * HighPre_d\right] + \theta_3 \left[TC_{dt} * HighPre_d\right] \\ & + \lambda_1 \left[TD_{dt} * LowPre_d\right] + \lambda_2 \left[TS_{dt} * LowPre_d\right] + \lambda_3 \left[TC_{dt} * LowPre_d\right] + \alpha_s + \alpha_t + \theta_{dt} + \varepsilon_{sdt}, \quad (2) \end{aligned}$$

where $HighPre$ and $LowPre$ are indicators for above-median ("high delay") and below-median ("low delay") districts, respectively. We also consider a more flexible specification where we allow treatment effects to differ by sextile of the pre-period processing time distribution.

To examine the evolution of PayDash effects over time, we use specifications of the following type:

$$Y_{sdt} = \sum_{\tau=-6}^{10} \left[\beta_{1,\tau} TD_{\tau,dt} + \beta_{2,\tau} TS_{\tau,dt} + \beta_{3,\tau} TC_{\tau,dt}\right] + \alpha_s + \alpha_t + \theta_{dt} + \varepsilon_{sdt}, \quad (3)$$

where $TD_{\tau,dt}$ is an indicator variable for whether month t in district d falls τ months relative to district-only PayDash provision, with the month prior to PayDash provision ($\tau = -1$) omitted.[26] $TS_{\tau,dt}$ and $TC_{\tau,dt}$ are the corresponding indicators for subdistrict-only and combined PayDash

[23] Appendix Table A6 and Figures A7 and A8 present results with these controls excluded.
[24] Appendix Table A7 shows that PayDash has an insignificant impact on number of muster rolls.
[25] Appendix Section B.2 provides additional details.
[26] $\tau = -6$ captures all periods 6+ months prior to rollout and $\tau = 10$ captures all periods 10+ months after rollout.

provision, respectively. We also estimate analogous specifications with the treatment-arm-specific indicators replaced by indicators for any PayDash provision, and/or allowing for heterogeneity by pre-period performance.

5 Results

5.1 Impacts on payment processing times

We start by considering the effects of providing PayDash to district and subdistrict officials on muster roll processing times. Table 2 presents analysis based on equation (1), with column (1) pooling all treatment arms into a single "Any PayDash" category and column (2) considering the PayDash treatment arms separately. PayDash decreases the average time taken to process a muster roll by approximately 1.2 days, or 11 percent of the control group pre-intervention mean, with insignificant differences in the magnitude of impact across treatment arms (p-value = 0.328).[27]

Next, we examine how treatment effects differ between districts that have above- versus below-median pre-period processing times, using the regression specification given in equation (2). Columns (3) and (4) of Table 2 show that providing PayDash to either or both levels of the MGNREGA bureaucratic hierarchy has a small and statistically insignificant impact on average processing times in low-delay districts. In contrast, we observe large drops in muster roll processing time (roughly 3.4 days) across all three treatment arms in high-delay districts.[28] Columns (5) and (6) demonstrate the robustness of the heterogeneity results to categorizing districts as high versus low delay based alternatively on the measure used in the generation of the randomization strata.[29]

We examine the progression of the impacts of PayDash over time in Figure 2, which plots the relative-month-specific estimated coefficients and 95 percent confidence intervals for the pooled treatment, based on equation (3). The top panel presents the results for all districts, the middle panel for high-delay districts, and the bottom panel for low-delay districts. PayDash reduces the average time to complete officer steps throughout the post-treatment period, driven by the impacts in high-delay areas. The same pattern holds when each treatment arm is considered separately (Appendix Figure A6), though the coefficients for district-only PayDash are less precisely estimated

[27] Appendix Table A5 demonstrates robustness of the results to conducting analysis at the village-month level.

[28] Using a more flexible specification where the effects of PayDash are allowed to vary by sextile of pre-period performance, Appendix Figure A9 shows that PayDash's impact on processing times generally increases as pre-period performance worsens throughout the distribution.

[29] The correlation of the two measures is 0.84.

than those for the other two treatment arms. Overall, we see clear, consistent impacts of PayDash reducing worker wage payment processing times in initially worse-performing areas.

5.2 Impacts on late completion and variability

In Table 3, we first examine whether PayDash influences the likelihood that work verification and payment processing are completed "late" (i.e., longer than the government mandated length of eight days for officer steps). Columns (1) and (2) show negative but statistically insignificant coefficients for each treatment arm, with a significant 4.8 percentage point (7.5 percent of the control pre-intervention mean) reduction in the probability of late processing completion when pooling the treatment arms. The results in columns (3) and (4) show that the overall effect is driven by improvements in high-delay areas, with roughly an 11 percentage point reduction in the probability of lateness from providing PayDash at either or both officer levels.

In columns (7) through (10), we further consider whether the variability of payment processing times, as measured by the absolute deviation from the locality-month median, is impacted by PayDash. We observe a similar pattern - borderline significant effects of PayDash overall, with large reductions in high-delay areas of similar magnitude across treatment arms.

5.3 Substitutability across hierarchy levels

We observe substitutability in the provision of PayDash to district and subdistrict level officers. Column (2) of Table 2 shows that the effect on payment processing times of providing PayDash to both levels of the bureaucratic hierarchy is significantly smaller than the sum of the district-only and subdistrict-only effects (i.e., $H_o : \beta_3 - (\beta_1 + \beta_2) = 0$ can be rejected). The substitutability between district and subdistrict level PayDash is much more pronounced within high-delay districts (columns (4) and (6)), where the impacts of PayDash are concentrated in the first place. In these regions, substitutability is also evident in the impacts on lateness and variability of muster roll processing times (columns (4) and (8) of Table 3).

Interpreted through our conceptual framework, the pattern of results for payment processing times – improvements from each of District and Subdistrict PayDash separately, with strong substitutability between the two – has two implications regarding channels of impact. First, it suggests that the gains from PayDash are not driven entirely by strengthening the performance incentives of subdistrict officers via improved monitoring by district officers. If this were the case, we would not

expect providing PayDash to subdistrict officers alone – which leaves the monitoring technology of district officers unchanged – to yield improvements in processing times. Given these impacts, information constraints at both the upper and middle levels of the bureaucratic hierarchy appear relevant in this context. Second, this result is consistent with treated district officers sharing information with block officials, leading to a redundancy when both levels are treated in at least some of the information gains from possessing PayDash directly. In Section 6, we provide additional evidence in support of these two channels.

5.4 Quality of officer work

A key concern is that PayDash's improvements in MGNREGA payment processing times may come at the expense of the quality of bureaucrat work related to payments or perhaps other activities. This could occur, for example, if PayDash redirects officials' attention away from quality dimensions and more toward processing payments quickly. We can generate a measure of one important dimension of the quality of officers' work by examining the rates at which worker payment requests are rejected after being submitted by subdistrict officials, which can be influenced by the attention they pay to ensuring information is collected and entered accurately by subordinates.

Following the completion of the "Stage 1" steps for a muster roll, the subdistrict office submits a funds transfer request to the central Public Financial Management System (PFMS). At the PFMS step, the most common reasons for a requested payment to an MGNREGA participant not to be accepted relate to invalid recipient account, bank, or individual identification (Aadhaar) numbers having been provided. In the case of a rejection, the subdistrict office can address the issue and re-submit the payment request. In practice, gathering necessary information from program participants requires coordination with relevant local-level officials, leading to additional delays in payment processing or potentially a failure to correct the reason for rejection at all. If village or subdistrict officials are less careful in gathering, entering, and verifying such details in areas with access to PayDash, downstream payment request rejection rates could increase. Alternatively, if PayDash frees up more time for officers to work on such issues or makes it easier to monitor and coordinate with subordinates, rejection rates may decrease.

Using administrative data on the universe of payment requests submitted in our study states, we calculate the average share of worker payment requests associated with each muster roll rejected at the PFMS step at the subdistrict-month level. Approximately 4 percent of these requests are

rejected in control districts in the pre-intervention period. Using the same empirical approach as above, we find no evidence of a reduction in quality as captured by payment request rejection. Table 4 shows rather that providing PayDash access to officers significantly reduces the average share of payment requests rejected by 0.9 percentage points, with insignificant differences between high-delay and low-delay areas. These results suggest that the improvements in the speed and variability of time taken to complete officer steps are accompanied by gains in at least one dimension of the quality of the underlying work.

6 Understanding Mechanisms

Thus far, we have seen that PayDash reduced time taken to process rural workers' MGNREGA wage payments, particularly in areas with higher pre-intervention delays. These improvements in payment processing time are accompanied by improvements in an important dimension of the quality of officer effort, suggesting officers' incentives are well-aligned to deliver payments on time to workers. In addition, our results in Section 5.3 are consistent with information sharing across levels of the bureaucratic hierarchy being an important operative channel of impact. In this section, we consider additional evidence from our app usage, officer survey, and transfers data to inform our understanding of mechanisms.

6.1 PayDash usage by officer hierarchy level

We next take advantage of the detailed usage data captured by the PayDash app itself to examine whether officers' usage patterns differ significantly when the platform is provided to officers at multiple levels of the bureaucratic hierarchy. Table 5 shows the following measures of platform usage for district and block officials: (i) total user sessions on the platform, (ii) total minutes of platform usage, and (iii) number of calls made and WhatsApp messages sent to subordinate employees using the in-app direct contact feature. These are defined at the locality-month level, summing across the CEO and PO positions within each level of the hierarchy.

Usage looks similar overall at the district and subdistrict levels. Officers average roughly four sessions per month, with a total usage time of approximately 20 minutes over the same time period. In Appendix Table A8, we find that the usage patterns within a given level of the hierarchy are not significantly impacted by the provision of PayDash to the other level of the hierarchy, suggesting that the substitutability of providing PayDash at the district and block levels in improving muster

roll processing times is not driven simply by reductions in usage when both bureaucrats are provided access to the tool.

6.2 Association of platform usage with processing times

In Table 6, we examine whether higher PayDash usage is associated with reductions in muster roll processing times and how this association may be influenced by whether the other level of the hierarchy has access to PayDash. Columns (1) and (3) present the results of subdistrict-month-level regressions of average processing time on interactions of measures of PayDash usage by district and subdistrict officials with an indicator for whether PayDash has been provided to both officer levels. The regressions also include indicators for PayDash treatment status and our standard set of controls. Columns (2) and (4) present results from analogous regressions where PayDash usage by district and subdistrict officials are themselves interacted.

In high-delay areas, the strong negative associations of subdistrict and district PayDash usage with processing time are significantly weakened when both officer levels have access to PayDash, as shown in columns (1) and (3). No such differences are observed in low-delay areas. Similarly, we observe in columns (2) and (4) that in high-delay areas PayDash usage is associated with a reduction in payment processing time for both district and subdistrict officers, with an opposite-signed coefficient on the usage interaction term.

These estimates provide suggestive evidence consistent with a setting in which the observed substitutability between Subdistrict and District PayDash is driven at least in part by usage of PayDash at one level of the bureaucratic hierarchy being less important when the other level also has platform access – potentially due to the cross-level sharing of information from PayDash. The survey evidence in the next section provides additional evidence in support of information sharing.

6.3 Officer surveys

Our analysis of officer baseline surveys suggests that while officers are well-educated and technologically proficient, their time is scarce and they are frequently balancing multiple, competing priorities. Evidence from our follow-up surveys with district and subdistrict POs in Madhya Pradesh suggests that an important avenue of PayDash's influence is the provision of information in a readily-accessible and actionable format to users, who also share this information with other bureaucrats involved in completing the work verification and payment processing steps.

As shown in Figure 3, 82 percent of district officials and 60 percent of subdistrict officials who received PayDash report that the platform made it easier for them to acquire information about wage payment processing in their jurisdictions. In addition, 23 percent of district officers and 27 percent of subdistrict officials state that PayDash allowed them to acquire information that they did not have before. While, as discussed previously, officers can technically generate the information provided in PayDash using data available through pre-existing government websites, accessing and processing this data such that it would be useful for day-to-day decision making is a more time-intensive process, and one that is potentially infeasible for officials to do regularly. Beyond easing information constraints, PayDash was reported to function as a reminder to pay more attention to wage payment processing by 35 percent of district officials and 46 percent of subdistrict officials.

When asked how they used the information from PayDash, 63 percent of district officers and 70 percent of subdistrict officials report sharing it with subordinates working on MGNREGA within their jurisdictions (Figure 4). Reports of using PayDash to monitor other officials are less frequent, though not uncommon, with 29 percent of district officials and 40 percent of subdistrict officers stating that they used PayDash to evaluate the performance of subordinates. Our survey evidence demonstrates that, from the perspective of the officers using the app themselves, PayDash reduced the costs of information acquisition for a large majority of users, and most officers were sharing that information with their subordinates in the bureaucratic hierarchy.

6.4 Officer transfers

While the impacts of PayDash on payment processing appear to come at least in part from cross-level information sharing, improved access to information about subordinates' performance may still influence the ways in which senior bureaucrats incentivize those below them. In bureaucratic systems where the use of financial incentives is often circumscribed, allocation to specific postings may be used as either punishment or reward (Khan et al. 2019). In our baseline surveys, 25 percent of officers report their colleagues had been purposely transferred to a better location, and 22 percent said their colleagues had been purposely transferred to a worse location. Such transfers are both costly to implement and a blunt tool to improve overall performance.[30] We therefore explore whether PayDash affects this performance management tool across the four sets of officers provided access to PayDash.

[30]For officers at different levels and positions, transfers have different implications. District officials are transferred around the state, while subdistrict POs largely remain in their home districts when transferred.

Table 7 presents results of cross-sectional analysis at the locality-position level examining whether access to PayDash affected the probability of officer transfer within a given period of time since intervention start. We use transfers data collected 6 months after PayDash was rolled out, and also after 17 months for Madhya Pradesh.[31] Across the study area, transfers are common: 44.7 percent of subdistrict officers and 52.5 percent of district officers in control locations had been transferred within 6 months of PayDash roll-out in their states.

Columns (1) and (2) of Panel A show that District PayDash reduced the probability that subdistrict officers were transferred within six months of rollout by 10.5 percentage points (23% of the control mean). The provision of Subdistrict PayDash has no such effect, nor does the impact of District PayDash differ by whether Subdistrict PayDash is available. Considering the longer-term transfer measure for Madhya Pradesh in Panel B, we see a reduction in the likelihood of subdistrict officer transfer of roughly the same absolute magnitude and, as before, no impact of subdistrict PayDash. The probability that district officers are transferred is unaffected by the provision of PayDash at either the district or subdistrict levels (columns (3) and (4)).

Columns (5) through (8) highlight that the drop in transfers at the subdistrict level is largely driven by reduced movement among subdistrict POs, who are directly in charge of processing MGNREGA payments, rather than subdistrict CEOS, who have many responsibilities besides MGNREGA.[32] These transfers of subdistrict POs overwhelmingly occurred within the same district; only 1% of locations had a transfer of this officer type to a different treatment location. As shown in Panel B, the reduction in transfers for subdistrict POs persisted in Madhya Pradesh until at least the longer-term follow up. The high-level takeaway here is that access to PayDash reduced a relatively costly form of performance management of subordinates by district officials.

7 Conclusion

Our field experiment, conducted at scale across two Indian states, involved the full populations of MGNREGA bureaucrats at senior and middle levels of the administrative hierarchy. We randomly assigned access to PayDash, a mobile- and web-based platform that allowed users to more easily manage and monitor the processing of wage payments for the world's largest workfare program. The

[31] We were only able to collect this additional, longer-term transfer data for Madhya Pradesh, where the intervention was rolled out earlier than in Jharkhand.

[32] Appendix Table A9 shows the absence of transfer effects for both district CEOs and POs separately. Appendix Table A10 shows that impacts on subdistrict PO transfers look similar across high and low delay areas.

platform lowered the costs of accessing information about the status of work verification and wage payment processing and helped supervisors more easily identify subordinate officials who needed to take action to address pending steps. We also randomly varied the level of the administrative hierarchy that received access to the e-platform to better understand how information is used and flows through the hierarchy.

In regions with poorer initial performance, provision of PayDash led to sizable reductions in payment processing times, whether made available at the district or subdistrict level. We see strong evidence of substitutability of district and subdistrict PayDash access in impacts on payment processing times, and a variety of evidence suggesting that this substitutability relates to officers using this information to help their subordinates, rather than simply better monitor their performance. These gains in payment processing times were not accompanied by deterioration in an important measure of officer work quality, payment rejections. Access to PayDash also reduced a costly form of officer performance management, the reallocation of subordinate officials across jurisdictions.

Since PayDash did not specifically provide new information to officers, but instead packaged information in a more readily-accessible format, results of this study highlight that seemingly small costs of information acquisition for the bureaucrats who administer public programs can be an important constraint to the quality of service delivery in low-income settings. Our findings also suggest the broader potential of exploiting technological advancements that in recent years have become widespread even in lower-capacity bureaucratic settings to develop new tools to reduce bureaucratic information constraints and achieve meaningful improvements in program implementation.

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8 Figures

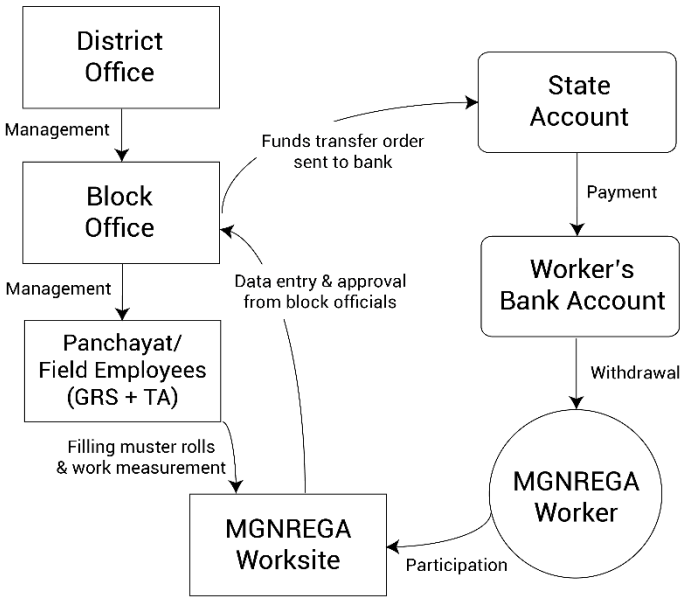

Figure 1: MGNREGA work, verification, and payment process

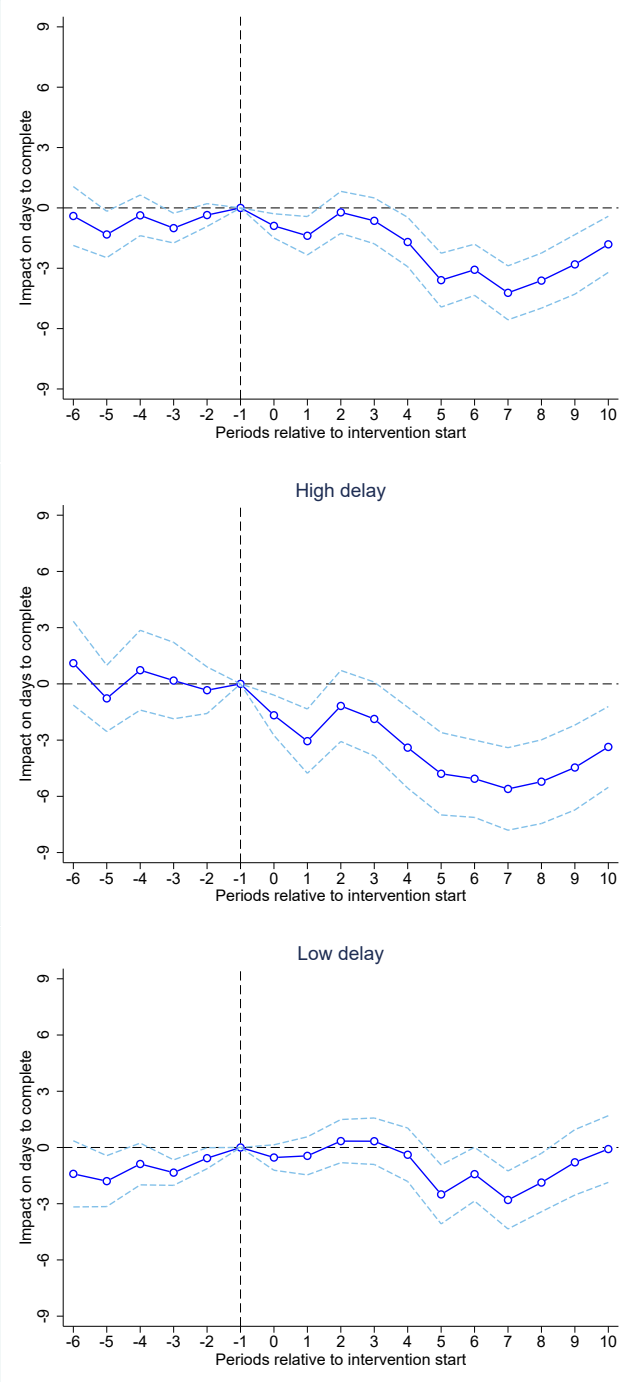

Figure 2: PayDash impacts on time to complete officer steps

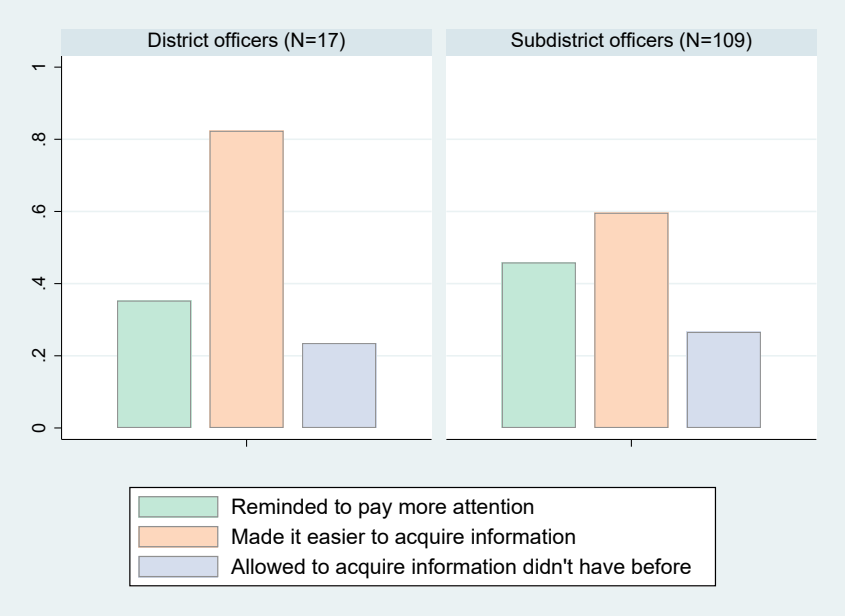

Figure 3: Endline survey - PayDash and wage payment processing

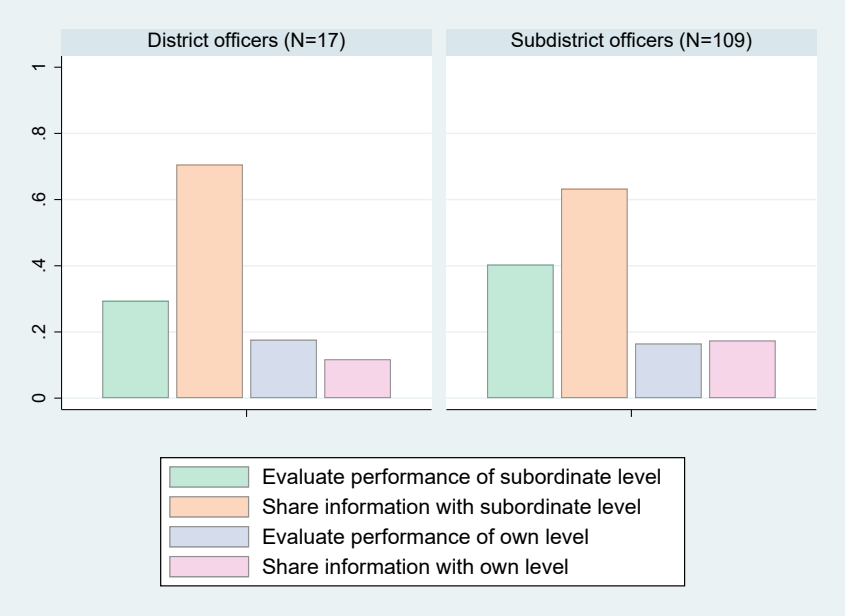

Figure 4: Endline survey - officer use of information from PayDash

9 Tables

Table 1: Balance check

	District Only PayDash (1)	Subdistrict Only PayDash (2)	Combination PayDash (3)	Control (4)	Diff. (1-4) (5)	Diff. (2-4) (6)	Diff. (3-4) (7)	Obs. (8)
Processing time (days)								
Average	17.6	18.9	16.1	18.4	-2.1	-1.0	-1.5	73
	[7.0]	[6.4]	[7.5]	[8.9]	(1.5)	(1.3)	(1.4)	
Standard deviation	14.7	16.0	14.8	15.6	-1.6	-0.4	-0.4	73
	[4.6]	[4.0]	[4.7]	[5.5]	(1.0)	(1.1)	(1.0)	
Absolute deviation from median	9.6	10.3	8.9	10.0	-1.0	-0.5	-0.7	73
	[3.7]	[3.4]	[4.1]	[4.3]	(0.7)	(0.7)	(0.7)	
Muster rolls processed, total (x1,000)	52.0	41.4	48.9	49.5	8.7	-0.6	-2.9	73
	[36.3]	[38.2]	[40.9]	[42.2]	(11.9)	(7.1)	(8.9)	
Persons demanding work, monthly average (x1,000)	28.7	21.1	26.2	22.7	6.8	-0.5	3.7	73
	[16.6]	[8.5]	[16.1]	[10.8]	(4.4)	(3.0)	(4.4)	
Person-days worked, total (x1,000)	2,361.6	1,800.4	2,336	1,943.9	513.2	-26.3	405.6	73
	[1,276.0]	[793.8]	[1,322.3]	[1,008.8]	(337.4)	(245.9)	(359.4)	
MGNREGA expenditure Rs., total (x1,000,000)	807.0	639.4	807.0	692.5	140.2	-211.1	122.9	73
	[400.7]	[256.2]	[480.2]	[331.2]	(107.0)	(828.7)	(127.5)	
Percent rural population [2011 census]	79.82	77.20	74.45	78.09	1.73	-0.89	-3.64	73
	[9.43]	[15.33]	[17.74]	[18.92]	(4.85)	(5.63)	(5.81)	
Number of subdistricts	8.31	6.65	8.25	7.55	0.76	-0.90	0.70	73
	[4.08]	[2.91]	[4.72]	[4.01]	(1.36)	(1.14)	(1.39)	

Notes: Column (1) presents the means and standard deviations of each variable for districts receiving only District PayDash. Column (2) gives this information for districts assigned only Subdistrict PayDash, while Column (3) does so for districts receiving both District and Subdistrict PayDash and Column (4) for control districts. Columns (5) through (7) present the coefficients and standard errors from a single district-level regression of each variable on separate indicators for assignment to each PayDash treatment arm and fixed effects for strata and state. The variables are calculated across the 12 months prior to intervention rollout in each district's state, with the exception of the percent rural population and number of subdistricts.

Table 2: PayDash impacts on time to complete officer steps

Outcome:	Time to complete officer steps (days)					
	(1)	(2)	(3)	(4)	(5)	(6)
Any PayDash (β)	-1.208***					
	(0.350)					
District Only PayDash (β_1)		-1.108				
		(0.877)				
Subdistrict Only PayDash (β_2)		-1.741***				
		(0.456)				
Combination (β_3)		-0.890**				
		(0.363)				
High Delay						
*Any PayDash (θ)			-3.418***		-2.473***	
			(0.652)		(0.628)	
*District Only PayDash (θ_1)				-4.558***		-3.898***
				(1.301)		(1.396)
*Subdistrict Only PayDash (θ_2)				-3.203***		-2.781***
				(0.573)		(0.635)
*Combination (θ_3)				-2.626***		-1.403***
				(0.816)		(0.605)
Low Delay						
*Any PayDash (λ)			-0.149		-0.420	
			(0.309)		(0.365)	
*District Only PayDash (λ_1)				-0.150		-0.127
				(0.611)		(0.676)
*Subdistrict Only PayDash (λ_2)				-0.090		-0.965
				(0.421)		(0.587)
*Combination (λ_3)				-0.181		-0.385
				(0.418)		(0.386)
Observations	14,553	14,553	14,553	14,553	14,553	14,553
High/low delay definition			Primary	Primary	Secondary	Secondary
$\beta_4 = \beta_3 - \beta_2 - \beta_1$		1.959*				
$\beta_4 = 0$, p-value		0.067				
$\theta_4 = \theta_3 - \theta_2 - \theta_1$				5.136***		5.276***
$\theta_4 = 0$, p-value				0.001		0.002
Control outcome mean	10.81	10.81				
Control outcome mean (high delay)			19.12	19.12	19.81	19.81
Control outcome mean (low delay)			9.67	9.67	9.84	9.84

Notes: Columns (1) and (2) report estimates from regressions at the subdistrict-month level of the listed variable on treatment arm indicators, subdistrict and month fixed effects, and linear controls for district time trends, weighting by the total number of muster rolls. The treatment arm indicators are interacted with above- and below-median pre-period average completion time indicators, defined based on the data source used to generate the outcome variable in columns (3) and (4) and the data source used to generate randomization strata in columns (5) and (6). Control means calculated over pre-intervention period. Standard errors clustered at the district level in parentheses. Significant at *10 percent, **5 percent,***1 percent.

Table 3: PayDash impacts on lateness and variability

Outcome:	"Late" (>8 days)				Absolute deviation (days)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Any PayDash (β)	-0.048*				-0.328*			
	(0.028)				(0.180)			
District Only PayDash (β_1)		-0.067				-0.247		
		(0.044)				(0.370)		
Subdistrict Only PayDash (β_2)		-0.039				-0.560**		
		(0.035)				(0.272)		
Combination (β_3)		-0.038				-0.223		
		(0.043)				(0.242)		
High Delay								
*Any PayDash (θ)			-0.113***				-1.342***	
			(0.041)				(0.343)	
*District Only PayDash (θ_1)				-0.165***				-1.783***
				(0.056)				(0.647)
*Subdistrict Only PayDash (θ_2)				-0.098**				-1.140***
				(0.049)				(0.427)
*Combination (θ_3)				-0.108*				-1.154**
				(0.062)				(0.453)
Low Delay								
*Any PayDash (λ)			-0.017				0.180	
			(0.036)				(0.174)	
*District Only PayDash (λ_1)				-0.047				0.223
				(0.052)				(0.259)
*Subdistrict Only PayDash (λ_2)				-0.029				0.042
				(0.050)				(0.284)
*Combination (λ_3)				-0.008				0.203
				(0.058)				(0.289)
Observations	14,553	14,553	14,553	14,553	14,553	14,553	14,553	14,553
$\beta_4 = \beta_3 - \beta_2 - \beta_1$		0.069				0.584		
$\beta_4 = 0$, p-value		0.300				0.249		
$\theta_4 = \theta_3 - \theta_2 - \theta_1$				0.154*				1.770**
$\theta_4 = 0$, p-value				0.071				0.040
Control outcome mean	0.638	0.638						
Control outcome mean (high delay)			0.954	0.954	5.72	5.72	8.45	8.45
Control outcome mean (low delay)			0.594	0.594			5.35	5.35

Notes: Columns (1)-(2) and (5)-(6) report estimates from regressions at the subdistrict-month level of the listed variable on treatment arm indicators, subdistrict and month fixed effects, and linear controls for district time trends, weighting by the total number of muster rolls. In columns (3)-(4) and (7)-(8) the treatment arm indicators are interacted with above- and below-median pre-period completion time indicators. Control means calculated over pre-intervention period. Standard errors clustered at the district level in parentheses. Significant at *10 percent, **5 percent,***1 percent.

Table 4: PayDash impacts on average share of payment requests rejected

Outcome:	Average share of payment requests rejected			
	(1)	(2)	(3)	(4)
Any PayDash (β)	-0.009**			
	(0.004)			
District Only PayDash (β_1)		-0.009		
		(0.008)		
Subdistrict Only PayDash (β_2)		0.002		
		(0.008)		
Combination (β_3)		-0.016***		
		(0.004)		
High Delay				
*Any PayDash (θ)			-0.005	
			(0.008)	
*District Only PayDash (θ_1)				-0.009
				(0.012)
*Subdistrict Only PayDash (θ_2)				0.006
				(0.014)
*Combination (θ_3)				-0.015**
				(0.006)
Low Delay				
*Any PayDash (λ)			-0.011**	
			(0.004)	
*District Only PayDash (λ_1)				-0.008
				(0.010)
*Subdistrict Only PayDash (λ_2)				-0.003
				(0.004)
*Combination (λ_3)				-0.016***
				(0.005)
Observations	14,266	14,266	14,266	14,266
Control outcome mean	0.040	0.040		
Control outcome mean (high delay)			0.052	0.052
Control outcome mean (low delay)			0.039	0.039

Notes: Columns (1)-(2) report estimates from regressions at the subdistrict-month level of the listed variable on treatment arm indicators, subdistrict and month fixed effects, and linear controls for district time trends, weighting by the total number of muster rolls. In columns (3)-(4) the treatment arm indicators are interacted with above- and below-median pre-period completion time indicators. Control means calculated over pre-intervention period. Standard errors clustered at the district level in parentheses. Significant at *10 percent, **5 percent,***1 percent.

Table 5: Officer usage of PayDash

	Number of sessions (1)	Usage duration (min) (2)	Messages sent + calls made (3)
Panel A. District officers			
District PayDash	3.90	19.44	8.68
	[8.27]	[53.70]	[45.36]
Observations	559	559	559
Panel B. Subdistrict officers			
Subdistrict PayDash	4.35	23.07	0.69
	[8.60]	[62.22]	[10.04]
Observations	4,114	4,114	4,114

Notes: Columns in each panel report the mean and standard deviation (in brackets) at the district-month (Panel A) or subdistrict-month (Panel B) level of the listed variables in localities receiving PayDash at the corresponding officer hierarchy level, restricted to post-treatment months. Observations with values above the postive-valued 99th percentile are top coded.

Table 6: Association of PayDash usage and time to complete officer steps

Outcome:	Time to complete officer steps (days)			
Usage measure:	Session count		Usage duration (x10 min)	
	(1)	(2)	(3)	(4)
High delay				
* District officer usage	-0.040***	-0.040**	-0.207**	-0.057
	(0.013)	(0.019)	(0.079)	(0.075)
* Subdistrict officer usage	-0.035**	-0.025**	-0.044**	-0.021
	(0.015)	(0.012)	(0.019)	(0.016)
* (District officer usage * Both levels PayDash)	0.026		0.257***	
	(0.040)		(0.090)	
* (Sudistrict officer usage * Both levels PayDash)	0.035**		0.048**	
	(0.017)		(0.021)	
* (Block officer usage * District officer usage)		0.003***		0.006*
		(0.001)		(0.003)
Low delay				
* District officer usage	0.011	0.027	0.015	0.019
	(0.028)	(0.019)	(0.035)	(0.030)
* Subdistrict officer usage	-0.001	-0.002	-0.020	-0.009
	(0.014)	(0.011)	(0.018)	(0.017)
* (District officer usage * Both levels PayDash)	0.046		0.020	
	(0.044)		(0.077)	
* (Subdistrict officer usage * Both levels PayDash)	-0.003		0.019	
	(0.019)		(0.028)	
* (Block officer usage * District officer usage)		0.000		0.001
		(0.002)		(0.003)
Observations	14,354	14,354	14,355	14,355

Notes: Columns (1) and (3) report estimates from subdistrict-month-level regressions of the listed variable on variables for PayDash usage at each hierarchy level interacted with an indicator for PayDash provision at both hierarchy levels and above-median and below-median pre-period average time to payment indicators, weighted by the total number of muster rolls. Also included are PayDash treatment arm indicators, subdistrict and month fixed effects, and linear controls for district time trends. Columns (2) and (4) report estimates from analogous regressions where the variables for PayDash usage at each hierarchy level are instead interacted with one another. Observations with values above the 99th percentile are trimmed. Standard errors clustered at the district level in parentheses. Significant at *10 percent, **5 percent,***1 percent.

Table 7: PayDash impacts on officer transfers

Outcome:	Any transfer							
	By hierarchy level				Within subdistrict level			
	Subdistrict officers		District officers		Subdistrict POs		Subdistrict CEOs	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. Within 6 months								
District PayDash	-0.105**	-0.105**	0.029	-0.002	-0.174*	-0.167**	-0.036	-0.043
	(0.053)	(0.040)	(0.111)	(0.078)	(0.093)	(0.067)	(0.047)	(0.032)
Subdistrict PayDash	0.017	0.018	-0.071	-0.101	0.076	0.084	-0.042	-0.049
	(0.067)	(0.039)	(0.119)	(0.080)	(0.115)	(0.065)	(0.053)	(0.032)
District PayDash * Subdistrict PayDash	0.001		-0.061		0.015		-0.013	
	(0.084)		(0.159)		(0.141)		(0.063)	
Observations	1,122	1,122	146	146	561	561	561	561
Control outcome mean	0.447	0.447	0.525	0.525	0.460	0.460	0.433	0.433
Panel B. Within 17 months (MP only)								
District PayDash	-0.123*	-0.100**	0.026	-0.095	-0.229*	-0.181**	-0.017	-0.020
	(0.063)	(0.043)	(0.099)	(0.069)	(0.117)	(0.078)	(0.056)	(0.040)
Subdistrict PayDash	-0.012	0.013	0.116	-0.000	-0.022	0.031	-0.002	-0.006
	(0.058)	(0.043)	(0.086)	(0.069)	(0.099)	(0.073)	(0.064)	(0.041)
District PayDash * Subdistrict PayDash	0.047		-0.241*		0.102		-0.007	
	(0.088)		(0.134)		(0.156)		(0.081)	
Observations	616	616	100	100	308	308	308	308
Control outcome mean	0.773	0.773	0.808	0.808	0.760	0.760	0.787	0.787

Notes: Columns in each panel report estimates from regressions at the locality-position level of the listed variable on indicators for PayDash availability at the district and subdistrict levels and, in odd numbered columns, their interaction. Additionally included are controls for randomization strata, position fixed effects in columns (1) through (4), and state fixed effects in Panel A. The outcome measure used in Panel B is only available for the state of Madhya Pradesh (MP). Standard errors clustered at the district level in parentheses. Significant at *10 percent, **5 percent,***1 percent.

Appendix A

A.1 Additional figures

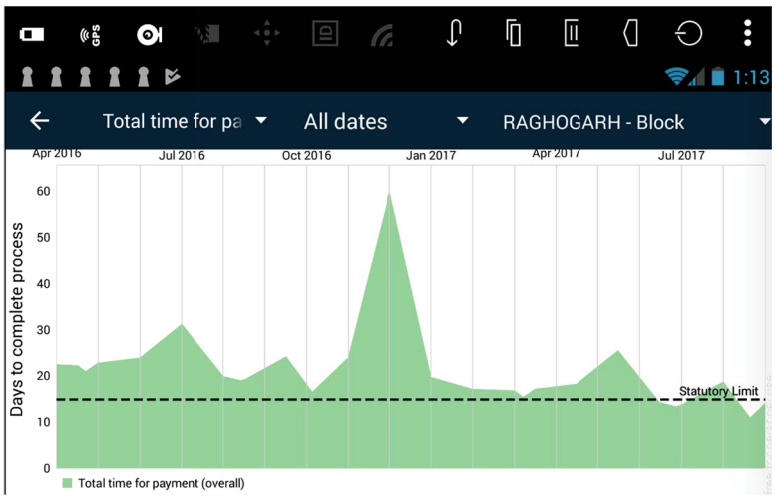

Figure A1: The performance dashboard of the Block PayDash app provides a historical overview of block performance.

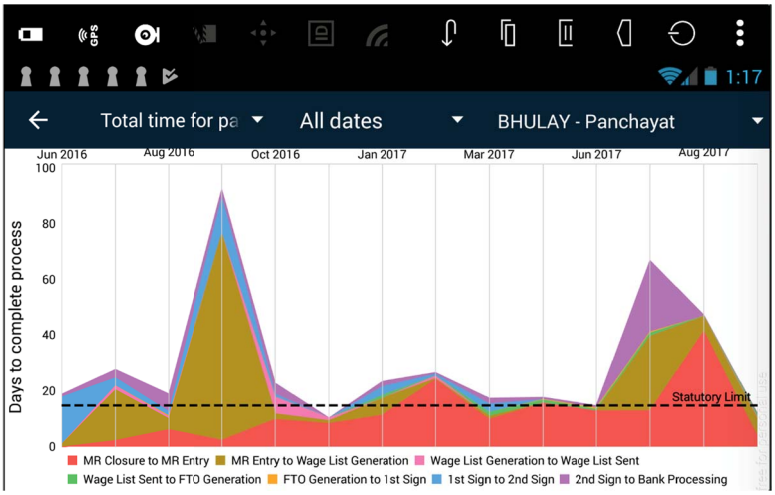

Figure A2: It is also possible to drill down by step and/or to the panchayat level.

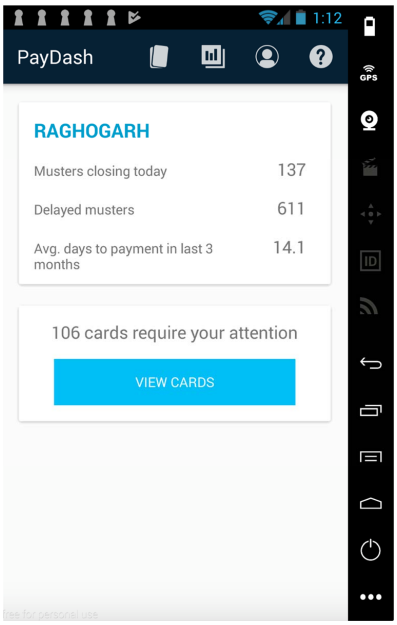

Figure A3: PayDash app homepage provides a near real-time overview of payment processing status within an officer's jurisdiction.

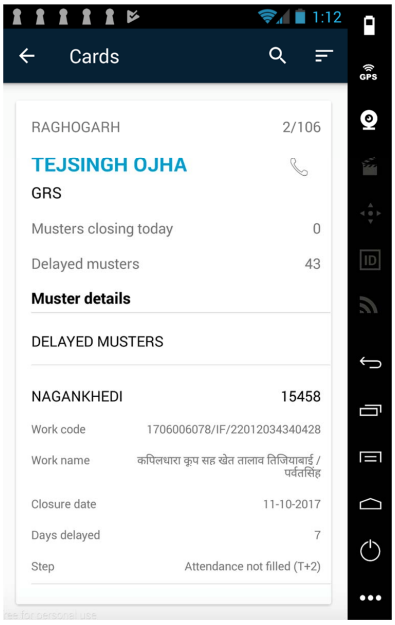

Figure A4: App screenshot with information about a local official. The app shows payment documents pending and allows officers to directly contact the individual responsible for processing the document.

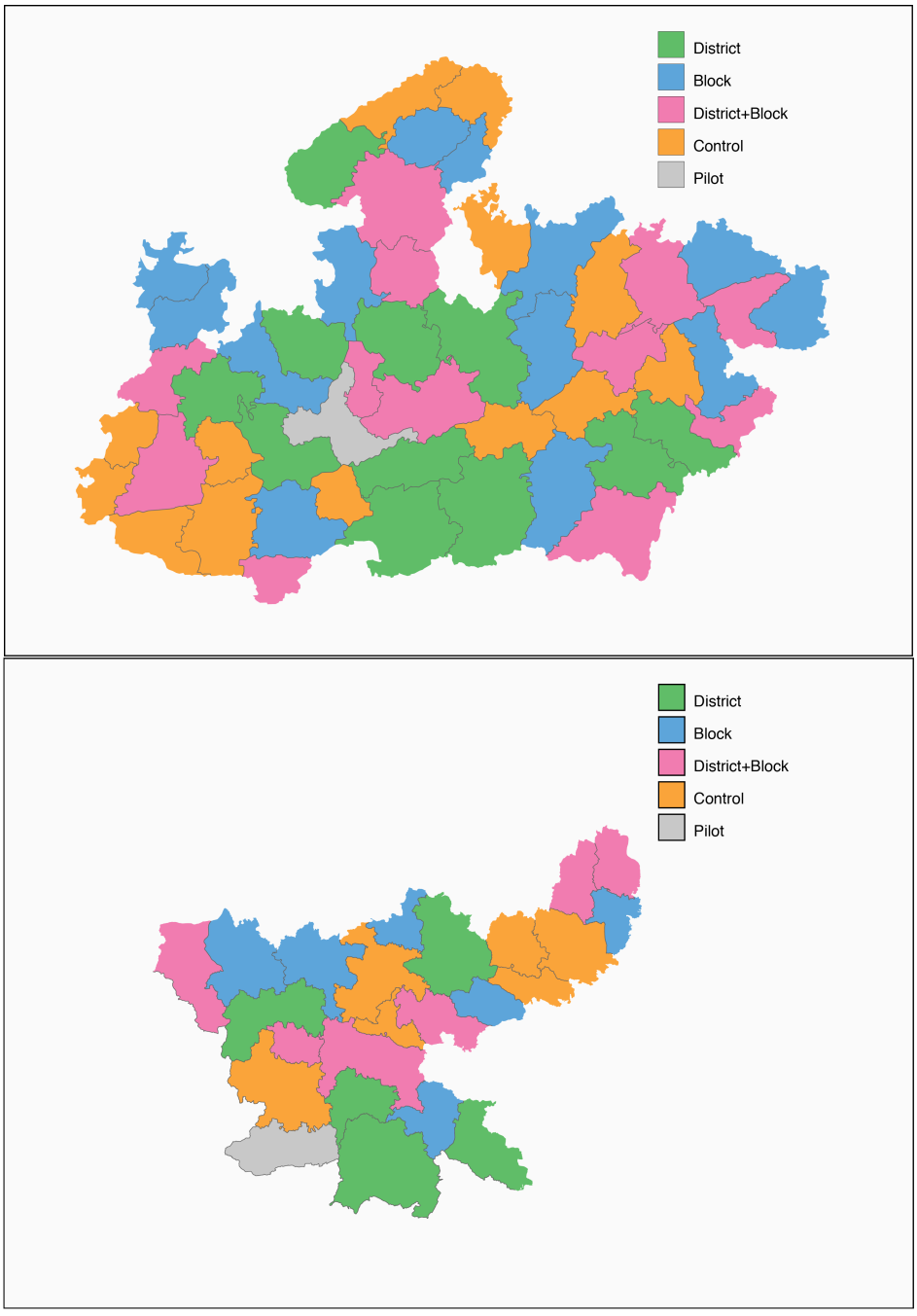

Figure A5: Randomized treatment assignments - Madhya Pradesh (top) and Jharkhand (bottom)

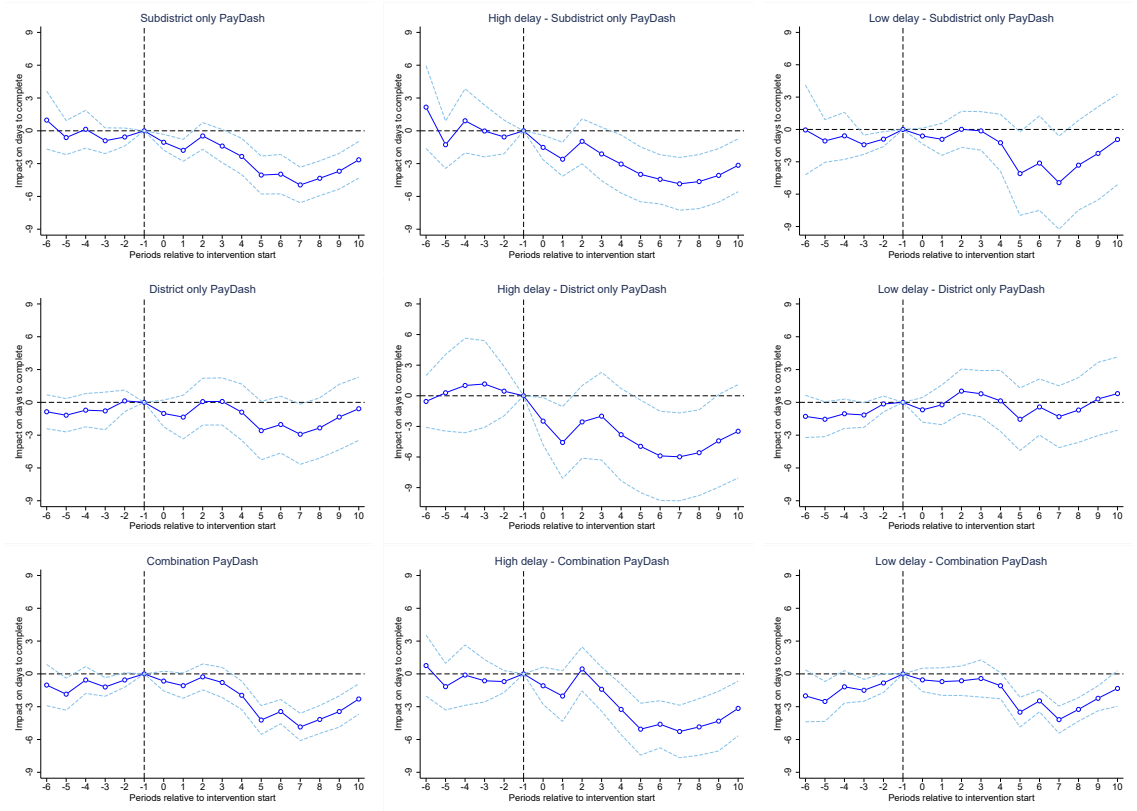

Figure A6: PayDash impacts on time to complete officer steps - by treatment arm, overall and high/low delay

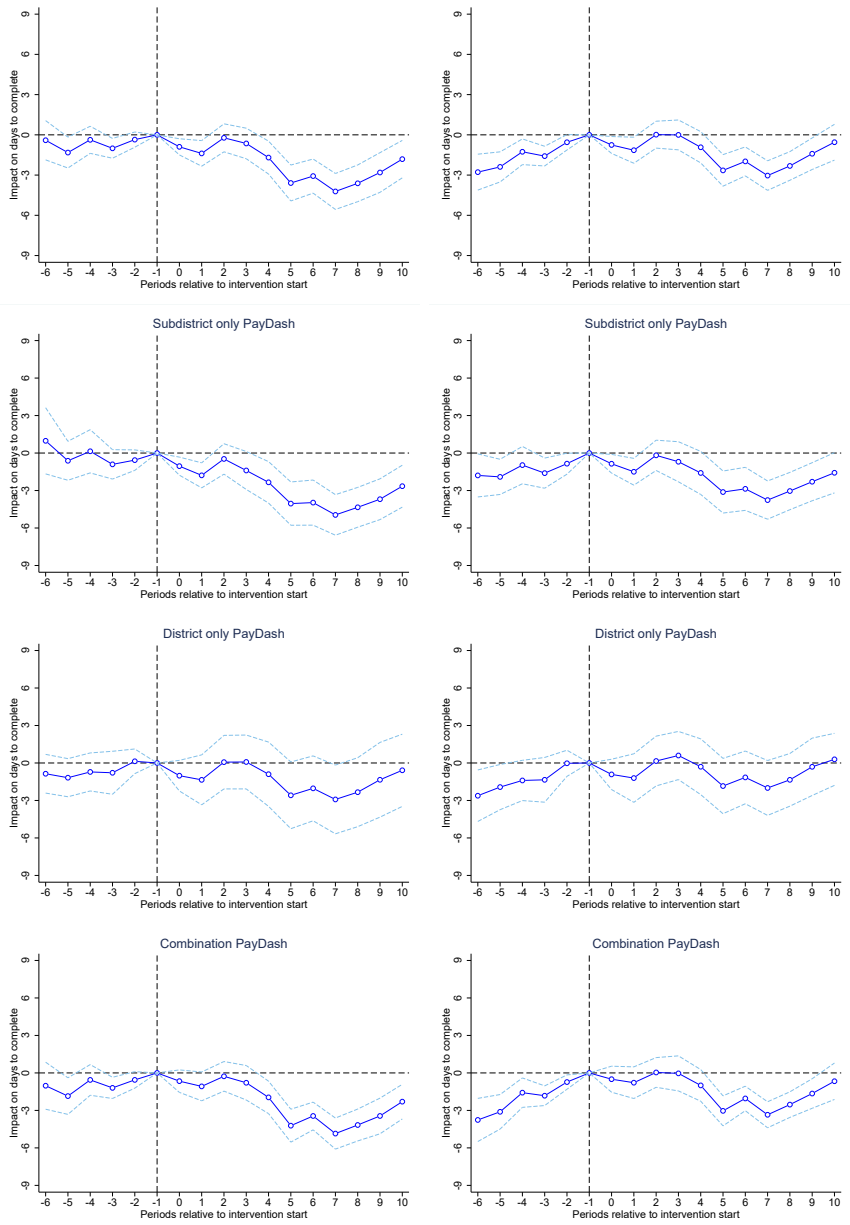

Figure A7: PayDash impacts on time to complete officer steps - with (L) / without (R) trends controls

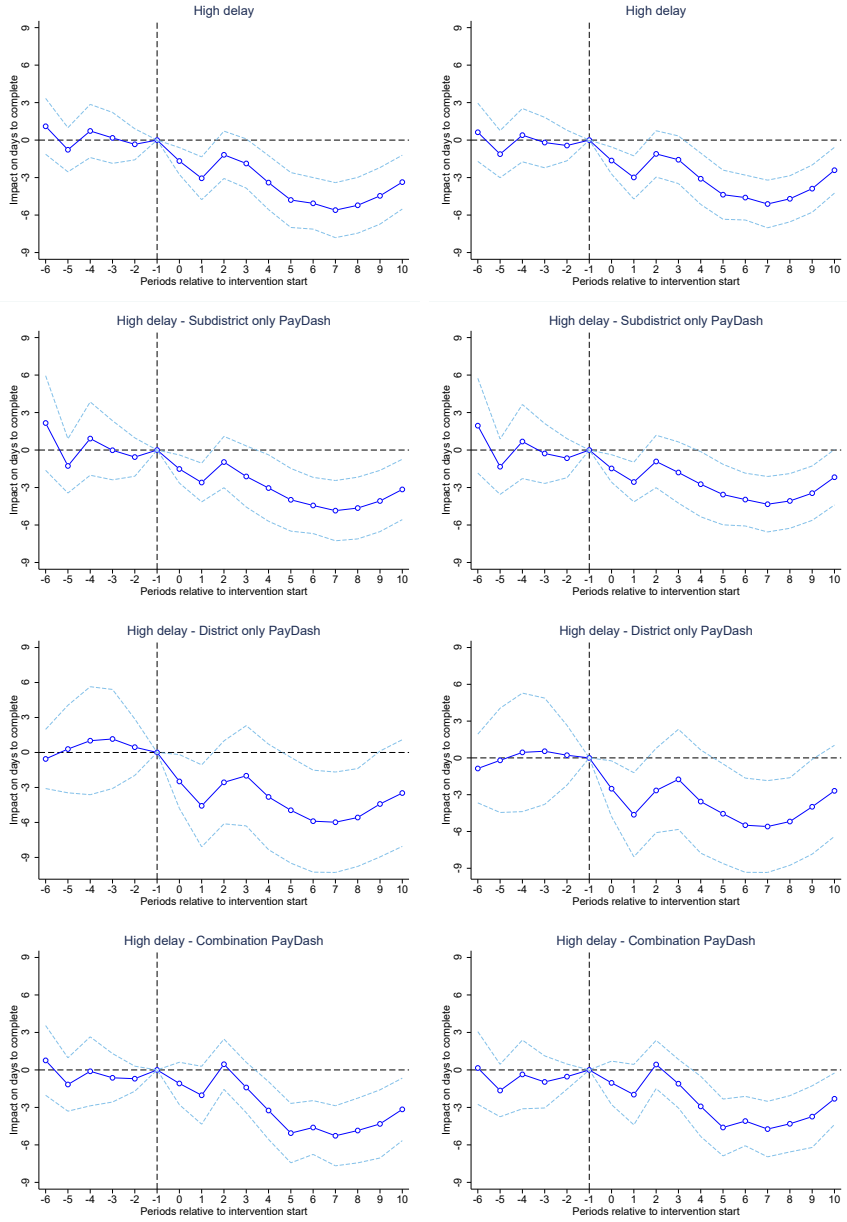

Figure A8: PayDash impacts on time to complete officer steps - with (L) / without (R) trends controls, high delay

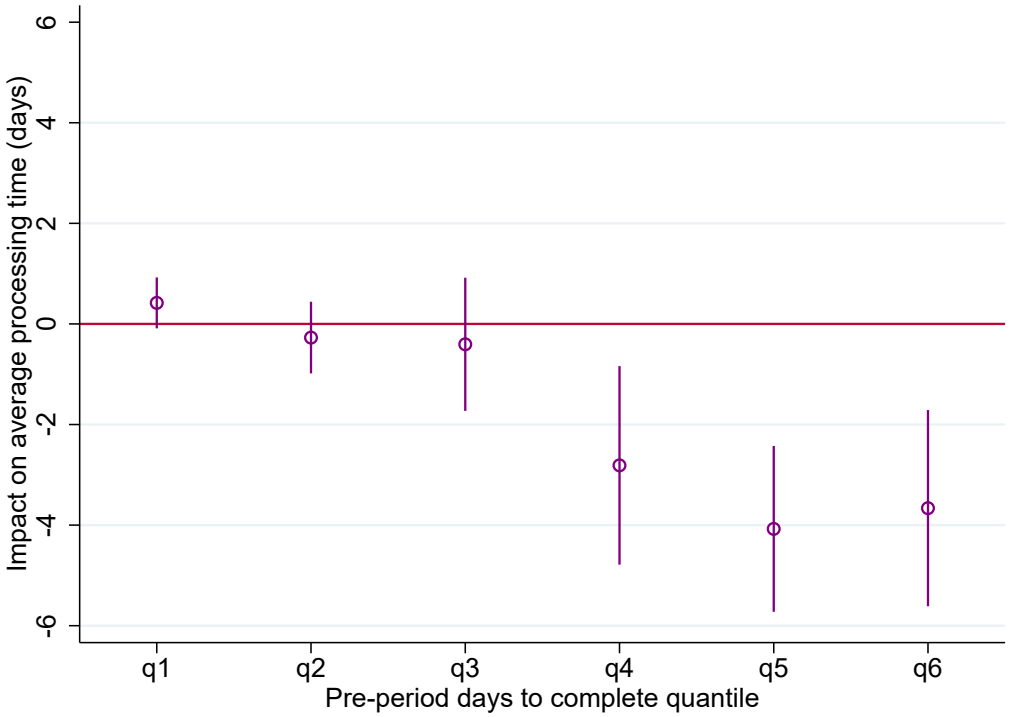

Figure A9: Heterogeneity in PayDash impact by pre-period performance sextile

A.2 Additional tables

Table A1: Balance check - District PO characteristics

	District Only PayDash (1)	Subdistrict Only PayDash (2)	Combination PayDash (3)	Control (4)	Diff. (1-4) (5)	Diff. (2-4) (6)	Diff. (3-4) (7)	Obs. (8)
Female	0.143	0.118	0.053	0.263	-0.107	-0.115	-0.217*	69
	[0.363]	[0.332]	[0.229]	[0.452]	[0.139]	[0.131]	[0.119]	
Age	42.714	40.412	41.850	43.632	-2.246	-4.427*	-1.566	70
	[7.518]	[7.706]	[8.106]	[8.757]	[2.681]	[2.422]	[2.289]	
Post-graduate complete	1.000	1.000	0.850	0.895	0.110	0.120	-0.043	71
	0.000	0.000	[0.366]	[0.315]	[0.074]	[0.075]	[0.103]	
OBC/SC/ST	0.667	0.235	0.579	0.632	0.058	-0.373**	-0.064	70
	[0.488]	[0.437]	[0.507]	[0.496]	[0.166]	[0.168]	[0.154]	
Raven's score	8.714	8.412	8.947	7.889	0.961	0.838	1.012	68
	[3.292]	[2.152]	[2.798]	[2.928]	[1.002]	[0.873]	[0.889]	
Years of government service	15.077	12.933	12.176	18.438	-5.355	-7.115***	-5.362**	61
	[10.547]	[7.923]	[7.152]	[9.709]	[3.369]	[2.646]	[2.444]	
Months in current post	60.769	85.583	55.294	57.154	6.161	33.124**	-1.571	55
	[39.584]	[26.019]	[40.395]	[37.747]	[15.890]	[14.209]	[14.232]	
All-India/state service officer	0.133	0.188	0.105	0.316	-0.211	-0.174	-0.195	69
	[0.352]	[0.403]	[0.315]	[0.478]	[0.140]	[0.138]	[0.118]	
Additional government posting	0.467	0.471	0.400	0.632	-0.201	-0.207	-0.220	71
	[0.516]	[0.514]	[0.503]	[0.496]	[0.173]	[0.157]	[0.146]	
Additional non-government job	0.000	0.000	0.056	0.000	0.004	0.004	0.052	64
	0.000	0.000	[0.236]	0.000	[0.011]	[0.012]	[0.052]	
Monthly salary	58,356.2	54,965.5	44,441.8	45,951.4	12,112.8	8,522.1	-1,352.9	69
	[70,300]	[66,300]	[11,400]	[10,200]	[17,900]	[17,000]	[3,537]	
Hours worked per week	69.933	68.438	78.278	68.684	-0.307	-0.872	9.269	68
	[21.496]	[16.633]	[24.657]	[17.227]	[7.086]	[5.323]	[6.056]	
Intrinsic motivation	0.733	0.647	0.842	0.789	-0.041	-0.122	0.045	70
	[0.458]	[0.493]	[0.375]	[0.419]	[0.156]	[0.159]	[0.127]	
Locus of control	0.005	-0.003	-0.054	0.124	-0.112	-0.128	-0.177	68
	[0.519]	[0.548]	[0.634]	[0.407]	[0.165]	[0.169]	[0.178]	
Reciprocity	2.446	2.412	2.408	2.528	-0.074	-0.130	-0.102	68
	[0.280]	[0.507]	[0.325]	[0.256]	[0.102]	[0.145]	[0.094]	
Corruption propensity	0.066	0.126	-0.160	-0.010	0.079	0.144	-0.151	70
	[0.470]	[0.772]	[0.447]	[0.574]	[0.182]	[0.242]	[0.171]	
Big 5	3.954	3.688	3.974	3.744	0.220	-0.056	0.223	67
	[0.468]	[0.444]	[0.469]	[0.449]	[0.174]	[0.163]	[0.154]	
Public service motivation	4.295	4.328	4.313	3.945	0.327	0.375	0.384	69
	[0.383]	[0.472]	[0.677]	[0.964]	[0.224]	[0.240]	[0.261]	
Smartphone ownership	1	1	1	1	0	0	0	71
	[0]	[0]	[0]	[0]	[0]	[0]	[0]	
WhatsApp group MGNREGA use	1	0.941	1	1	0.002	-0.057	0.000	70
	[0]	[0.243]	[0]	[0]	[0.008]	[0.057]	[0.007]	

Notes: Column (1) presents the means and standard deviations of each variable for District POs in districts receiving only District PayDash. Column (2) gives this information for districts assigned only Subdistrict PayDash, while Column (3) does so for districts receiving both District and Subdistrict PayDash and Column (4) for control districts. Columns (5) through (7) present the coefficients and robust standard errors from a single district-level regression of each variable on separate indicators for assignment to each PayDash treatment arm and fixed effects for strata and state.

Table A2: Balance check - Subdistrict PO characteristics

	District Only PayDash (1)	Subdistrict Only PayDash (2)	Combination PayDash (3)	Control (4)	Diff. (1-4) (5)	Diff. (2-4) (6)	Diff. (3-4) (7)	Obs. (8)
Female	0.202	0.227	0.156	0.193	0.012	0.038	-0.035	523
	[0.403]	[0.421]	[0.364]	[0.396]	[0.060]	[0.063]	[0.057]	
Age	38.633	38.745	38.097	38.241	-0.240	-0.042	-0.144	530
	[5.984]	[6.246]	[5.381]	[6.104]	[0.815]	[0.819]	[0.873]	
Post-graduate complete	0.872	0.874	0.847	0.882	-0.025	-0.020	-0.032	529
	[0.335]	[0.333]	[0.361]	[0.323]	[0.049]	[0.044]	[0.046]	
OBC/SC/ST	0.691	0.642	0.625	0.685	0.026	-0.027	-0.058	514
	[0.464]	[0.482]	[0.486]	[0.466]	[0.082]	[0.086]	[0.077]	
Raven's score	8.128	8.409	8.934	8.301	0.073	0.389	0.628	520
	[2.857]	[2.740]	[2.795]	[2.785]	[0.389]	[0.356]	[0.359]	
Years of government service	10.525	10.385	9.452	8.992	0.834	0.605	0.521	500
	[5.961]	[6.140]	[5.152]	[5.832]	[0.818]	[0.751]	[0.772]	
Months in current post	61.267	57.298	49.855	60.530	-1.224	-5.463	-9.498	448
	[47.374]	[42.154]	[40.241]	[42.566]	[7.628]	[7.362]	[6.159]	
All-India/state service officer	0.128	0.046	0.067	0.076	0.032	-0.050	-0.010	514
	[0.335]	[0.211]	[0.250]	[0.267]	[0.049]	[0.032]	[0.028]	
Additional government posting	0.291	0.333	0.221	0.137	0.124*	0.167***	0.087	523
	[0.456]	[0.474]	[0.416]	[0.346]	[0.071]	[0.052]	[0.061]	
Additional non-government job	0.000	0.010	0.000	0.009	-0.007	0.004	-0.009	474
	0.000	[0.101]	0.000	[0.092]	[0.008]	[0.013]	[0.008]	
Monthly salary	24,408.3	24,179.8	23,699.9	23,805.8	-680.4	-866.5	-196.1	498
	[5,169.1]	[4,036.1]	[5,188.4]	[5,391.5]	[537.6]	[635.3]	[565.1]	
Hours worked per week	75.808	80.833	76.799	72.953	1.624	6.752	3.830	516
	[16.751]	[22.416]	[20.806]	[20.273]	[3.030]	[3.265]	[3.002]	
Intrinsic motivation	0.544	0.574	0.630	0.667	-0.134**	-0.104	-0.035	519
	[0.500]	[0.497]	[0.484]	[0.473]	[0.063]	[0.066]	[0.065]	
Locus of control	-0.010	-0.033	-0.015	0.055	-0.067	-0.089*	-0.069	525
	[0.596]	[0.530]	[0.541]	[0.479]	[0.070]	[0.053]	[0.055]	
Reciprocity	2.496	2.443	2.507	2.462	0.036	-0.023	0.042	515
	[0.393]	[0.367]	[0.440]	[0.318]	[0.041]	[0.036]	[0.042]	
Corruption propensity	0.016	-0.056	0.009	0.007	0.007	-0.066	0.007	531
	[0.519]	[0.512]	[0.503]	[0.563]	[0.068]	[0.071]	[0.069]	
Big 5	3.729	3.806	3.729	3.757	-0.027	0.052	-0.030	496
	[0.475]	[0.435]	[0.417]	[0.432]	[0.070]	[0.067]	[0.057]	
Public service motivation	4.166	4.225	4.160	4.254	-0.078	-0.016	-0.092	531
	[0.605]	[0.537]	[0.635]	[0.494]	[0.074]	[0.058]	[0.059]	
Smartphone ownership	0.968	0.982	0.987	0.971	0.000	0.014	0.015	529
	[0.176]	[0.133]	[0.113]	[0.170]	[0.021]	[0.022]	[0.016]	
WhatsApp group MGNREGA use	0.992	1.000	1.000	0.993	0.001	0.009	0.007	528
	[0.088]	0.000	0.000	[0.086]	[0.011]	[0.008]	[0.008]	

Notes: Column (1) presents the means and standard deviations of each variable for subdistrict POs in districts receiving only District PayDash. Column (2) gives this information for districts assigned only Subdistrict PayDash, while Column (3) does so for districts receiving both District and Subdistrict PayDash and Column (4) for control districts. Columns (5) through (7) present the coefficients and robust standard errors from a single district-level regression of each variable on separate indicators for assignment to each PayDash treatment arm and fixed effects for strata and state.

Table A3: Balance check - District CEO characteristics

	District Only PayDash (1)	Subdistrict Only PayDash (2)	Combination PayDash (3)	Control (4)	Diff. (1-4) (5)	Diff. (2-4) (6)	Diff. (3-4) (7)	Obs. (8)
Female	0.125	0.000	0.188	0.222	-0.082	-0.209*	-0.029	69
	[0.342]	0.000	[0.403]	[0.428]	[0.133]	[0.105]	[0.150]	
Age	41.692	43.722	39.938	41.667	-0.168	1.814	-1.734	65
	[11.138]	[11.462]	[10.331]	[10.748]	[4.226]	[3.477]	[3.646]	
Post-graduate complete	0.750	0.789	0.500	0.833	-0.101	-0.067	-0.338**	69
	[0.447]	[0.419]	[0.516]	[0.383]	[0.141]	[0.134]	[0.167]	
OBC/SC/ST	0.385	0.444	0.188	0.471	-0.035	0.012	-0.263*	64
	[0.506]	[0.511]	[0.403]	[0.514]	[0.188]	[0.170]	[0.157]	
Years of government service	12.143	14.313	10.857	11.857	0.835	2.950	-0.995	51
	[11.261]	[13.350]	[10.974]	[10.516]	[5.056]	[4.358]	[4.262]	
Months in current post	16.556	13.538	9.467	9.267	6.602*	4.795	0.581	52
	[8.560]	[9.675]	[9.553]	[5.885]	[3.547]	[3.218]	[3.039]	
Additional government posting	0.375	0.286	0.267	0.375	0.063	-0.053	-0.096	53
	[0.518]	[0.469]	[0.458]	[0.500]	[0.222]	[0.175]	[0.166]	
Hours worked per week	74.923	76.526	72.412	71.882	4.168	5.253	1.403	66
	[20.089]	[14.558]	[21.051]	[14.225]	[6.582]	[4.641]	[5.276]	
Intrinsic motivation	0.615	0.833	0.643	0.667	-0.040	0.180	-0.015	63
	[0.506]	[0.383]	[0.497]	[0.485]	[0.187]	[0.152]	[0.169]	
Locus of control	-0.142	0.010	-0.041	0.074	-0.238	-0.089	-0.135	59
	[0.816]	[0.552]	[0.719]	[0.602]	[0.314]	[0.215]	[0.247]	
Reciprocity	2.438	2.453	2.417	2.483	-0.074	-0.065	-0.070	58
	[0.415]	[0.421]	[0.430]	[0.258]	[0.138]	[0.139]	[0.141]	
Corruption propensity	0.206	-0.039	-0.050	-0.063	0.255	0.010	0.003	63
	[0.561]	[0.518]	[0.305]	[0.546]	[0.197]	[0.192]	[0.144]	
Big 5	3.764	3.962	3.767	3.906	-0.155	0.029	-0.170	58
	[0.518]	[0.361]	[0.255]	[0.360]	[0.187]	[0.136]	[0.129]	
Public service motivation	4.477	4.471	4.350	4.521	-0.043	-0.052	-0.181*	63
	[0.459]	[0.602]	[0.235]	[0.320]	[0.154]	[0.126]	[0.106]	
Smartphone ownership	1	1	0.938	1	-0.006	-0.007	-0.067	68
	[0]	[0]	[0.250]	[0]	[0.013]	[0.013]	[0.065]	
WhatsApp group MGNREGA use	1	1	1	1	0	0	0	69
	[0]	[0]	[0]	[0]	[0]	[0]	[0]	

Notes: Column (1) presents the means and standard deviations of each variable for District POs in districts receiving only District PayDash. Column (2) gives this information for districts assigned only Subdistrict PayDash, while Column (3) does so for districts receiving both District and Subdistrict PayDash and Column (4) for control districts. Columns (5) through (7) present the coefficients and robust standard errors from a single district-level regression of each variable on separate indicators for assignment to each PayDash treatment arm and fixed effects for strata and state.

Table A4: Balance check - Subdistrict CEO characteristics

	District Only PayDash (1)	Subdistrict Only PayDash (2)	Combination PayDash (3)	Control (4)	Diff. (1-4) (5)	Diff. (2-4) (6)	Diff. (3-4) (7)	Obs. (8)
Female	0.093	0.121	0.126	0.187	-0.097**	-0.068	-0.057	518
	[0.292]	[0.328]	[0.333]	[0.391]	[0.048]	[0.050]	[0.048]	
Age	46.244	43.963	44.108	42.427	3.056**	0.635	1.928**	514
	[9.618]	[8.771]	[8.583]	[8.531]	[1.164]	[1.045]	[0.863]	
Post-graduate complete	0.639	0.566	0.706	0.692	-0.064	-0.137	0.018	518
	[0.482]	[0.498]	[0.457]	[0.464]	[0.053]	[0.054]	[0.051]	
OBC/SC/ST	0.605	0.593	0.677	0.634	-0.002	-0.014	0.032	513
	[0.491]	[0.494]	[0.469]	[0.484]	[0.073]	[0.067]	[0.063]	
Raven's score	8.234	8.686	9.228	8.915	-0.523	0.000	0.250	475
	[3.110]	[2.779]	[2.723]	[2.575]	[0.424]	[0.387]	[0.437]	
Years of government service	18.053	15.952	14.773	12.169	4.559***	2.403*	3.091***	501
	[12.853]	[11.517]	[11.018]	[10.511]	[1.459]	[1.259]	[0.995]	
Months in current post	33.026	28.453	28.069	27.903	1.905	-3.330	1.224	488
	[51.827]	[48.582]	[41.585]	[46.084]	[6.352]	[6.046]	[5.070]	
All-India/state service officer	0.975	0.991	0.987	1.000	-0.022	-0.007	-0.015	515
	[0.157]	[0.097]	[0.113]	0.000	[0.016]	[0.010]	[0.010]	
Additional government posting	0.286	0.358	0.373	0.356	-0.031	0.037	-0.001	518
	[0.454]	[0.482]	[0.485]	[0.481]	[0.055]	[0.067]	[0.068]	
Additional non-government job	0.000	0.000	0.007	0.000	0.001	0.001	0.007	476
	0.000	0.000	[0.085]	0.000	[0.002]	[0.002]	[0.007]	
Monthly salary	53,500.1	49,327.5	53,338.8	49,809.7	4,550.9***	502.6	3,296.0**	511
	[12,000]	[11,800]	[10,700]	[11,200]	[1,593.1]	[1,654.1]	[1,396.1]	
Hours worked per week	87.202	86.879	84.100	84.206	2.767	2.475	-0.118	497
	[20.773]	[19.800]	[20.076]	[18.929]	[2.896]	[3.406]	[3.139]	
Intrinsic motivation	0.642	0.683	0.649	0.563	0.086	0.121*	0.083	484
	[0.482]	[0.468]	[0.479]	[0.498]	[0.068]	[0.062]	[0.065]	
Locus of control	0.005	-0.019	0.120	-0.105	0.107**	0.083	0.226***	500
	[0.531]	[0.650]	[0.460]	[0.546]	[0.053]	[0.072]	[0.047]	
Reciprocity	2.482	2.524	2.446	2.498	-0.033	0.009	-0.044	490
	[0.423]	[0.457]	[0.431]	[0.438]	[0.063]	[0.059]	[0.056]	
Corruption propensity	-0.009	-0.037	-0.006	0.047	-0.055	-0.089	-0.053	510
	[0.483]	[0.514]	[0.572]	[0.583]	[0.074]	[0.070]	[0.069]	
Big 5	3.748	3.756	3.825	3.775	-0.033	-0.011	0.055	460
	[0.537]	[0.495]	[0.443]	[0.460]	[0.058]	[0.060]	[0.055]	
Public service motivation	4.367	4.187	4.326	4.289	0.087	-0.092	0.033	510
	[0.567]	[0.792]	[0.545]	[0.500]	[0.067]	[0.099]	[0.071]	
Smartphone ownership	0.966	0.972	0.981	0.992	-0.023	-0.016	-0.012	514
	[0.183]	[0.167]	[0.136]	[0.087]	[0.021]	[0.015]	[0.012]	
WhatsApp group MGNREGA use	1.000	0.981	0.994	0.992	0.009	-0.010	0.001	518
	0.000	[0.137]	[0.079]	[0.087]	[0.007]	[0.013]	[0.009]	

Notes: Column (1) presents the means and standard deviations of each variable for subdistrict CEOs in districts receiving only District PayDash. Column (2) gives this information for districts assigned only Subdistrict PayDash, while Column (3) does so for districts receiving both District and Subdistrict PayDash and Column (4) for control districts. Columns (5) through (7) present the coefficients and robust standard errors from a single district-level regression of each variable on separate indicators for assignment to each PayDash treatment arm and fixed effects for strata and state.

Table A5: Robustness to village-month-level analysis

Outcome:	Time to complete officer steps (days)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Any PayDash (β)	-1.208***	-1.087***						
	(0.350)	(0.334)						
District PayDash (β_1)			-1.108	-1.048				
			(0.877)	(0.845)				
Subdistrict PayDash (β_2)			-1.741***	-1.593***				
			(0.456)	(0.428)				
Combination (β_3)			-0.890**	-0.736**				
			(0.363)	(0.347)				
High Delay								
*Any PayDash (θ)					-3.418***	-3.176***		
					(0.652)	(0.634)		
*District Only PayDash (θ_1)							-4.558***	-4.376***
							(1.301)	(1.297)
*Subdistrict Only PayDash (θ_2)							-3.203***	-2.977***
							(0.573)	(0.516)
*Combination (θ_3)							-2.626***	-2.317**
							(0.816)	(0.778)
Low Delay								
*Any PayDash (λ)					-0.149	-0.090		
					(0.309)	(0.296)		
*District Only PayDash (λ_1)							-0.150	-0.112
							(0.611)	(0.586)
*Subdistrict Only PayDash (λ_2)							-0.090	-0.038
							(0.421)	(0.424)
*Combination (λ_3)							-0.181	-0.096
							(0.418)	(0.404)
Observations	14,553	593,781	14,553	593,781	14,553	593,781	14,553	593,781
Subdistrict, Month FEs	X		X		X		X	
Village, Month FEs		X		X		X		X
$\beta_4 = \beta_3 - \beta_2 - \beta_1$			1.959*	1.905*				
$\beta_4 = 0$, p-value			0.067	0.062				
$\theta_4 = \theta_3 - \theta_2 - \theta_1$							5.136***	5.037***
$\theta_4 = 0$, p-value							0.001	0.001

Notes: Columns (1)-(4) report estimates from regressions at the subdistrict-month or village-month level of the listed variable on treatment arm indicators, subdistrict or village fixed effects, month fixed effects, and linear controls for district time trends, weighting by the total number of muster rolls. In columns (5)-(8) the treatment arm indicators are interacted with above- and below-median pre-period completion time indicators. Standard errors clustered at the district level in parentheses. Significant at *10 percent, **5 percent,***1 percent.

Table A6: Comparison of PayDash impacts with/without trends controls

Outcome:	Time to complete officer steps (days)							
	Without time trend controls				With district time trend controls			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Any PayDash (β)	0.014				-1.208***			
	(0.336)				(0.350)			
District Only PayDash (β_1)		0.408				-1.108		
		(0.673)				(0.877)		
Subdistrict Only PayDash (β_2)		-1.078**				-1.741***		
		(0.430)				(0.456)		
Combination (β_3)		0.543				-0.890**		
		(0.407)				(0.363)		
High Delay								
*Any PayDash (θ)			-3.263***				-3.418***	
			(0.637)				(0.652)	
*District PayDash (θ_1)				-3.780***				-4.558***
				(1.094)				(1.301)
*Subdistrict PayDash (θ_2)				-3.089***				-3.203***
				(0.621)				(0.573)
*Combination (θ_3)				-2.679**				-2.626***
				(1.030)				(0.816)
Low Delay								
*Any PayDash (λ)			0.678**				-0.149	
			(0.336)				(0.309)	
*District PayDash (λ_1)				1.071**				-0.150
				(0.451)				(0.611)
*Subdistrict PayDash (λ_2)				-0.319				-0.090
				(0.322)				(0.421)
*Combination (λ_3)				1.018**				-0.181
				(0.398)				(0.418)
Observations	14,553	14,553	14,553	14,553	14,553	14,553	14,553	14,553
$\beta_4 = \beta_3 - \beta_2 - \beta_1$		1.213				1.959*		
$\beta_4 = 0$, p-value		0.184				0.067		
$\theta_4 = \theta_3 - \theta_2 - \theta_1$				4.191***				5.136***
$\theta_4 = 0$, p-value				0.007				0.001

Notes: Columns (1)-(2) and (5)-(6) report estimates from regressions at the subdistrict-month level of the listed variable on treatment arm indicators, subdistrict fixed effects, and month fixed effects, weighting by the total number of muster rolls. Columns (5)-(8) also include linear controls for district time trends. In columns (3)-(4) and (7)-(8) the treatment arm indicators are interacted with above- and below-median pre-period completion time indicators. Standard errors clustered at the district level in parentheses. Significant at *10 percent, **5 percent,***1 percent.

Table A7: Muster rolls volume and length

Outcome:	Number of muster rolls		Muster roll length (days)	
	(1)	(2)	(3)	(4)
Any PayDash (β)	-23.6		0.043	
	(198.2)		(0.091)	
District PayDash (β_1)		203.2		0.131
		(312.5)		(0.106)
Subdistrict PayDash (β_2)		-34.2		-0.045
		(232.2)		(0.132)
Combination (β_3)		-185.0		0.050
		(225.7)		(0.145)
Observations	14,554	14,554	14,554	14,554

Notes: All columns report estimates from regressions at the subdistrict-month level of the listed variable on treatment arm indicators, weighting by the number of muster rolls in columns (3) and (4). Additionally included are subdistrict and month fixed effects. Standard errors clustered at the district level in parentheses. Significant at *10 percent, **5 percent,***1 percent.

Table A8: Cross-level impacts of PayDash access on usage

	Number of sessions	Usage duration (min)	Messages sent + calls made
	(1)	(2)	(3)
Panel A. District Officers			
Both levels PayDash	-0.20	-7.06	-11.09
	(1.71)	(11.57)	(12.25)
Constant	3.94***	22.40***	14.31
	(1.39)	(10.52)	(12.07)
Observations	559	559	559
Panel B. Subdistrict Officers			
Both levels PayDash	0.89	2.17	0.18
	(0.65)	(4.42)	(0.53)
Constant	3.75***	21.07***	0.56*
	(0.42)	(3.00)	(0.31)
Observations	4,114	4,114	4,114

Notes: Columns in each panel report estimates from regressions at the district-month (Panel A) or subdistrict-month (Panel B) level of the listed variables on an indicator for PayDash provision at the corresponding officer level and at the other officer level, restricted to post-treatment months in localities receiving PayDash at the corresponding officer level. Observations with values above the postive-valued 99th percentile are trimmed. Standard errors clustered at the district level in parentheses. Significant at *10 percent, **5 percent,***1 percent.

Table A9: PayDash impacts on officer transfers - district positions

Outcome:	Any transfer			
	District POs		District CEOs	
	(1)	(2)	(3)	(4)
Panel A. Within 6 months				
District PayDash	0.109	0.020	-0.051	-0.023
	(0.143)	(0.099)	(0.170)	(0.117)
Subdistrict PayDash	-0.050	-0.137	-0.093	-0.066
	(0.143)	(0.099)	(0.165)	(0.117)
District PayDash * Subdistrict PayDash	-0.178		0.055	
	(0.201)		(0.236)	
Observations	73	73	73	73
Control outcome mean	0.400	0.400	0.650	0.650
Panel B. Within 17 months (MP only)				
District PayDash	0.062	-0.103	-0.010	-0.087
	(0.192)	(0.131)	(0.115)	(0.081)
Subdistrict PayDash	0.162	-0.004	0.070	-0.004
	(0.169)	(0.131)	(0.071)	(0.078)
District PayDash * Subdistrict PayDash	-0.329		-0.154	
	(0.260)		(0.159)	
Observations	50	50	50	50
Control outcome mean	0.692	0.692	0.923	0.923

Notes: Columns in each panel report estimates from regressions at the locality-position level of the listed variable on indicators for PayDash availability at the district and subdistrict levels and, in odd numbered columns, their interaction. Additionally included are controls for randomization strata, and state fixed effects in Panel A. The outcome measure used in Panel B is only available for the state of Madhya Pradesh (MP). Standard errors clustered at the district level in parentheses. Significant at *10 percent, **5 percent,***1 percent.

Table A10: PayDash impacts on officer transfers - subdistrict POs, by high/low delay

Any transfer within:	6 months		MP only 17 months	
	(1)	(2)	(3)	(4)
High Delay				
* District PayDash	-0.129	-0.123	-0.290**	-0.193**
	(0.151)	(0.108)	(0.115)	(0.082)
* Subdistrict PayDash	0.110	0.115	-0.063	0.012
	(0.157)	(0.110)	(0.107)	(0.082)
* (District PayDash * Subdistrict PayDash)	0.011		0.176	
	(0.217)		(0.172)	
Low Delay				
* District PayDash	-0.204*	-0.197**	-0.107	-0.154
	(0.111)	(0.097)	(0.248)	(0.212)
* Subdistrict PayDash	0.064	0.075	0.263	0.082
	(0.185)	(0.088)	(0.195)	(0.163)
* (District PayDash * Subdistrict PayDash)	0.018		-0.217	
	(0.203)		(0.269)	
Observations	561	561	308	308
Control outcome mean	0.460	0.460	0.760	0.760

Notes: All columns report estimates from regressions at the locality-position level of the listed variable on indicators for PayDash availability at the District and Subdistrict levels and, in odd numbered columns, their interaction, further interacted with above- and below-median pre-period average processing time indicators. Additionally included are controls for randomization strata, and, in columns (1) and (2), state fixed effects. The outcome measure used in columns (3) and (4) is only available for the state of Madhya Pradesh (MP). Standard errors clustered at the district level in parentheses. Significant at *10 percent, **5 percent,***1 percent.

Appendix B

B.1 PayDash training

To introduce officers to PayDash, we invited all relevant government officials in the study area - typically a permanent district officer overseeing multiple development schemes in their district, the contract district worker specifically overseeing MGNREGA, a permanent block officer overseeing multiple development schemes in the block, and a contract block officer specifically overseeing only MGNREGA in the block - to a half-day session.

Both control and treatment officials went through the same roll-out process, with the exception that only treatment officials were introduced to and provided PayDash. First, we collected baseline survey data from all officials through a self-administered, paper survey. Then we conducted a session outlining data-based management tools available to officials in the MGNREGA MIS and asked officials to share about their work and professional challenges they face.

After this, control officials were dismissed. In sessions with treatment officers, the training continued with an additional 1.5 hour session where officers were introduced to PayDash and its mobile platform, and they downloaded the app and conducted preliminary exercises on the platform to ensure it was functional and they understood how to use it. To avoid treatment contamination, officers from treatment areas were trained on separate days and/or locations from those in control areas. To encourage survey response and PayDash coverage, we made extensive efforts (by calling up to five times on different dates, and having the state send a letter instructing all officials to report for this official training) to maximize the likelihood of officer presence at the training sessions during the state roll-out.

For those officials that did not attend the group-based training, we conducted individual surveying and onboarding to PayDash (when relevant). To avoid sensitivities related to officials' seniority, we conducted sessions separately not only for treatment and control officials, but also for block and district-level officials within these groups.

B.2 Randomization strata and heterogeneity analysis

Randomization strata

The district-level average processing time measure used in defining the randomization strata was calculated across muster-roll-by-workers reaching processing completion within each district over

the April 2015 to May 2016 range for Madhya Pradesh and the April 2015 to June 2016 range for Jharkhand. The district-level per-block volume of person-days worked measure used was the average of the block-level monthly totals of person-days worked across blocks within each district, over the April 2015 to April 2016 range for Madhya Pradesh and the April 2015 to June 2016 range for Jharkhand. These measures were constructed using the more limited administrative data available to us at the time of randomization.

Heterogeneity analysis

The district-level average processing time measure used in the primary categorization of "high delay" versus "low delay" districts for heterogeneity analysis is calculated across muster rolls that began verification and processing within each district over the April 2015 to June 2016 range for both Madhya Pradesh and Jharkhand. We use this as our primary measure because it is generated from the same data as our main outcome of interest, and so can be calculated across muster rolls over the same time range for both states and allows for grouping of muster rolls by processing start date. The time range of construction is chosen to match the maximum range used for the randomization measure. The correlation of average processing time defined over the April 2015 to June 2016 range with average processing time defined over the 2015-16 fiscal year (April 2015 to March 2016) is 0.99. As a robustness check, we also conduct the heterogeneity analysis defining "high delay" versus "low delay" districts based on the same measure used in the generation of the randomization strata. The correlation of this secondary measure with our primary measure is 0.84.