NBER WORKING PAPER SERIES

INCENTIVIZED PEER REFERRALS FOR TUBERCULOSIS SCREENING: EVIDENCE FROM INDIA

Jessica Goldberg
Mario Macis
Pradeep Chintagunta

Working Paper 25279
http://www.nber.org/papers/w25279

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 01238
November 2018

This project was approved by IRB committees at the University of Maryland (College Park, MD,USA), Johns Hopkins University (Baltimore, MD, USA), and the Institute for Financial Management and Research (Chennai, India) and registered with the AEA Trial Registry (AEARCTR-0000773). It was also reviewed and approved by the Indian Council of Medical Research (ICMR). The work was funded by grants from the World Bank Strategic Innovation Fund (SIEF), the International Growth Centre (IGC India Central), the Johns Hopkins Center for Global Health, the Maryland Population Research Center, the University of Chicago Trust (India), and Jaithirth (Jerry) Rao. We appreciate the assistance of Thomas Bossuroy and Drew von Glahn, the World Bank TTLs. Field work and data collection were conducted by JPAL-South Asia, where Pratyusha Govindaraju, Putul Gupta, Shaheen Madraswala, and Niloufer Taber capably managed the project with the help of dedicated teams. Tara Kaul and Sai Luo provided outstanding research assistance. We are grateful for useful comments from Junaid Ahmad, Marcella Alsan, Dan Bartels, Jacob Bor, Erich Battistin, Richard Chaisson, Berkeley Dietvorst, Pascaline Dupas, Susan Godlonton, Jonathan Golub, Alaka Holla, Ronald Mutasa, Jeffrey Smith, Janardan Prasad Singh, K. Sudhir, Abby Sussman, Sergio Urzua, and participants at several seminars and conferences. Dr. Kuldeep S. Sachdeva and Dr. Amar Shah (Revised National Tuberculosis Control Programme), Dr. K. K. Chopra (New Delhi Tuberculosis Centre), Dr. Ashwani Khanna and Dr. Shivani Chandra (Delhi State TB Office), and members of the Delhi State and the National Operational Research Committees offered advice and feedback about the design and implementation of the study. We appreciate the assistance of the district and state TB officers in the areas where we operated. We are especially grateful to Sandeep Ahuja, Shelly Batra, and their committed team at Operation ASHA. All errors and omissions are our own. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

Incentivized Peer Referrals for Tuberculosis Screening: Evidence from India
Jessica Goldberg, Mario Macis, and Pradeep Chintagunta
NBER Working Paper No. 25279
November 2018, Revised in October 2020
JEL No. I1,O1

ABSTRACT

We study whether and how peer referrals increase screening, testing, and identification of patients with tuberculosis, an infectious disease responsible for over one million deaths annually. In an experiment with 3,176 patients at 122 tuberculosis treatment centers in India, we find that small financial incentives raise the probability that existing patients refer prospective patients for screening and testing, resulting in cost-effective identification of new cases. Incentivized referrals operate through two mechanisms: peers have private information about individuals in their social networks to target for outreach, and they are more effective than health workers in inducing these individuals to get tested.

Jessica Goldberg
Department of Economics
University of Maryland
3115C Tydings Hall
College Park, MD 20742
and NBER
goldberg@econ.umd.edu

Pradeep Chintagunta
University of Chicago
Booth School of Business
Chicago, IL
pradeep.chintagunta@ChicagoBooth.edu

Mario Macis
Johns Hopkins University
Carey Business School
100 International Drive, Office 1333
Baltimore, MD 21202
and IZA
and also NBER
mmacis@jhu.edu

A randomized controlled trials registry entry is available at https://www.socialscienceregistry.org/trials/773

1 Introduction

Targeted communication of accurate, actionable information about infectious diseases is essential for protecting individuals and societies. This paper studies the role of peer networks in sharing information about tuberculosis (TB), based on referral strategies that are well-understood in labor market contexts and more recently applied to technology diffusion, but not commonly used in public health settings.

Tuberculosis, a highly contagious, airborne respiratory disease, is responsible for more fatalities than any other infectious disease; in 2018, it caused about 1.5 million deaths (World Health Organization, 2019).[1] About 10.4 million people worldwide, three million of them in India alone, developed active TB in 2018.[2] The disease is most

This project was approved by IRB committees at the University of Maryland (College Park, MD, USA), Johns Hopkins University (Baltimore, MD, USA), and the Institute for Financial Management and Research (Chennai, India) and registered with the AEA Trial Registry (AEARCTR-0000773). It was also reviewed and approved by the Indian Council of Medical Research (ICMR). The work was funded by grants from the World Bank Strategic Innovation Fund (SIEF), the International Growth Centre (IGC India Central), the Johns Hopkins Center for Global Health, the Maryland Population Research Center, the University of Chicago Trust (India), and Jaithirth (Jerry) Rao. We appreciate the assistance of Thomas Bossuroy and Drew von Glahn, the World Bank TTLs. Field work and data collection were conducted by JPAL-South Asia, where Pratyusha Govindaraju, Putul Gupta, Shaheen Madraswala, and Niloufer Taber capably managed the project with the help of dedicated teams. Tara Kaul and Sai Luo provided outstanding research assistance. We are grateful for useful comments from Junaid Ahmad, Marcella Alsan, Dan Bartels, Jacob Bor, Erich Battistin, Richard Chaisson, Berkeley Dietvorst, Pascaline Dupas, Susan Godlonton, Jonathan Golub, Alaka Holla, Ronald Mutasa, Jeffrey Smith, Janardan Prasad Singh, K. Sudhir, Abby Sussman, Sergio Urzua, and participants at several seminars and conferences. Dr. Kuldeep S. Sachdeva and Dr. Amar Shah (Revised National Tuberculosis Control Programme), Dr. K. K. Chopra (New Delhi Tuberculosis Centre), Dr. Ashwani Khanna and Dr. Shivani Chandra (Delhi State TB Office), and members of the Delhi State and the National Operational Research Committees offered advice and feedback about the design and implementation of the study. We appreciate the assistance of the district and state TB officers in the areas where we operated. We are especially grateful to Sandeep Ahuja, Shelly Batra, and their committed team at Operation ASHA. All errors and omissions are our own.

[1]There were 1.1-1.3 million TB deaths among HIV-negative people and 223,000-281,000 TB deaths among HIV-positive people; the latter are classified as HIV deaths in official reports (World Health Organization, 2017).

[2]Between 1 and 2 billion people globally are estimated to have "latent" TB (Chaisson, 2018). These individuals are infected with *Mycobacterium tuberculosis* but do not have symptoms of the disease and cannot spread the infection to others. However, without treatment, individuals with latent TB have a

common among vulnerable populations in poor countries in Africa and Asia (World Health Organization, 2019). Mortality from untreated TB is high (45% for HIV-negative and nearly 100% for HIV-positive individuals (World Health Organization, 2019)) and the disease is highly debilitating even among those who survive it, with serious—often devastating—consequences for human productivity.

Despite the high personal cost of illness and the availability of highly effective treatment that is free to patients in developing countries, a large share of those infected with TB do not receive timely diagnoses or appropriate treatment. In India, about 40% of TB cases are not reported to the public health authorities (Cowling et al., 2014), as would be necessary to facilitate treatment and contact tracing. Even though the symptoms of TB are widely known in India, they are also associated with other diseases, including asthma, upper respiratory infection, and cancer. Also, the efficacy of TB treatment may not be well-understood, particularly by the marginalized populations who are most at-risk for the disease. This implies that many individuals who have TB symptoms may underestimate the expected benefits of formal diagnosis with and treatment for the disease. Additionally, active case-finding to identifying TB patients has proven very costly. One reason is that even in contexts with high TB prevalence, large numbers of individuals must be screened to identify individuals with symptoms that require testing (herafter, we use the term "symptomatics" to refer to individuals whose symptoms of TB are confirmed by health workers, and distinguish them from "suspects," who are individuals identified by peers as those who would benefit from testing but who have not yet been screened by health workers for the presence of symptoms). For example, Charles et al. (2010) report findings from a large-scale study in southern India. More than 18,000 individuals were screened, resulting in the identification of 640 individuals with symptoms consistent with TB.[3]

In this work, we study whether outreach by existing patients who are benefiting from treatment of their own TB can contribute to reducing these imperfect information problems and improving case-finding. Individuals receiving appropriate medical care

5%–15% lifetime probability of developing active TB (World Health Organization, 2017).

[3]In Charles et al. (2010), the prevalence of so-called "chest symptomatics" was 2.7% in rural areas and 4.9% in urban areas.

have information about personal and logistical aspects of TB screening, testing and treatment based on their own experience as patients. They are likely to have social ties to others who would benefit from testing and treatment, both because they share risk factors and because the disease is contagious. In particular, they may have connections to at-risk people who are hard for health workers to identify and reach in a timely manner. Existing patients might also be able to credibly vouch for the quality of the health care provider and the benefits of treatment, providing personal testimonials that could be more compelling to some prospective patients than information from health workers.[4] Thus, peer referrals can potentially complement or supplement outreach by public health workers along two dimensions: they can increase the scope and scale of outreach, and improve the ability to identify and persuade at-risk individuals. Therefore, we designed an experiment to investigate the potential of peer referrals from existing patients to resolve informational barriers to screening and case detection, much as referrals are used in labor markets to identify high-quality employees.

We partnered with Operation ASHA, a non-governmental organization (NGO) that runs Directly Observed Treatment Short Course (DOTS) centers in several cities in coordination with the Indian Government's TB control program, the Revised National Tuberculosis Programme (RNTCP), to implement a randomized controlled trial of financial incentives and peer outreach strategies for identifying and testing previously unserved individuals with symptoms of TB.[5] We randomly assigned 122 DOTS centers treating 3,176 existing patients and located across nine cities to either a control group where new patient intake followed Operation ASHA's standard procedures, or one of nine active case-finding strategies. Our experimental outreach strategies varied the presence and conditionality of incentives for making referrals, and whether prospective patients were approached directly by TB patients in their own social networks or by health workers following up on leads generated by current TB patients. While financial incentives

[4]Conveying otherwise-hidden information to prospective patients makes the peer referral mechanism we study distinct from community- or network-based targeting, where the objective is typically to aggregate information from the network to share with a third party.

[5]India launched its National Tuberculosis Programme (NTP) in 1961. Later, in order to standardize TB treatment and implement the DOTS strategy, the Revised National Tuberculosis Control Programme (RNTCP) was started in 1997. Over the next nine years, it expanded across the country.

have been used to shape health behaviors in other contexts,[6] introducing experimental variation in the degree and nature of existing patients' engagement in outreach is a novel contribution to the literature on referrals and allows us to disentangle the effect of private information about prospective targets from the effect of information conveyed by peers.

Our results indicate that existing TB patients have valuable information about other individuals in their social network–but outside their own household–who would benefit from TB screening and testing, and are effective in conveying it to their peers, particularly when they are offered financial incentives. Relative to encouragement alone, financial incentives to existing patients doubled the number of new suspects who came in for screening. On average, providing incentives resulted in one new patient screened for every 10 existing patients, compared to one new patient screened every 22 existing patients in the absence of incentives. These additional screenings were well targeted: incentives also had statistically significant effects on other measures of case-finding, including the numbers of new suspects sent for testing on the basis of their symptoms, of those symptomatics who were actually tested, and of patients with active TB identified and subsequently, started on a treatment regimen.

Direct outreach by peers was more effective in identifying prospective patients for screening, and ultimately finding individuals with TB, than the alternative of outreach by health workers. In fact, outreach by existing patients resulted in an average of one new suspect screened for every 8 existing patients, and one new symptomatic tested for every 11 existing patients. These were more than double the levels of case-finding when outreach was conducted by health workers. Further, incentives strongly complemented peer outreach: on average, incentivized peer outreach resulted in one new patient screened for every 5.6 existing patients, and one new symptomatic sent for testing for every 7.4 existing patients. Incentives appear to have increased the effort that existing patients exerted in both convincing contacts to get screened for TB and identifying those contacts who were more likely to have the disease.

[6] See Baird et al. (2012); Kohler and Thornton (2011); Walque et al. (2012); Thornton (2008); Kremer et al. (2009); Miller et al. (2012); Basing et al. (2011) for examples.

Because of the effectiveness of small financial incentives and the comparatively lower cost of time for existing patients than health workers, incentivized peer outreach in TB screening is highly cost-effective when compared to health-worker outreach. We estimate that peer outreach results in the screening of new symptomatics at 20% of the cost of outreach by health workers, and it identifies new TB cases at 28%–38% of that cost.

The reach of peers extends well beyond immediate family members (who in this study were excluded by design), including neighbors, co-workers, and friends. Incentives and peer outreach each demonstrated the potential to increase identification of marginalized patients. The prospective patients identified by current patients who received incentives for referrals were more socially and economically disadvantaged than those identified by current patients who did not receive financial incentives, and new prospective patients identified through peer outreach were more socially disconnected than those from the health worker outreach arms.

Our study demonstrates that, in its context, the necessary conditions for large-scale, community-based referral schemes to be effective in identifying patients with TB exist. Existing patients have useful information; they are able to pass on that information and to target at-risk individuals; and they are willing to do this in return for small, cost-effective payments. We emphasize the establishment of these necessary conditions in terms of existing patients' access to information and their ability and willingness to share it, rather than the ability of peer referral schemes to tackle the scale of India's TB problem. Although India has the highest TB burden in the world, infection is still a relatively rare occurrence and it would require a prohibitively large sample to identify a large number of TB-positive individuals.

Our work contributes to large literatures in economics that considers the effects of social networks on individuals' economic outcomes and behaviors (Jackson, 2011). The role of peers has been documented in the context of technology diffusion, particularly in agriculture (Beaman et al., 2018a; Fafchamps et al., 2018), in the targeting of social protection programs and microfinance loans (Alatas et al., 2016; Hussam et al., 2017), and in the dissemination of information about a public health insurance program (Berg et al., 2019).[7] Moreover, firms that sell goods or services often rely on referrals from current customers—who have private information about quality—to market their products to new ones (Kumar et al., 2010; Godes and Mayzlin, 2009). Firms also use referrals to attract and screen workers (Bryan et al., 2010; Heath, forthcoming; Kugler, 2003). The potential role of referrals in attracting candidates with specific characteristics in employment settings has been measured in experimental studies in India (Beaman and Magruder, 2012) and Malawi (Beaman et al., 2018b), as well as in experimental and nonexperimental studies in the United States (Burks et al., 2015; Friebel et al., 2018).

Although our application shares some features with labor or product markets and with health applications that have been studied previously, our context is distinct from the settings in which referrals have been most intensively studied. First, stigma about TB may make the costs of sharing information about treatment higher than those of sharing information about jobs or products. Second, the highly contagious nature of the disease means there are public as well as private benefits to increased identification of individuals with TB. This implies that results from marketing or employment contexts may not generalize to a health context.[8] Moreover, in the context of job market referrals, referrers typically both identify targets and perform the outreach, whereas the design of our field experiment allows us to disentangle these two distinct channels through which referrals may operate.[9] Our work also complements related research by Berg et al. (2019)

[7]A growing set of studies document the respective effects of social interactions, networks, and peers on health behaviors including obesity (Christakis and Fowler, 2007), smoking (Christakis and Fowler, 2008), and the use of hygiene products (Oster and Thornton, 2012), as well as on choices associated with HIV treatment (Balat et al., 2018), hospital (Pope, 2009), and health insurance (Sorensen, 2006).

[8]In labor markets, homophily might lead to undesirable outcomes from referrals by limiting diversity in hiring (Beaman et al., 2018b; Hoffman, 2017) or inducing nepotism (Wang, 2013), which in some cases could cause referrals to have negative net welfare effects. In our context, homophily is likely to benefit disadvantaged populations because our referrer population is marginalized and thus likely to reach out to other marginalized individuals. At the same time, it is possible that excessive reliance on a referrals mechanism might disadvantage individuals who do not enjoy large social networks. This highlights the importance of analyzing, as our study does, precisely which types of individuals are recruited through the various referral schemes.

[9]We are aware of only one marketing study that contrasts the effectiveness of outreach by current customers (analogous to patients in our context) and independent agents (Godes and Mayzlin, 2009). In that study, outcomes cannot be directly associated with specific individuals on either side of the interaction since the relationship being measured is between aggregate sales in a market and the total

that studied the effect of incentives paid to agents hired to disseminate information about public health insurance in Southern India. Incentive pay for agents increased potential customers' knowledge of the insurance product and increased take-up. A key distinction between this context and the one we study is that in Berg et al. (2019), the health insurance product was designed to be beneficial for the entire population, while TB screening and testing only benefits those with symptoms of or exposure to the disease – a relatively rare (and hard to identify) population even in a high-TB burden setting. Therefore, incentives in the Berg et al. (2019) context may increase effort in the extensive and intensive margins, while incentives for outreach to TB patients affect effort along both of those dimensions and also in targeting.

In addition to contributing to the academic literature on networks, referrals, and incentives, our study is relevant to public health policy. It is closely aligned with and designed to study potential improvements to the strategies used to fight TB by both the World Health Organization (WHO) and India's RNTCP.[10] Furthermore, other communicable diseases such as HIV/AIDS and COVID-19 present challenges related to informational barriers that are similar to those posed by TB. These diseases also dispro-

amount of word-of-mouth content spread by customers and agents in that market.

[10]To improve outreach and reduce its cost, recent WHO guidelines encourage high TB-burden countries to incorporate community-based outreach in national campaigns to prevent and treat TB. These guidelines, called the ENGAGE-TB approach (Haileyesus Getahun et al., 2012), include a specific emphasis on the role of communities in assisting in the detection of TB, especially in its early stages. The guidelines emphasize referrals by community health workers and volunteers; the referral strategies we test in this study are consistent with the WHO recommendations. Following the recent WHO guidelines, public health scholars and practitioners have begun to explore peer referrals as a case-finding tool. Some studies focus on HIV case finding among high-risk communities (see, e.g., Glasman et al. (2016); Gwadz et al. (2017); Shangani et al. (2017)), and one study considers identification of malaria cases (Faye, 2012). In the context of TB, Joshi et al. (2017) implement a peer-led screening project in Nepal, where 30 volunteers received intensive training to perform TB screening, collect sputum samples, accompany the newly diagnosed patients to obtain treatment, and support them during treatment. Similar strategies were implemented in the Democratic Republic of the Congo (Munyanga Mukungo and Kaboru, 2014; André et al., 2018). These studies, which do not include experimental control groups and are not designed to investigate mechanisms, included intensive training of groups of selected former TB or HIV patients who deployed as community health workers, often for prolonged periods of time. Methodologically, our study differs from existing research in using an RCT to identify causal impacts of various referral and incentive schemes and to distinguish between competing barriers to information sharing. Operationally, it mobilizes existing patients during the course of their treatment and requires minimal training.

portionately affect vulnerable, marginalized populations and, in the case of HIV/AIDS, carry social stigma. Insights from conducting outreach to TB patients may prove useful in these contexts and even suggest ways strategies for using targeted information to combat newly emerging infectious diseases.

In the next section, we present the simple conceptual framework we used to design the experiment and guide our analysis. In Section 3, we describe the context and the experimental design. In Section 4, we present results, and in Section 5, we offer our conclusions.

2 Conceptual Framework

Referrals can be used to overcome imperfect information when individuals have private knowledge that may be obtained from and shared through their social networks. The best-known examples are in labor markets, where current employees may have better information than firms about the characteristics of prospective new workers (Bryan et al., 2010; Heath, forthcoming; Kugler, 2003; Beaman and Magruder, 2012; Beaman et al., 2018b; Burks et al., 2015; Friebel et al., 2018).

The conceptual framework that guides our experimental design is grounded in our focus on the choices of existing patients, who face potential costs and benefits from referring others for TB screening. The framework is based on Beaman and Magruder (2012), who applied it to the more traditional context of job referrals. The framework fixes ideas about how incentives affect current patients' expected benefits of making referrals, and provides a formal description of the margins of effort through which current patients can influence the behavior of their contacts. It provides high-level motivation for considering the interaction of incentives and outreach modality.

We assume that each existing patient EP_i undergoing TB treatment at a certain health care provider is endowed with a given number of contacts $j = 1, ..., n_i$. From the perspective of EP_i, the individual making the referral, each of his contacts j is a potential subject of the referral and is characterized by:

1. A net benefit d_{ij} that EP_i receives when referring contact j to the provider,[11] defined as d_{ij} = g_{ij} - s_{ij} - c_{ij}, where g_{ij} is the value of any utility generated by the interaction (such as the "warm glow" described by Andreoni (1990) that EP_i might experience from knowing he helped contact j improve her health), s_{ij} denotes any disutility of the interaction due to the stigma and discrimination associated with TB, and c_{ij} is the time and effort cost of identifying, interacting with, and providing contact j with information about TB, screening opportunities, etc. Thus, the net benefit d_{ij} can be positive or negative, depending on whether its positive or negative components prevail.

2. A fixed payment from a third party, f_i, received for referring contact j, if j presents for TB screening, irrespective of the test results.

3. A contingent payment from the third party, p_i, received only if contact j tests positive for TB. Implicitly, p_i is conditional on j getting screened and tested, and testing positive.

4. The subjective probability π_j that contact j has TB, as assessed by EP_i after observing signals such as whether j presents symptoms consistent with the disease.

5. The probability $\lambda_{ij}(X_j,q_{ij})$ that contact j will present for screening, which is a function of j's characteristics, X_j, as well as q_{ij}, the quality of information that is available to j about the costs and benefits of screening and treatment, which can be influenced by her interactions with EP_i.

An individual EP_i will make a referral if his net expected benefit from the referral is positive; that is, if:

$$d_{ij} + \lambda_{ij}(f_i + \pi_j \times p_i) > 0 \tag{1}$$

[11] In our framework, existing patients consider a single prospective referral at a time. They do not consider tradeoffs between referring different contacts, which we operationalize by explicitly allowing an unlimited number of referrals. Although this set-up is realistic in our context (as we show below, the modal number of names provided and referrals made by each patient, conditional on giving any names or making any referrals at all, is one), allowing existing patients to consider multiple referrals at the same time could have different implications.

Due to lack of awareness of the social benefits of making referrals, and possibly because of the stigma associated with TB (Kelly, 1999; Atre et al., 2011), the net reward d_{ij} for making a referral is likely to be small or negative. This would explain why, in the absence of other incentives, referrals in this context are rare—in contrast to the job referral context, where the social reward for a referral is typically positive.[12]

Motivated by this simple framework, our experiment includes manipulations of payments to EPs as well as outreach modalities varying EPs' involvement in the referral process. Our experiment includes an "encouragement" condition without any financial incentives; this increases the salience of the social importance of testing anyone with TB symptoms and therefore, the perceived positive component of d_{ij}; this might motivate the existing patient to identify potential targets as well as exert effort to improve q_{ij}, thereby increasing the probability that person j presents to get screened. We also included payments to the referrer, which may be entirely fixed ($f_i > 0$ and $p_i = 0$) or depend on the prospective patient's TB test results ($p_i > 0$).[13] Knowing that their contact is receiving an incentive (conditional or unconditional) might also provide suspects j with social cover for seeking screening, which might counteract the stigma s_{ij} associated with visiting the health center (Thornton (2008) made this argument in the context of incentivized HIV testing and learning the test results).

When the reward is fixed, the incentive for referring contacts depends only on their willingness to be screened for TB, and not directly on whether they have symptoms consistent with TB. If a person's willingness to get screened and tested (λ_{ij}) increases with π_j, the likelihood of having the disease, then existing patients have private incentives to target referrals to contacts most likely to be infected even under a system of fixed payments only. However, existing patients and their contacts could behave strategically

[12]In other health applications, financial incentives have been used to overcome pecuniary and non-pecuniary costs of behavioral change (Baird et al., 2012; Kohler and Thornton, 2011; Walque et al., 2012; Thornton, 2008; Kremer et al., 2009; Miller et al., 2012; Basing et al., 2011).

[13]As we describe later in more detail, we calibrate the payment structure in our experiment such that the total expected value of third-party payments for a new referral is the same for existing patients assigned to pure fixed-payment incentives or to a combination of a fixed payment plus a contingent reward. Equalizing expected payments allows us to remove income effects and isolate the incentive effect of the different incentive schemes.

to take advantage of fixed payments. The introduction of contingent payments allows us to determine the extent of such opportunistic behavior. When contingent payment is introduced, EP_i's expected payment depends directly on his information about a contact's characteristics, and EP_i has stronger incentives to make use of his knowledge about his contact's health. Therefore, the probability that any prospective patient actually has TB is greater when that individual is referred by an existing patient eligible for contingent payments p_i, rather than by an existing patient eligible for a fixed payment f_i of equal expected value.

Referrals can be operationalized in one of two ways. The first involves personal contact between EP_i and j. Alternatively, EP_i could provide contact information for j to a third party, such as a health worker. The health worker could either reveal EP_i's identity as the impetus for the contact or conceal it. These strategies vary in their implications for q_{ij}, the quality of information received by j, and s_{ij} and c_{ij}, the social and effort cost to EP_i of referring j. Direct conversation between EP_i and j can transmit both objective (symptoms of TB, location of testing center and health care provider, duration of regimen, etc.) and subjective (personal experience with health workers, experience with side effects of medication, etc.) information. That information may carry additional weight because of the preexisting relationship between EP_i and j. In contrast, outreach by a health worker transmits objective information but not the subjective experience of a personal contact. The perceived quality of the information conveyed by the health worker may be enhanced when the health worker indicates to j that she visits at the behest of EP_i. Whether the ultimate quality of information received by j is higher or lower for outreach by existing patients or health workers depends on the weight j places on subjective versus objective information and on the effectiveness and accuracy of (and effort exerted by) existing patients relative to health care workers in communicating about TB screening. If prospective TB patients value subjective information highly or trust their contacts substantially more than they trust health workers, then outreach by existing patients could raise q_{ij} by more than outreach by health workers, making it more likely that the prospective patient presents for screening.

Variation in whether outreach is conducted by existing patients or health workers also manipulates c_{ij} and s_{ij}, the economic and social costs to EP_i of referring j. While personal contact between EP_i and j may facilitate the exchange of information about the benefits of treatment, EP_i incurs time costs for the interaction, which may increase in the quality of information conveyed. Peer outreach also potentially reveals EP_i's status as a TB patient to j and therefore increases EP_i's social costs. If, instead, a health worker reaches out to j and conceals EP_i's identity, this removes the stigma cost term s_{ij} but does not necessarily affect the positive component of d_{ij} because EP_i may still enjoy the "warm glow" of having helped someone (and is free to personally tell j of the referral if he so chooses). Thus, if stigma is an important deterrent to referrals, then we expect more referrals in experimental conditions that conceal the existing patient's identity. If the intensity of peer outreach increases q_{ij}, then peer referral should be more effective when peers are incentivized to exert more effort and provide high-quality information.

The predictions we have discussed thus far relate to how changes in the value of fixed and contingent third-party payments affect the probability that an existing patient i refers a social contact j for TB screening. We now consider two additional implications of our framework and experimental design. The first regards the characteristics of the social contacts $j = 1, ..., n_i$ who are referred for TB screening. While current TB patients likely face lower outreach costs than health workers because the patients regularly interact with people who share their TB risk factors, their contacts vary in vulnerability and marginalization. On one hand, more vulnerable individuals may be more likely to have TB but less likely to have access to information about testing and treatment. On the other, social costs associated with referring a more vulnerable or marginalized contact may be higher because of lower social reward or higher time cost for the interaction. Therefore, both types of incentives may change the composition of referred contacts by increasing the chance that vulnerable individuals are identified.

While this framework characterizes the mechanisms through which existing patients' effort can affect referrals and how effort is affected by incentives, it also illustrates the difficulty of distinguishing between margins of effort: either increasing q_{ij} or choosing contacts with higher values of π_j raises the expected benefit to the current patient, and does so as a linear function of the contingent payment. The model also illustrates the challenges of separating the costs associated with potentially revealing one's own TB status from any benefits such revelation may have in increasing λ_{ij}, the probability that a contact gets screened. Rather than derive predictions from the model, we use it to map the experimental treatments to the current patients' choice problem, and to provide intuition for the mechanisms through which outreach modality and incentives affect current patients' expected benefits from making referrals.

3 Context and Experimental Design

3.1 Context

Tuberculosis is a disease caused by bacteria that spread from person to person through the air. TB typically affects a person's lungs, although it can affect other body parts such as the brain and kidneys as well. The TB bacteria attack the body, destroying tissue. Symptoms of pulmonary TB include chest pain, persistent cough, coughing of blood and phlegm, weakness and fatigue, night sweats, and weight loss. The disease is debilitating and has a high mortality rate when untreated. As noted earlier, TB is currently the ninth leading cause of death worldwide and the leading cause of death from a single infectious agent.

Tuberculosis can be treated and cured by multi-drug regimens that have been available since the 1950s. Treatment consists of several antibiotics that kill the TB bacteria; a typical treatment course takes six months and patients take medicines two to three times per week. The Indian Government (in partnership with the WHO) provides these medicines at no cost to patients.[14] [15]

[14] Laurence et al. (2015) report that in India, the cost of a full course of medication for drug-susceptible TB was $US 15 per patient as of 2005; on average across low-income countries, the cost was $US 49 per patient.

[15] Although patients typically start to feel better after taking the medicines for a few weeks, it is important to take them as prescribed and to complete the entire treatment course in order to be cured. Failure to complete the treatment not only results in failure to be cured, but it may facilitate the growth of bacteria resistant to the medicines, leading to Drug-Resistant TB (DR-TB), Multi-Drug-Resistant TB (MDR-TB), or even rarer and harder-to-treat strains. DR-TB and MDR-TB are more difficult

Tuberculosis is a major public health problem in India. The nation has the largest number of TB cases in the world and accounts for more than one-quarter of the global TB burden. Almost three million people develop active TB each year and the disease caused 435,000 deaths in India in 2016. The country is among the WHO's "high-burden" countries for TB, MDR-TB, and TB/HIV co-infections (World Health Organization, 2017). The Indian Government's TB control initiative, the RNTCP, is coordinated by TB officers appointed at the district and state levels. TB services are delivered through the existing health infrastructure in which community centers serve as treatment clinics to administer DOTS to patients and monitor treatment. Non-governmental and private providers are systematically and actively engaged under the RNTCP. In 2008, about 3,000 NGOs and 20,000 private practitioners were part of the RNTCP effort.

Our study partner, Operation ASHA, operates about 200 community-based DOTS centers in several cities in 11 Indian states. Operation ASHA employs community health workers, known as "providers" or "counselors," whose job description includes detection of and outreach to new symptomatics as well as monitoring of drug therapy for patients in treatment. Although Operation ASHA is an NGO, it works within the existing structure of the RNTCP. When prospective patients ("suspects") are identified by Operation ASHA's health workers as presenting symptoms consistent with TB ("symptomatics"), they are directed to a government testing center for a sputum test. Those who test positive for TB enroll in one of Operation ASHA's clinics, where their medication is dispensed at no charge to them, according to DOTS standards and conforming with RNTCP guidelines and protocols.[16]

(and more expensive) to treat than drug-susceptible TB because the bacteria are resistant to one or more drugs.

[16]Patients present at the clinic to take their medication according to treatment regimen and start date. As part of the proprietary biometric monitoring system employed by Operation ASHA, counselors verify patients' fingerprints before dispensing medication. At the end of the prescribed treatment period, all patients are tested (at government testing centers) to determine whether they have been cured.

3.2 Experiment setup

Our study consisted of a randomized controlled trial implemented in 122 DOTS centers in 10 cities across three states (Delhi NCR, Madhya Pradesh, and Rajasthan). The intervention was implemented by JPAL-South Asia in five waves between January 2016 and October 2017.

We augmented Operation ASHA's established use of community health workers and DOTS treatment by incorporating various types of referrals of new suspects by existing patients. Specifically, we used a cross-randomized design to test, respectively, three types of incentives for referrals and three types of outreach to prospective TB patients (described in detail below). The baseline sample included all Operation ASHA patients receiving treatment for drug-susceptible TB who were at least two weeks into their medication course when the baseline surveys commenced. We expanded the sample to include patients who had completed their six-month treatment in the three months before the start of the baseline surveys. Existing patients were either in the intensive phase (IP) of treatment, where they came to the clinic three times per week, or in the continuing phase (CP) of treatment (typically following IP), which required them to come to the clinic once a week.[17] In cases where the patient was a minor, the survey questions and interventions were addressed to the legal guardian. The experiment was rolled out in five waves between March 2016 and October 2017. To address the possibility of spillover effects between patients, we randomized by center.[18] A total of 3,176 patients were included in our study.[19]

[17]Patients suffering from MDR-TB, Extremely Drug-Resistant (XDR-TB), or Totally Drug-Resistant (TDR-TB) were not included in the sample.

[18]The potential for spillovers across centers was much more limited. Operation ASHA chooses where to locate its centers in order to make their location as convenient as possible for patients and spread them out geographically to maximize their total reach and minimize possible overlap between potential patient populations across areas.

[19]The Operation ASHA patient lists we received included 4,203 patients. Of these, 3,402 (81% of the total) were surveyed at baseline and enrolled in the study. Reasons why some patients were not surveyed included: a move to another city or district, inability to track them after three enumerator visits, or a diagnosis of MDR-, XDR-, or TDR-TB. There was no economically or statistically significant association between the proportion of listed patients who could not be surveyed at baseline and experimental conditions (see Appendix Table A1). The baseline included 226 patients in 10 clinics who were subsequently omitted from the analysis because a change in Operation ASHA's relationship

For treatment and control centers, each existing patient was visited by a survey enumerator in a private location such as the patient's home. Enumerators obtained informed consent and administered a baseline survey. Information was collected on the existing patient's socioeconomic characteristics, physical and psychological health, and TB treatment, as well as on information-sharing networks. At the end of the survey, patients at treatment and control centers were prompted to think about individuals outside their households who they believed might be affected by TB. ("Please think of people you know who have TB symptoms.") According to RNTCP protocol, immediate family members of TB patients are automatically tested for TB, and as such, were excluded from our referral schemes because they were already known to the system. Then, for treatment centers only, all patients were told, "We are promoting outreach for tuberculosis to encourage more people to get tested and treated, and we invite you to join this effort." They could do this by recommending TB testing for people they knew socially and believed to have symptoms; these new suspects would receive referral cards with information about the screening process. An example of the referral card distributed by existing patients is provided in Figure 1. The cards contained information about Operation ASHA, names and addresses of local providers and treatment clinics, a list of TB symptoms, and an ID number used by Operation ASHA and the research team to link the card to the referrer and to distribute incentives according to the study design. New suspects were asked to bring these referral cards to Operation ASHA centers, where they would be screened by health providers and sent for further testing (if required) as per RNTCP mandates.

This process, from a suspect's arrival at an Operation ASHA health center to testing and, if necessary, treatment, was recorded in a referral register at the center that was updated with the relevant outcome at each step, including the result of the screening, whether the new symptomatic got tested, the results of the test (for symptomatics who got tested), and whether the newly identified TB-positive individual enrolled in treatment.

with the leadership at the government testing center in Bhubaneshwar (Odisha) meant we were not permitted to access administrative endline data for these patients.

New suspects were always told that they had been targeted for outreach by someone who knew them personally, and shown where their information would be recorded on the card that linked them back to the contact who provided the referral. While they were asked to bring referral cards with them to Operation ASHA, they – like any other individual – could seek care at Operation ASHA (or a public sector facility) without providing a referral card or other documentation. Operation ASHA continued to conduct outreach, screening, and enrollment of new patients following its regular procedures throughout the duration of the study, including enrolling new patients who did not have referral cards. Any new suspect who was approached by or on behalf of an existing patient in this study, but who was concerned about having their visit to Operation ASHA linked to the contact who referred them, could present for screening and receive identical care without submitting the referral card.[20] To the extent that this occurred, we will underestimate the extent of case-finding as a result of the outreach and incentive conditions tested in this study.

3.3 Experimental variation: incentive conditions

The first type of experimental variation was in the reward offered for each new suspect who sought screening and presented a referral card linked to an existing patient. In one-third of centers, there was no financial reward, only encouragement to participate for the good of the community. In these centers, both f_i and p_i (see Section 2) were thus zero. In another third of centers, existing patients were offered Rs. 150 for each new suspect who got screened at their behest. This treatment condition corresponds to $f_i = 150$ and $p_i = 0$. This amount equals about $US 3 and is roughly equivalent to the median daily income in India.[21]

In the remaining third of centers, existing patients were offered Rs. 100 for each new suspect who got screened and an additional Rs. 150 if the suspect tested positive for TB.

[20] As described in more detail below, all new suspects were surveyed at intake by J-PAL enumerators, and the survey included questions about their perception of and experience with Operation ASHA. There were no reports of problematic interactions or negative perceptions.

[21] Diofasi and Birdsall (2016) report median daily incomes of $US 2.50 in rural India and $US 3.50 in urban India.

This corresponds to $f_i = 100$ and $p_i = 150$. The fixed payment provided some insurance to the referrer; the size of the fixed payment and the bonus was calibrated such that the conditional and unconditional incentives were of equal expected value based on the rate of positive tests in a pilot study conducted between June and September 2012. As we will show, these turned out to be roughly the same in the full study.

Note that while all incentive treatments designate financial rewards to be paid to the existing patient, it is possible that existing patients and the new suspects they identified chose to divide the money between themselves according to a sharing rule of their own selection. This does not undermine our research design; such side payments are simply an element of the social reward that forms part of the expected benefit (or cost) of making a referral. The policy-relevant estimate of the effect of incentives allows for side payments to take place naturally at the discretion of existing patients and new suspects.

3.4 Experimental variation: outreach conditions

The second type of experimental variation was in the modality of the referral itself. We compare peer outreach to two types of health-worker-facilitated outreach. In the one-third of centers assigned to the peer-outreach conditions, referral cards were given to existing patients. They were asked to approach people they knew socially and believed to have TB symptoms, inform them about TB's consequences and treatment, give them cards, and encourage them to get tested. Existing patients had up to 30 days to deliver the cards, and new suspects had an additional 30 days to present themselves at an Operation ASHA center for screening.[22] The enumerators asked existing patients to emphasize to the new suspects the importance of bringing the card when coming for screening, though treatment by Operation ASHA was never conditional on bringing a referral card and new patients identified outside of our study were screened for symptoms and treated identically by health workers despite not bringing referral cards. Existing patients were also told they were free to request additional cards, if needed; this was done to avoid creating a perception of scarcity that might have resulted in different

[22] A new suspect who arrived outside the 60-day window would still be screened, tested, and treated if necessary, but the existing patient would not receive credit for the referral per study protocols.

opportunity costs of providing cards in the various experimental conditions.

The health-worker outreach conditions represent the current best practice regarding outreach and treatment of communicable disease, and they are conceptually closest to community-based targeting schemes. In these treatment centers, existing patients were asked to provide names and contact information of people in their social network who might benefit from getting tested for TB, so that a health worker could follow up by visiting these individuals.[23] Existing patients were shown the referral cards and told that the Operation ASHA health worker would deliver the cards to the people they named. As in the peer conditions, existing patients were told they had 30 days to provide names and the new suspects were to present for screening within 30 days after receiving cards from a health worker.

Half of the health-worker outreach centers were assigned to the "referrer-identified" condition, in which existing patients were told their names would be used when the health worker approached new suspects on their behalf; the specific language was, "I have come to see you because [Name], who cares about you, asked me to visit". Like the peer-outreach condition, the referrer-identified condition carries a risk of stigma because the current patient is revealed to be associated with a TB treatment organization, and that association would otherwise be hidden in the normal course of business because it is thought by patients and staff at Operation ASHA to raise suspicions of infection.[24] The remaining health-worker outreach centers were assigned to the "anonymous" condition, in which existing patients were told their names would not be revealed to the individuals they referred. Instead, health workers would tell the new suspects, "I have come to see you because someone who cares about you asked me to visit".

To ensure that existing patients in the peer-outreach conditions received the same

[23]Contact information could be an address, instructions about how to reach a contact's home, a phone number, or other information available to existing patients that would enable health workers to visit their contacts. This flexibility was intended to reduce barriers to making referrals.

[24]The full script was: "My name is [Operation ASHA health worker's name], I am here from Operation ASHA. Operation ASHA is [description of Operation ASHA]. I have come because [Name of existing patient OR "someone who cares about you"] asked me to visit. This person knows about TB, and thought you would benefit from learning how to get tested and treated for TB. Here is a referral card [hand out card]."

level of priming as those in the health worker outreach conditions, patients in the peer-outreach conditions were also asked to provide names and contact information of people they knew who might benefit from getting screened for TB.[25]

While effort by peers is an outcome of the study, we monitored the Operation ASHA health workers closely to ensure they visited all the contacts named by the existing patients. Health workers were told that the JPAL team would survey each contact and ask whether they had been visited by an Operation ASHA representative and given the referral cards. Health workers were compensated for their participation in the outreach and monitoring activities required by the study. They received fixed monthly payments if the JPAL team determined they completed required activities. Compliance was high: 87.5% of new suspects named in the health worker outreach arms were visited by Operation ASHA staff (85% in the encouragement arms and 88.4% in the incentivized arms).

This experimental variation in outreach strategy corresponds to the social and economic costs of a referral. As discussed in Section 2, peer referrals carry two types of costs: the time cost of the interaction itself (c_{ij}) and the stigma cost (s_{ij}) of revealing one's own TB status to a peer (and hinting that the peer might have TB). Referrer-identified outreach by health workers eliminates the time cost to the existing patient (and shifts it to a health worker) but, because the health worker explicitly names the peer who provided the referral, it maintains the stigma cost. Anonymous outreach by health workers carries neither time nor stigma cost at the margin for the existing patient. In both conditions, however, the new suspect might incur a psychological cost from inferring that someone in their social network (named or not) believes that they might have an infectious disease.

Making referrals may also entail a social benefit (g_{ij} in the framework outlined in Section 2). It is unclear how to rank the treatments in terms of their social benefits to existing patients. Existing patients may experience a "warm glow" from helping

[25]Of course, patients in the peer-outreach conditions were not limited to reaching out to the contacts they named. As shown in Appendix Table A4, patients in the peer-outreach conditions initially listed fewer names than those in the health worker outreach arms. However, they made more referrals than the names they provided at baseline.

others even if their contribution is anonymous. Or, they may feel greater satisfaction—or receive gratitude from their peers—for in-person or identified outreach strategies. Since peer referrals may have higher costs and benefits than identified or anonymous heath worker outreach, the question of which strategy will generate more referrals is an empirical one.

In the public health context, the quality of information conveyed to new suspects (q_{ij}) is paramount. Health workers and peers may differ in the content of the information they convey, and in the credibility with which the information is perceived. On one hand, health workers may be better informed about symptoms and treatment of TB, and their expertise may be respected by prospective patients. On the other hand, existing patients are able to provide firsthand testimonials about the experience and benefits of treatment from a patient's perspective. Furthermore, because existing patients are asked to speak to people they know personally and believe to have symptoms of TB in the peer outreach condition, the personal connection may also build trust and enhance the value of the information exchanged. In the health worker outreach conditions in which the identity of the referring existing patient is revealed, some of that credibility may be recovered through the endorsement.

The final design thus randomly assigned 122 clinics to a pure control condition or one of nine treatment conditions. Figure 2 summarizes the research design and indicates how many clinics and patients were assigned to the pure control condition and to each of the nine treatment conditions.[26]

[26] We had originally planned equal-sized arms both in terms of number of centers and average number of original patients per center. Figure 2 shows that the number of centers ranged from 10 to 14 across arms. The reason for this variation is that the randomization was done by wave, and the number of centers available at the start of each wave varied. Centers also varied in size, and although we stratified on city, we did not have sufficient centers in each wave to also be able to stratify on center size. The average center had 26 original patients (standard deviation = 19.4). Treated centers had about 7 more patients on average than control centers (p=0.13) but there were no economically or statistically significant differences in the number of original patients across incentive conditions and outreach conditions (see Appendix Table A2). There were no differences across experimental arms in original patient attrition at baseline (see Appendix Table A1) and, as described in detail below, the samples are balanced on observables. Moreover, as shown in the Appendix and discussed below, the results are robust to weighing observations by the inverse of the number of original patients per center, and center-level regressions find very similar effects as at the original patient level. This suggests that there was no interaction between treatment and unobserved characteristics that are correlated with

3.5 Incentivized elicitation of outreach effort

After responding to the endline survey (see next section for details on data collection), participants were offered the opportunity to return unused referral cards to the enumerators for a payment of Rs. 10 per card. This provided an incentive-compatible measure of how many cards were not distributed, in contrast to simply asking respondents, who may exaggerate the number of cards distributed because of experimenter demand effects. By combining this measure of the number of cards not distributed with administrative data about the number of cards brought to Operation ASHA providers, we were able to compute the number of cards distributed by existing patients but not redeemed by suspects—information that helped us identify the nature of the barriers to referrals and testing (see Section 4.4.6 below). Patients were not told about the card buyback in advance in order to prevent strategic or risk-averse behavior with regard to card distribution.

4 Data and Results

4.1 Data

Our analysis combines administrative data from Operation ASHA with two rounds of surveys of existing patients and the new suspects they identified. The administrative data include rosters of baseline patients and new suspects (collected as part of the normal outreach and enrollment procedures), ID numbers for existing patients who referred each new suspect, and information on treatment adherence for all patients. Baseline surveys of existing patients measured their socioeconomic characteristics, physical and psychological health, risk- and information-sharing networks, and attitudes toward Operation ASHA and TB treatment. After the intervention, endline surveys were conducted with existing patients to capture information on health outcomes and satisfaction with Operation ASHA. Intake surveys were also administered to the new suspects identified through the schemes: these measured their characteristics and history of care for TB.

center size.

4.2 Patient characteristics and balance tests

Tables 1 and 2 provide the means and standard errors of existing patients' baseline characteristics overall as well as by incentive condition and outreach type. As a result of working with a large provider operating in multiple states, our sample is not only large but also heterogeneous on many sociodemographic dimensions. The average existing patient in the study was approximately 37 years old, and about 40% of baseline patients were women (World Health Organization (2017) reports that 65% of new incident TB cases are male). About 70% of the patients had some literacy, 30% had secondary education, and 61% had a bank account. Eighty-three percent of the respondents had never been treated for TB before receiving care at Operation ASHA.

Tables 1 and 2 show that the randomization resulted in patients having similar characteristics across experimental conditions. To formally test for balance, we implemented omnibus balance tests that compared pairs of treatments using linear probability models. Specifically, we compared the probability of assignment to each of the three incentive treatments (separately) relative to the control group and to the other incentive treatments, and to each of the three outreach treatments (separately) relative to the control group and to the other outreach treatments. These tests involve 12 separate regressions: six comparing an incentive or outreach treatment to the pure control group, three comparing pairs of incentive treatments, and three comparing pairs of outreach treatments.

The p-values for the F-tests that the covariates included in Tables 1 and 2 jointly predict assignment are reported in Appendix Table A3. Six specifications compare a treatment arm to the pure control group. In all six, we fail to reject the null that the covariates jointly predict assignment at the 95% confidence level (the p-value for the F-test for the comparison between any treatment group (pooling across the nine treatment arms) and the pure control group is 0.4497). Among the outreach treatments, covariates are reasonably well-balanced between each of the three possible pairs of treatments, with p-values of 0.18 or greater in two cases (peer outreach compared to anonymous outreach by health workers, and identified compared to anonymous outreach by health workers), and a p-value of 0.025 in one case (peer outreach compared to identified health worker outreach). We also fail to reject the null that covariates are well-balanced between the unconditional incentive and encouragement treatments and between the conditional and unconditional incentive treatments. However, the p-value for the test that the coefficients on covariates are jointly zero when comparing the conditional incentive to the encouragement treatment is 0.001. Of 12 tests, two p-values are less than 0.05. In economic magnitude, the control group has a higher value of the asset index (0.15 standard deviations) and reports between 0.43 and 0.84 more social contacts than each of the treatment arms. While our preferred specifications mirror the experimental design in including only city fixed effects, the magnitudes and statistical significance of our estimates are virtually unchanged by the inclusion of the baseline covariates from Tables 1 and 2 or, alternatively, covariates selected using the double-lasso procedure described in Belloni et al. (2014). Details on the double-lasso procedure are provided in section 4.4.5 and results from these alternative specifications are reported in the Appendix (Tables A10 and A11).

4.3 Overview of aggregate outcomes

Although our experiment is designed to measure the effects of various referral schemes on individual patients' behaviors, we begin by presenting the aggregate outcomes of the study. A total of 216 new suspects were screened by Operation ASHA health workers as part of this study in the nine experimental conditions combined. (These individuals constitute the "referrals" discussed in subsequent analysis.) Of these, 170 (78.7%) presented symptoms consistent with TB and were sent for testing at the government testing centers; we follow Operation ASHA and call them "symptomatics." Compared to other case-finding efforts in India, this effort identified a large number of symptomatics, especially relative to the scale of outreach. As noted earlier, Charles et al. (2010) conducted outreach to 18,417 individuals and found 640, or 3.5%, had symptoms consistent with TB.

In our study, 123 of these symptomatic individuals subsequently presented themselves for testing at a government center. Thirty-five were found to have active TB, of whom 34 began treatment immediately. All were previously unknown to the TB treatment system. Because of the study's stringent requirements, none were immediate family members of the existing patients who referred them, so they were not likely to be located through health worker outreach by Operation ASHA or government labs under existing protocols. Prospective patients screened in the health worker outreach conditions were neighbors (47%), relatives (41%), and friends or coworkers (12%) of the existing patients who referred them. The corresponding percentages in the peer-outreach conditions were 48%, 35%, and 17%, respectively.[27] The 28% infection rate of the new symptomatics who were identified and tested through our referral schemes is more than twice as large as the 12% average TB-positive rate reported in official RNTCP statistics (the average rates in the states where we conducted our study were 14% in Delhi and Madya Pradesh, and 17% in Rajasthan).[28]

4.4 Analysis

We study existing patients' responses to incentives and their efficacy as outreach agents by matching new suspects who were screened and tested to the existing patients who referred them through the unique ID codes embedded in the referral cards. We report four nested outcomes, each an integer value and measured at the level of the existing patient.

First, we measure the total number of new suspects who were linked to an existing patient and who presented themselves for screening at the Operation ASHA centers. Second, we measure the number of these suspects who were subsequently sent for testing (the number of "symptomatics"). This distinction is important because it indicates whether the referral strategies in this experiment resulted in targeted testing of symptomatic individuals, or whether existing patients were unable (or unwilling) to distinguish between peers with symptoms of TB that warranted testing and those without. As part of its partnership with the RNTCP, Operation ASHA routinely screens prospective patients and sends those with symptoms indicative of TB for testing at

[27] The provision of incentives did not have any economic or statistically significant effects on the relationship between referrer and referee.

[28] In a study in Nepal that used peer volunteers to identify TB cases (Joshi et al., 2017), 6,046 suspects were tested over a period of 16 months, resulting in 287 TB diagnoses, or 4.3%.

government-designated microscopy centers (DMCs). It played the same gatekeeping role in screening prospective patients identified through our referral schemes. Third, we measure the number of symptomatics who actually got tested, as testing is a necessary condition to obtain treatment but requires effort by symptomatics (who have to report to a DMC) and represents a critical juncture for loss to follow-up. Finally, we measure and report the number of positive cases of TB attributed to the outreach of each existing patient in the sample.

Note that we instituted procedures to capture any peer referrals made by existing patients of pure control centers. Operation ASHA health workers at all centers kept a record of the source of each new suspect screened during the intervention period. But in practice, and in accordance with the extremely low rate of peer referrals that motivated this study, all outcomes equal zero for existing patients in the pure control group.

Also note that our outcome variables are the union of behavior by existing patients—who decide whom to approach or to have contacted by a health worker, how much effort to exert, and what information to share—with the behavior of new suspects, who decide whether to follow up to be screened and, when recommended, tested. Each of the referral modalities we consider has advantages and disadvantages to existing patients and new suspects. Our approach is to test the relative performance of each type of referral using reduced-form specifications that capture the total effects of the ways these strategies differ in costs, benefits, and information provided. Nonetheless, a comparison of the effects of various incentive types and outreach modalities provides information about the mechanisms through which referrals may (or may not) prove valuable in this context.

4.4.1 Financial incentives

To measure the effect of incentives on referrals generated by existing patients, we use OLS to estimate linear models of the form:

$$y_{ijc} = \alpha + \beta_1 \text{Encouragement}_{jc} + \beta_2 \text{Conditional}_{jc} + \beta_3 \text{Unconditional}_{jc} + \Gamma_c + \epsilon_j \quad (2)$$

where i indexes existing patients, j are clinics (the level of treatment), and c are cities. Γ_c are city fixed effects, which absorb state and wave fixed effects (randomization was stratified by city). The omitted category in this specification is pure control clinics, so β_1 is the effect of encouraging existing patients to make referrals, relative to the status quo; β_2 is the effect of offering existing patients Rs. 100 for each new patient screened at their recommendation, plus an Rs. 150 reward for any referrals who tested positive for TB (corresponding to $f_i = 100$ and $p_i = 150$); and β_3 is the effect of offering existing patients Rs. 150 for any new patient screened at their recommendation, regardless of test outcome ($f_i = 150$ and $p_i = 0$). We also report the estimated effect of financial incentives relative to encouragement (and the p-value for the tests that $\beta_1 = \beta_2$ and $\beta_1 = \beta_3$), and compare the conditional and unconditional incentive structures (reporting the p-value for the test that $\beta_2 = \beta_3$). Recall that treatment is assigned at the clinic level; standard errors are therefore clustered at the clinic level.[29] Additionally, we report p-values adjusted for testing 12 hypotheses (three coefficients and four outcomes), using the false-discovery rate methodology of Benjamini and Hochberg (1995).[30]

While encouragement without financial reward does increase referrals relative to the pure control condition, the results from the main OLS specifications reported in Table 3 clearly indicate that financial incentives matter. From column 1, patients at clinics assigned to the encouragement arm referred, on average, 0.044 new suspects. Patients eligible for conditional incentives referred 0.102 new suspects and those eligible for unconditional incentives referred 0.096 new suspects. The p-value for the difference between encouragement and the conditional incentive is 0.09, and the p-value for the difference between encouragement and the unconditional incentive is 0.03. While money matters, conditionality apparently does not: the p-value for the test that the conditional and unconditional incentives have equal effect is 0.84. The pattern persists in other measures of referrals, including the number of new suspects recommended for testing (column 2),

[29] Our primary results are from linear models. Below, we also report estimates from linear probability specifications for binary analogs of the outcomes.

[30] As we discuss in section 4.4.5, our results and conclusions are robust to a set of alternative specifications in which we include baseline covariates, or weigh observations based on the size of Operation ASHA centers at baseline, or estimate our models using aggregate, center-level outcomes.

and the number of symptomatics actually tested for TB (column 3). In particular, note that the vast majority of suspects identified through this scheme were sent for testing, indicating that existing patients were able and willing to identify individuals with TB symptoms warranting testing. We find similar patterns when we consider positive TB tests (column 4), even though the results are less precise because this outcome variable is defined more granularly and with correspondingly lower variation. As noted in section 4.3, more than one-quarter (28%) of the new suspects identified through any of the treatment arms who got tested were ultimately diagnosed with TB, a higher rate than in the public sector in India during the same time period. As shown in column 4 of Table 3, existing patients in the unconditional incentive treatment group identified, on average, 0.013 new TB patients, whereas existing patients in the conditional incentive treatment group identified 0.005 new TB patients (the p-value for the test that the effect of the two incentive treatments is jointly zero is 0.04).[31] The estimated effects of unconditional and conditional incentives remain statistically significant even after adjustment for multiple hypothesis testing for suspects screened, tests recommended, and symptomatics tested (but not for positive tests).

These results indicate that existing patients respond to encouragement—and especially to financial incentives—to share information about screening for a communicable disease. Screening, testing, and identification of TB patients are all measures of welfare in a context with a high disease burden, where it is important to either diagnose TB or rule it out as a cause of illness. Behavioral responses by existing patients, who can identify more new suspects when offered a financial incentive to do so, translate into small but economically meaningful and statistically significant increases in case finding.

4.4.2 Outreach strategies

The second set of existing patient-level analyses focuses on the effects of peer outreach and two variants of health worker outreach, identified and anonymous, relative to a pure

[31] In the encouragement group, existing patients were responsible for detecting an average of 0.003 cases of TB. The difference between the encouragement group and the unconditional group is significant at the 90% confidence level (p=0.09), and the difference between the encouragement group and the conditional incentive group is not significant at conventional levels (p=0.30).

control condition. While the analysis in section 4.4.1 is similar to the analysis of referrals in labor market contexts, this section explores a margin of referrals not discussed in the job referrals literature that is potentially especially important in a health context.

In all clinics, including the pure control group, health workers are tasked with routine outreach to and screening of the immediate household members of newly diagnosed patients. Our analysis focuses on suspects who are screened and tested because of the recommendation of an existing patient, not through Operation ASHA's standard operating procedures. Outcomes for existing patients in the control group are equal to zero in practice, though not by definition.

As in the previous section, we pool across treatment arms to estimate regressions of the form:

$$y_{ijc} = \alpha + \gamma_1 \text{Peer}_{jc} + \gamma_2 \text{Identified}_{jc} + \beta_3 \text{Anonymous}_{jc} + \Lambda_c + \mu_j \tag{3}$$

Any peer-facilitated outreach is more effective than the status quo; 10 of the 12 coefficients reported in Table 4 are significantly different than zero even after adjustment for multiple hypothesis testing, and we reject that the joint effect of the three treatment arms is equal to zero for all four outcomes. Peers are more effective than trained and paid health workers at inducing the new suspects to get screened and tested, even though the suspects approached in both health worker outreach arms are identified by existing patients. The interaction between an existing patient and a suspect increases the probability of screening and testing. Existing patients who were asked to recruit new suspects directly through peer outreach induced an average of 0.124 new suspects to report for screening, compared to 0.054 for those approached by health workers on behalf of a named peer (health worker outreach – identified) or 0.056 for those approached by health workers on behalf of an unnamed peer (health worker outreach – anonymous). The p-values for the differences between peer outreach and the two health worker outreach arms are 0.01 and 0.03, respectively. There is no economic or statistically significant difference between the anonymous and identified outreach modalities. The three treatments are comparable in their efficacy in increasing the number of symptomatics tested. Peer referrals have a statistically significant effect (at the 95% level) on the number of TB cases found (0.010 per existing patient in the peer-outreach arm), but differences with respect to the health worker outreach arms are estimated imprecisely.

Peer outreach results in the screening of twice as many new suspects as outreach by health workers, despite the additional transaction costs borne by existing patients in the peer-outreach conditions. This suggests peers are more effective at conveying information about the benefits of treatment to convince suspects to seek health counseling, an intuition that is confirmed by the analysis of complementarities between financial incentives and peer outreach in Section 4.4.4 as well as by the analyses and discussion in Section 4.4.6.

4.4.3 Extensive margin

The magnitude of the individual response to incentives documented above is substantial. Previous sections consider the number of new suspects detected, but for a more complete understanding of the referral process, and for the purpose of comparing the magnitudes of our results to the related literature on job referrals, we also estimate linear probability models that correspond to equations (1) and (2) but have binary dependent variables: any new suspects screened, any new symptomatics sent for testing, any new symptomatics who get tested, and any new symptomatics whose sputum test results are positive.

Some 3.8% of existing patients in the encouragement arm made at least one referral that resulted in a screening, compared to 6.1% of patients who received the unconditional incentive of Rs. 150 for each new suspect screened; the difference of 2.3 percentage points is statistically significant at the 90% level (see Appendix Table A6). In the conditional incentive arm, 4.9% of existing patients made at least one referral that resulted in the screening of a new suspect, an effect that is significantly different from zero but not from the point estimates for either encouragement only or the unconditional incentive.[32] Since

[32] In an experiment with a similar design but a different context for social costs and benefits, Beaman and Magruder (2012) found that an unconditional incentive of Rs. 110 (in 2009, equivalent to Rs. 184 in 2017) increased the probability of referring a contact for a day of paid employment by 7.7 percentage points, from a base probability of 69.5. In percentage terms, similar economic incentives had a bigger

the modal number of new suspects screened conditional on making any referrals is one, it is not surprising that the extensive margin results are qualitatively very similar to the results in the previous sections; both the financial incentives and outreach interventions operate primarily at the extensive margin.

4.4.4 Complementarities between incentives and outreach modalities

Next, we investigate whether there are complementarities between incentives for referrals and outreach modality. Peer outreach is more costly to existing patients than providing names to health workers because of the time and effort required to perform outreach activities as well as the social cost of interacting with others to discuss a potentially uncomfortable subject. Therefore, we hypothesize that incentives might be more effective under the peer-outreach modality.

Because the results in sections 4.4.1 and 4.4.2 indicate no economically or statistically meaningful differences of the conditionality of incentives or anonymity of health worker outreach, we test for complementarities between financial incentives and peer outreach by pooling the two incentive types and the two health worker outreach variants to estimate the following regression:

$$\begin{aligned} y_{ijc} = \alpha + \psi_1 \text{no\$Peer}_{jc} + \psi_2 \text{no\$Health worker}_{jc} + \psi_3 \text{\$Peer}_{jc} + \psi_4 \text{\$Health worker}_{jc} \\ + \Gamma_c + \epsilon_j \end{aligned} \tag{4}$$

where no$ denotes conditions with no incentives and $ indicates groups with incentives.

The results from this exercise, shown in Table 5, indicate strong complementarities between financial incentives and peer outreach. Each existing patient in the peer-outreach conditions produced, on average, 0.178 new suspects (significantly different from zero in the control group at the 99% level) when incentives were provided, compared to 0.036 (not statistically significant) in the absence of incentives. The p-value for

effect on referrals in our public health context than in the employment context. This is striking since the total social costs s_{ij} of referrals for TB testing and treatment may be higher due to stigma, and because job referrals may generate income that a contact can share with a referrer, but health referrals do not—at least in the short term.

the test that peer outreach is equally effective with and without incentives is 0.01. Similar patterns are observed for the other outcome variables, with incentives significantly enhancing the effect of peer outreach on the number of new symptomatics recommended for testing, the number of symptomatics actually tested, and the number of new TB cases detected. In all cases, the estimated effects remain statistically significant at the 95% level even after adjustment for multiple hypothesis testing. Existing patients in the incentivized peer-outreach conditions identified, on average, 0.017 new TB patients (significantly different from zero in the control group at the 95% level), and the p-value for the test that incentivized and nonincentivized peer outreach are equally effective at identifying TB-positive cases is 0.05.

In contrast, the estimated effects of health worker outreach are similar with and without financial incentives. For example, each patient in the health worker outreach conditions resulted in 0.063 new suspects screened (significantly different from zero at the 95% level) with incentives and 0.048 new suspects (significant at the 99% level) screened without incentives. For all four outcomes, we cannot reject that outreach by health workers is equally effective when implemented with and without financial incentives. Moreover, the differential effectiveness of peer outreach relative to health worker outreach is driven by the interaction with financial incentives.

4.4.5 Alternative specifications

All of the specifications described above are robust to including the patient-level covariates from the balance tests (Appendix Tables A8 and A9) as well as covariates selected using the double-lasso procedure described by Belloni et al. (2014) (Appendix Tables A10 and A11). This three-step procedure first uses lasso to select controls from among all of the baseline variables in our sample (and, for continuous variables, their squares) that are correlated with treatment assignment; second, it uses lasso to select additional controls that predict the outcome variable; and third, it estimates our models via OLS, including all of the selected controls. We implement this procedure using the Stata command "pdslasso," selecting controls separately for each of the four outcomes of interest, and including city fixed effects as unpenalized regressors. Point estimates for the effects of the experimental treatments are very similar using this double-lasso procedure as in our main specifications with no baseline covariates.

In the Appendix, we also report results from weighted regressions where each observation is weighted by the inverse of the number of original patients per center (Tables A12-A14), and we compute p-values obtained by wild cluster bootstrap (Appendix Tables A15 and A16; these p-values were obtained using the Stata command "boottest"). Further, we reestimated our models at the clinic level, where outcomes are clinic-level averages and regressions account for different-sized clinics (Appendix Tables A17-A19). The magnitude and statistical significance of the main estimated coefficients of interest are largely unchanged in these alternative specifications.

4.4.6 Effort by existing patients

Existing patients could exert effort through screening potential referees (choosing those with higher p_j), contacting them (the extensive margin), or by convincing them to get tested (the intensive margin, q_{ij}). While we cannot fully separate those channels, data about the number of potential contacts named at the outset of the intervention, the number of card distributed in the peer outreach arms, and the conversion rate from screening to testing help us understand these mechanisms. At the onset of the intervention, existing patients in all outreach arms – including peer outreach – were asked to provide the names and contact information of people they would contact or who should be contacted by health workers. In the health worker outreach arms, knowing that health workers were responsible for outreach, 11.09 percent of existing patients who were not offered financial incentives and 11.35 percent of existing patients who were offered incentives provided at least one name (see Appendix Table A4). In the peer outreach arms, 4.43 percent of existing patients who were not offered incentives and 7.68 percent of those who were offered incentives provided at least one name. This is consistent with both the previous result that financial incentives complemented peer outreach by compensating existing patients for the required effort, and with the notion that existing patients immediately recognized that peer outreach required greater effort.

In the health worker outreach arms, all of the potential symptomatics named at baseline were contacted by Operation ASHA staff, with no additional effort required by existing patients; the number of names listed corresponds to the number of potential patients who received information about testing and treatment. In the peer outreach arms, though, existing patients may have contacted all, some, or none of the people who they identified at baseline; they also may have contacted people not on their initial lists. While we do not have perfect data about outreach attempts by existing patients, we did obtain an incentivized measure of effort in contacting suspect from existing patients assigned to the peer-outreach arms. Recall that only existing patients in the peer outreach arm were given referral cards to pass on to their contacts. After the endline survey, we offered to buy back any remaining referral cards from these existing patients. The difference between the ten cards initially distributed to existing patients and the number of cards returned to the survey team provides a proxy for the extensive margin of outreach in the peer outreach arm.

Some patients reported they had lost their cards; of 869 respondents assigned to peer outreach and surveyed at endline, the 195 who returned zero cards represent those who distributed 10 cards and those who lost or discarded the materials. The number of cards returned is a lower bound on the number of cards not distributed to new suspects. Nonetheless, a comparison of the number of cards returned by existing patients eligible for different incentive schemes provides some information about the margin of effort. In the encouragement arm, existing patients returned an average of 7.24 cards. Existing patients eligible for unconditional incentives returned 0.05 additional cards and those eligible for conditional incentives returned 0.07 fewer cards; relative to the encouragement arm, those differences are neither statistically nor economically significant.[33] Not only are the means similar, the distribution of the number of cards returned by the two groups is almost identical.[34]

This is striking in light of the previous result that financial incentives strongly complemented peer outreach in increasing the number of new suspects screened and tested.

[33]See Appendix Table A5, Panel A. The regression specification corresponds to equation (7) and the sample includes all patients assigned to the peer-outreach arms.

[34]See Appendix Table A5, Panel B. Kolmogorov-Smirnov equality-of-distributions tests give p-values of 0.993 (no incentive vs. any incentive) and 0.795 (unconditional incentive vs. conditional incentive).

Now, we see that this complementarity was achieved without an increase in the number of cards distributed. This pattern suggests that financial incentives increased existing patients' efforts to improve the quality of information they conveyed to new suspects (q_{ij}) or to identify suspects who had a greater likelihood of having TB (p_j). While we are not fully able to separate these two components of existing patient effort, comparing the conversation rates from screening to testing provides suggestive evidence that incentives increased effort by both improving the quality of information shared with new suspects and by targeting those most likely to have TB.

We know from the data about cards bought back that financial incentives did not change the number of outreach attempts. However, as we saw in Table 5, incentives did increase the number of new suspects who were screened, which is consistent with an effect on q_{ij}. Though the small absolute number of new suspects who were screened and tested limits subsequent analysis, we can compare the fraction positive for TB among those who were referred by incentivized and non-incentivized existing patients. Of the new suspects screened (sent for testing) as a result of referrals from existing patients in the peer outreach, no incentives arm, 8.33 (16.67) percent tested positive. Of those referred by existing patients in the peer outreach, financial incentives arm, 17.14 (30.09) percent tested positive. Since test results are only available for those new suspects who came to Operation ASHA for screening, their test results conditional on screening are a measure of p_j for those for whom the perceived benefits of screening were sufficiently high to show up. In this group, those who were referred by incentivized existing patients were twice as likely to have symptoms of TB and twice as likely to actually have TB as other individuals who were convinced to show up by an existing patient who did not receive incentives. Therefore, incentives appear to have improved screening as well as increasing the quality of information conveyed by existing patients to their contacts.

4.4.7 Heterogeneity by existing patient characteristics

Just as network position matters in the diffusion of agricultural information (Beaman et al., 2018a), it may also affect who is well-positioned to spread information about public health. Banerjee et al. (2019) find that individuals nominated by their communities are better at spreading information (in this case, about immunization camps) that increases the take-up of vaccines than are randomly selected individuals. Several papers emphasize the identification of individuals who are most efficient in gathering or spreading information within their network based on their position within the network structure or observable characteristics. These works consider information aggregation (Alatas et al., 2016) and dissemination (Beaman et al., 2018b; Banerjee et al., 2019) separately, while referrals in our context transmit information in both directions.

We do not capture full social networks, so our analysis of heterogeneous treatment effects is based on subgroup analysis of how existing patients with different baseline characteristics respond to the incentive and outreach treatments. We revert to to separate specifications for incentive type and outreach type, and focus on five characteristics that potentially predict differential responses: asset ownership, social connection, delay in seeking treatment for TB symptoms, phase of treatment, and gender. Having demonstrated equal effects of conditional and unconditional incentives, and health worker outreach on behalf of identified and anonymous peers, respectively, we pool across treatment conditions.

Existing patients with higher asset levels are likely to enjoy higher levels of consumption and to have higher opportunity cost of time. Wealthier existing patients may be less responsive to incentives because the payments represent a smaller fraction of consumption. Wealthier patients may also be less effective when tasked with peer referrals because of their higher opportunity cost of time.

Existing patients who are more socially connected (measured by their number of contacts in the previous 24 hours) may face lower costs (lower c_{ij}) for each referral, predicting both more referrals on average and possibly a stronger response to financial incentives.[35] The lower c_{ij} may also give these highly connected patients an advantage over less connected patients in making peer referrals.

Existing patients who seek treatment quickly may receive a higher social benefit (s_{ij})

[35]Our measure of social connectedness should be interpreted as an indication of opportunities for social interaction, not necessarily as a measure of the size of an individual's network. In fact, low-income individuals who live in highly crowded urban areas may have many interactions that do not generate "social capital" that confers material benefits.

because of their own motivation or the perceived intrinsic value of making a referral. These patients may also be more effective in convincing peers to seek testing and treatment; this information can improve q_{ij} only if it is conveyed directly in the peer-outreach treatment but not indirectly in the health worker outreach arms. Therefore, we expect more referrals from existing patients assigned to the encouragement group who quickly seek treatment for their own symptoms, but we have no clear prediction for the response to financial incentives. We also expect these early treatment seekers to be more effective in referring new suspects than are existing patients who delay their own care. The early treatment seekers may also make more referrals in health worker outreach arms, but only through naming more contacts and not through communicating their own experiences.

Existing patients in the intensive phase (again, IP) of treatment have realized fewer benefits of treatment than those in the continuation phase (again, CP). They are more likely to experience side effects from the higher doses of medication they take and they are required to take observed doses more frequently than those in the CP. Therefore, they may bear higher costs of conducting outreach (higher c_{ij}), leading to predictions opposite those for patients with many social contacts: fewer referrals on average, a weaker response to financial incentives, and less willingness to make peer referrals. The patients in the intensive phase have also reaped fewer benefits from treatment, so they may be less effective in communicating its benefits.

Finally, we consider heterogeneity by gender. This analysis is standard in public health and in studies of India, a highly gendered society. It is particularly relevant in the context of our study, because in at least some of the communities where we worked, women's movement outside the household is strictly limited and social relationships are strictly gendered: men socialize with men, and women socialize with women. This means that women may have lower ability to make peer referrals and that new suspects they refer (who are disproportionately likely to be women themselves) may be less likely to report for screening.

To test these predictions, we create indicators for above-median asset ownership, connection, starting TB treatment without delay, and for being in the IP of treatment, respectively,[36] as well as for being female. We then estimate interacted versions of equations (1) and (2), pooling conditional and unconditional incentives and identified and anonymous health worker outreach treatments, respectively. The specification for the tests of incentives is:

$$
\begin{aligned}
y_{ijc} = \alpha &+ \delta_0 \text{Above median} + \delta_1 \text{Encouragement}_{jc} + \delta_2 \text{Financial incentive}_{jc} \\
&+ \delta_3 \text{Above median} \times \text{Encouragement}_{jc} + \delta_4 \text{Above median} \times \text{Financial incentive}_{jc} \\
&+ \Gamma_c + \epsilon_j \qquad (5)
\end{aligned}
$$

and the specification for the test of outreach strategies is:

$$
\begin{aligned}
y_{ijc} = \alpha &+ \theta_0 \text{Above median} + \theta_1 \text{Peer}_{jc} + \theta_2 \text{Health worker}_{jc} \\
&+ \theta_3 \text{Above median} \times \text{Peer}_{jc} + \theta_4 \text{Above median} \times \text{Health worker}_{jc} \\
&+ \Gamma_c + \epsilon_j \qquad (6)
\end{aligned}
$$

Note that while we use the notation "above median" for convenience, the relevant indicator is coded as 1 for female patients and for those in the IP, respectively, in the specifications that consider those dimensions of heterogeneity. Because of statistical power considerations and to reduce the number of reported outcomes, we estimate these equations for only one outcome: the number of screened patients (corresponding to the outcome in column 1 of Tables 3 and 4).

We begin with Table 6, which estimates equation (5). As predicted, and shown in column 1, when assigned to the encouragement treatment, high-asset existing patients made somewhat fewer referrals than existing patients with below-median assets. While highly socially connected existing patients made more referrals on average, they did not respond differentially to the financial incentives. In the encouragement arm, existing patients who began their own TB treatment without delay made more referrals than

[36] The IP lasts for the first two months of treatment and the CP for months three through six. However, many patients require more than six months to complete treatment due to missed doses or other considerations. We set the indicator for intensive treatment equal to 1 for patients in the first two months of treatment and 0 for those in months 3–24. The indicator is coded as missing for the less than 1% of patients who reported that they started treatment more than 24 months before the survey.

those who delayed seeking treatment, and they referred 0.037 more suspects than those who delayed their own treatment. There is no clear pattern of differential response based on treatment phase. Finally, women did not make fewer referrals on average or respond differently to financial incentives than men.

Table 7 reports results for estimates of equation (6). While this specification confirms that highly connected patients make marginally more referrals (column 2), there is almost no evidence of differential effectiveness across the outreach modalities. In most cases, the interaction effects are precisely estimated zeros. The statistical significance of the outreach strategies, the magnitudes of the coefficients, and the pattern that peer outreach generates approximately twice as many referrals as either of the health worker outreach strategies are similar to those in Table 4.

4.5 Characteristics of referred patients across interventions

The previous sections focused on the number of suspects screened and tested, and they relied on administrative outcomes. This section considers as outcomes the characteristics of the suspects who were referred to Operation ASHA and screened by a counselor (corresponding to outcomes in column 1 of Tables 3 and 4).[37] The unit of analysis is the new symptomatic. The objective is to learn whether financial incentives and peer outreach, respectively, are effective tools to identify disadvantaged individuals in need of TB care. We consider four outcomes, gender, and three measures of social status: literacy, asset ownership, and social inclusion.

First, we compare new symptomatics to existing patients at baseline and present group means in Table 8. Forty percent of existing patients and 37% of the new symptomatics were female. On other dimensions, the new symptomatics appear disadvantaged relative to the existing patients, despite being drawn from the same social networks by design. Almost 70% of existing patients had at least some literacy, compared to 45% of the new symptomatics (the p-value for the test that existing patients and new symp-

[37] Of the 216 referrals screened, field teams were able to survey 172. Others had moved, refused to participate in the survey, or could not be tracked. There was no economic or statistically significant relationship between the probability that a suspect could be surveyed and whether the existing patient who referred them was assigned to one of the treatment arms or the pure control condition.

tomatics have equal literacy rates is 0.00). Existing patients spoke to an average of 2.6 people outside their households in the 24 hours before the baseline survey, while new symptomatics were less well-connected, with an average of 1.4 contacts (p=0.01). Of course, this may reflect that the new symptomatics were in poor health, while the existing patients were on the way to recovery. Finally, there is suggestive evidence to indicate that the new symptomatics were poorer than the existing patients: while the existing patients had a mean asset index value of 0.031, the new symptomatics averaged -0.144. The difference is imprecisely estimated (p=0.43) but large in magnitude.

Next, we study whether outreach strategies differed in their ability to identify disadvantaged individuals. For this analysis, each new symptomatic was assigned the treatment condition of the clinic where the referral originated. Since no suspects were screened as a result of referrals in the control clinics, the specifications in this section omit the control clinics. While the sample is both small and selected, Tables 9 and 10 provide descriptive evidence about the characteristics of prospective patients identified under various schemes.

In the first set of results, we estimate:

$$y_{ijc} = \alpha + \delta_1 \text{Financial incentive}_{jc} + \Gamma_c + \epsilon_j \tag{7}$$

where we pooled the conditional and unconditional incentive arms, and the encouragement condition is the reference category.

There is no indication that financial incentives caused existing patients to identify relatively better-off patients than when they were asked to participate for altruistic reasons only. While the point estimates in Table 9 indicate little effect of incentives on the gender or literacy level of new symptomatics, those identified by incentivized existing patients had lower asset levels than those identified by existing patients in the encouragement condition. The difference of -0.675 points on the asset index is large relative to the mean asset score for symptomatics identified in the encouragement group (0.21), and the effect is significant at the 95% level.

We estimate similar specifications to compare the characteristics of symptomatics identified under the peer- and health worker outreach strategies. In these specifications, the reference category is health worker outreach (again, pooling the anonymous and identified arms):

$$y_{ijc} = \alpha + \theta_1 \text{Peer outreach}_{jc} + \Gamma_c + \epsilon_j \tag{8}$$

Suspects identified via peer referrals appear more disconnected than those identified through the health worker outreach strategies. On average, new symptomatics identified via health worker outreach had 2.12 social contacts in the 24 hours preceding the survey, whereas we estimate that those identified through peer outreach had 1.77 fewer contacts (an effect statistically significant at the 95% level). It is striking that peer referrals resulted in the screening of suspects with statistically and meaningfully fewer social contacts than did outreach via health workers. These results suggest peers can effectively reach disconnected patients.

4.6 Clinic-level analysis of potential crowding-out

While both financial incentives and outreach strategies affect individual-level behavior in meaningful ways, the total number of new suspects screened through the outreach schemes tested here is small relative to the stock and flow of these clinics.[38] We study clinic-level outcomes to rule out crowd-out rather than to precisely estimate an aggregate effect on the patient loads of these clinics. Crowd-out could occur through competition for health workers' time, especially if they allocate a fixed-time budget to outreach activities and substitute time spent on outreach to or screening of new suspects identified through the referral schemes for their status quo outreach efforts.

Appendix Table A20 presents results of clinic-level regressions where the dependent variable is the total number of new TB patients enrolled at Operation ASHA clinics during the study period, normalized by the clinic-level number of patients at baseline. We estimate four specifications, aggregating the experimental conditions as in Section

[38] On average, clinics in the control group added eight patients during the two months of the study, whereas the treated clinics added 11. Normalizing by the size of the clinic-level patient population at baseline, control clinics added 0.44 new patients and treated clinics added 0.52 new patients for each existing baseline patient.

4.4.4. Eight of nine estimated coefficients are positive, including economically meaningful positive effects of peer outreach, although for the reasons explained above, the study is not adequately powered to detect differences in the number of new patients at the clinic level. Nevertheless, the point estimates do not suggest that the intervention crowded out enrollment of new patients through other intake streams, or otherwise had negative effects on new patient enrollment.

4.7 Cost analysis

The academic research questions posed by this experiment concern the behavior of existing patients. From a policy perspective, the key parameters of interest are the costs of detecting individuals with TB symptoms (who require screening, even if negative tests ultimately rule out TB and indicate the need for different treatment) and of identifying those who have the disease. We consider four categories of recurring expenses: incentive payments made for referrals, the production of referral cards, time costs of explaining the scheme to existing patients, and wages paid to health workers. We calculate costs per treatment arm, aggregating as in the previous sections. We calculate average costs per treatment arm by dividing the total number of symptomatics screened or new cases detected, respectively, by the total across the four categories of costs within the treatment arm.

Incentive payments are straightforward to calculate and reflect actual amounts paid to existing patients, depending on the rules of the treatment arm to which they were assigned. They are zero by definition in encouragement arms.

The referral cards printed for the project cost Rs. 8 ($US 0.12) per card. In peer outreach arms, each existing patient was given 10 cards, and we include the cost of all those cards even though not all were distributed to prospective patients. In the health worker outreach arms, cards were distributed to health workers based on the number of referral names provided during the baseline survey, so the per-current-patient cost of cards was actually lower than in the peer outreach arms.

We use administrative data captured by our computer-assisted interview interface to track the amount of time spent explaining the referral scheme to existing patients, and arrive at an estimate of 10 minutes per patient to explain the scheme, in both peer and health worker outreach arms. Computed at the daily wage for field staff, these explanations cost Rs. 10.42 ($0.15) per existing patient.

Finally, while the health workers in this study were paid regular wages by Operation ASHA, the outreach required by this project was outside their usual scope of work. Our project offered a fixed stipend of Rs. 1,800 ($US 26.44) per month (increased to Rs. 2,000 ($US 29.38) per month in the second year of the project) to Operation ASHA staff whose centers were assigned to the health worker outreach arms to cover time and transportation costs for outreach. The stipend was worth about 22.5% of their average monthly salaries and was the minimum compensation deemed acceptable by Operation ASHA's senior leadership.[39] Operation ASHA estimates that its DOTS providers allocate one-third of their time to outreach activities, though the vast majority of these efforts are devoted to tracing members of existing patients' households (a population not targeted by our intervention). This outreach is considered part of health workers' core job responsibilities and covered by the monthly salary, though they also receive small financial incentives and penalties for a range of activities including treatment initiation and completion.

Table 11 summarizes the results of this exercise by incentive type (Panel A) and outreach type (Panel B). Based on costs incurred during the study, it was less expensive to use financial incentives to identify a patient with TB than it was not to use them. Each positive case of TB identified cost $US 253 in the conditional treatment arms or $US 183 in the unconditional arms, relative to $US 410 in the encouragement arm. This is because while the financial incentives themselves were small relative to other costs—especially of outreach (balanced across the incentive types because of the cross-randomized design)—they were effective in increasing the number of cases detected. Costs per suspect screened are, by definition, lower: $US 33 using conditional incentives, $US 36 using unconditional incentives, and $US 70 without financial incentives.

The cost-effectiveness of peer outreach is even more pronounced. In peer arms, the

[39]To implement health worker outreach for the first time also requires training the health workers. We have omitted this fixed cost from our calculations; including it would make peer outreach relatively more cost-effective.

average cost per detection was $US 114. Active case finding by health workers was 2.5 to 3.5 times as expensive: $US 402 per case detected when using the name of the referring EP and $US 302 per case detected when the identity of the referring EP was anonymous. Costs per suspect screened were $US 14 in the peer-outreach arms and $US 75 and $US 71 using health worker outreach on behalf of anonymous and identified peers, respectively. The differences across treatment arms are driven by the greater number of suspects screened and detected as a result of peer outreach, as indicated in Table 4, and the higher costs of compensating health workers (via stipends) than existing patients.

We made every effort to minimize costs in all treatment arms during the study. Yet having completed it, we recognize two areas in which future implementation of these schemes could further reduce costs. The first is to distribute fewer cards to existing patients for peer referrals. Ninety percent of existing patients in the peer outreach arms distributed five or fewer cards, so we reestimate costs assuming that five cards rather than 10 were printed and distributed to each existing patient in the peer referral treatments. The second is to reduce the stipend to health workers. Our data do not offer guidance about the optimal stipend level, but as a benchmark, we consider reducing the stipend to health workers by half, to Rs. 900 ($US 13.22) per month. Table A21 presents estimates for this alternate scenario, which has the biggest effect on the comparison between peer outreach and health worker outreach. While the differences between peer outreach and health worker outreach are smaller in this hypothetical than the realized costs in our study, they still clearly indicate the cost advantage of using peers for active case finding: costs would fall to $US 71 for each case detected through peer outreach, compared to $US 210 for outreach by health workers who identified the referrers and $US 158 for health worker outreach on behalf of anonymous peers. In fact, assuming the same detection rates as in the current study and distributing the original 10 cards per existing patient, peer outreach remains more cost-effective than case finding by health workers for any stipend above Rs. 560 ($US 8.62) per month, 31% of the actual stipend paid to health workers in the study.

Few estimates of the cost of outreach are available in the literature. A study from South Africa estimates the cost of identifying a TB patient among a high-prevalence sample (of HIV patients, where co-infection increases patients' risk but decreases the average cost of detection) to be $US 381 (Kranzer et al., 2012). Although incentivized peer outreach should not replace other outreach strategies, it is clearly an effective complement with the potential to reach marginalized patients.

5 Conclusion

Underdetection of tuberculosis has serious health consequences for infected individuals, their families, and others exposed to the disease. Despite the availability of free treatment throughout India, an estimated one million people with TB have not been tested and are not receiving the necessary treatment. The value of private information may be especially high in this context: the public health system and not-for-profit providers working under its auspices are often overwhelmed and unable to mount intensive contact tracing efforts. Existing outreach strategies are insufficient to overcome informational barriers that prevent some people with symptoms from seeking testing and treatment. In contrast, people who are currently undergoing treatment for TB have relatively lower time costs to identify and reach others with symptoms, and they may have particularly relevant information about the benefits of treatment. Despite this, peer referrals are virtually unheard of, partly due to the stigma associated with TB.

The results of our field experiment in India demonstrate that, just as referrals are valuable for leveraging private information to identify well-qualified employees, they are highly effective for outreach to TB symptomatics. Encouragement and, especially, financial incentives induce existing patients to refer others in need of testing, which results in the testing of new symptomatics and the detection of new TB cases. Moreover, peers are particularly effective in outreach. Our experimental design allowed us to discover that peer referrals are effective not only because existing patients have—and can be induced to reveal—useful information about members of their social network who need screening for TB, but also because of the direct role they can play in outreach to these contacts. Among peer referrers, incentives increased the number of prospective patients who were screened without affecting the number of cards distributed, suggesting that financial incentives increased the quality of information conveyed or outreach target selected.

Our study demonstrated that incentivized, community-based referral schemes can serve as a useful complement to existing TB case-finding strategies. Both financial incentives and peer outreach are highly cost-effective at $US 114 for each case of active TB identified through peer outreach, compared to $US 300–$US 400 for outreach by health workers. Because other diseases such as HIV/AIDS and STDs present challenges similar to TB including under-diagnosis, a reluctance to get tested, and high costs of identifying new cases, insights from this study may also prove useful in other contexts.

References

Ahrens, A., C. B. Hansen, and M. E. Schaffer (2018): "pdslasso and ivlasso: Programs for Post-Selection and Post-Regularization OLS or IV Estimation and Inference." http://ideas.repec.org/c/boc/bocode/s458459.html.

Alatas, V., A. Banerjee, A. Chandrasekhar, R. Hanna, and B. Olken (2016): "Network Structure and the Aggregation of Information: Theory and Evidence from Indonesia." *American Economic Review*, 106, 1663–1704.

André, E., O. Rusumba, C. Evans, P. Ngongo, P. Sanduku, M. Elvis, H. Celestin, I. Alain, E. Musafiri, J. Kabuayi, and O. de Waroux (2018): "Patient-Led Active Tuberculosis Case-Finding in the Democratic Republic of the Congo." *Bulletin of the World Health Organization*, 96.

Andreoni, J. (1990): "Impure Altruism and Donations to Public Goods: A Theory of Warm-Glow Giving." *Economic Journal*, 100, 464–477.

Atre, S., A. Kudale, S. Morankar, D. Gosoniu, and M. Weiss (2011): "Gender and Community Views of Stigma and Tuberculosis in Rural Maharashtra, India." *Global Public Health: An International Journal for Research, Policy, and Practice*, 6.

Baird, S., R. Garden, C. McIntosh, and B. Ozler (2012): "Effect of a Cash Transfer Programme for Schooling on Prevalence of HIV and Herpes Simplex Type 2 in Malawi: A Cluster Randomised Trial." *The Lancet*.

Balat, J. F., N. W. Papageorge, and S. Qayyum (2018): "Positively Aware? Conflicting Expert Reviews and Demand for Medical Treatment." *National Bureau of Economic Research w24820*.

Banerjee, A., A. Chandrasekhar, E. Duflo, and M. Jackson (2019): "Using Gossips to Spread Information: Theory and Evidence from Two Randomized Controlled Trials." *Review of Economic Studies*, 0, 1–38.

Basing, P., P. Gertler, A. Binagwaho, A. Soucat, J. Sturdy, and C. Vermeersch (2011): "Effect on Maternal and Child Health Services in Rwanda of Payment to Primary Health-Care Providers for Performance: An Impact Evaluation." *The Lancet*, 377, 1421–1428.

Beaman, L., A. BenYishay, J. Magruder, and A. M. Mobarak (2018a): "Can Network Theory-based Targeting Increase Technology Adoption?" Working Paper.

Beaman, L., N. Keleher, and J. Magruder (2018b): "Do Job Networks Disadvantage Women? Evidence from a Recruitment Experiment in Malawi." *Journal of Labor Economics*, 36, 121–157.

Beaman, L. and J. Magruder (2012): "Who Gets the Job Referral? Evidence from a Social Networks Experiment." *American Economic Review*, 102, 3574–3593.

Belloni, A., V. Chernozhukov, and C. Hansen (2014): "Inference on Treatment Effects after Selection among High-Dimensional Controls." *Review of Economic Studies*, 81, 608–650.

Benjamini, Y. and Y. Hochberg (1995): "Controlling the False Discovery Rate: A Practical and Powerful Approach to Multiple Testing." *Journal of the Royal Statistical Society, Series B (Methodological)*, 57, 289–300.

Berg, E., M. Ghatak, R. Manjula, D. Rajasekhar, and S. Roy (2019): "Motivating knowledge agents: Can incentive pay overcome social distance?" *Economic Journal*, 129, 110–142.

Bryan, G., D. Karlan, and J. Zinman (2010): "Making the Most of the Friends You Have: Referrals and Enforcement in a Referrals Field Experiment." Working Paper, Department of Economics, Yale University.

Burks, S. V., B. Cowgill, M. Hoffman, and M. Housman (2015): "The Value of Hiring through Employee Referrals." *Quarterly Journal of Economics*, 130, 805–839.

Chaisson, R. E. (2018): "Advances in Tuberculosis." Lecture delivered at the Conference on Retroviruses and Opportunistic Infections.

Charles, N., B. Thomas, B. Watson, V. Chandrasekeran, and F. Wares (2010): "Care Seeking Behavior of Chest Symptomatics: A Community Based Study Done in South India after the Implementation of the RNTCP." *PLoS One*, 5.9.

Christakis, N. A. and J. H. Fowler (2007): "The Spread of Obesity in a Large Social Network over 32 Years." *New England Journal of Medicine*, 357, 370–379.

——— (2008): "The Collective Dynamics of Smoking in a Large Social Network." *New England Journal of Medicine*, 358, 2249–2258.

Cowling, K., R. Dandona, and L. Dandona (2014): "Improving the Estimation of the Tuberculosis Burden in India." *Bulletin of the World Health Organization*, 92, 817–825.

Fafchamps, M., A. Islan, A. Malek, and D. Pakrashi (2018): "Can Referral Improve Targeting? Evidence from an Agricultural Training Experiment." Working Paper.

Faye, F. (2012): "Responsabiliser les Relais Communautaires pour le Traitement Préventif Intermittent Saisonnier du Paludisme (TPI) au Sénégal: Enjeux, Modalités, Défis." *Autrepart*, 1, 129–146.

Friebel, G., M. Heinz, M. Hoffman, and N. Zubanov (2018): "Why do Employees (Not) Make Referrals?" Working Paper.

Glasman, L. R., J. Dickson-Gomez, J. Lechuga, S. Tarima, G. Bodnar, and L. R. de Mendoza (2016): "Using Peer-Referral Chains with Incentives to Promote HIV Testing and Identify Undiagnosed HIV Infections among Crack Users in San Salvador." *AIDS and Behavior*, 20, 1236–1243.

Godes, D. and D. Mayzlin (2009): "Firm-Created Word-of-Mouth Communication: Evidence from a Field Test." *Marketing Science*, 28, 721–739.

Gwadz, M., C. M. Cleland, D. C. Perlman, H. Hagan, S. M. Jenness, N. R. Leonard, A. S. Ritchie, and A. Kutnick (2017): "Public Health Benefit of Peer-Referral Strategies for Detecting Undiagnosed HIV Infection among High-Risk Heterosexuals in New York City." *Journal of Acquired Immune Deficiency Syndromes*, 74, 499.

Haileyesus Getahun, J., L. Tomaskovic, and M. C. Raviglione (2012): "Engage-TB: Integrating Community-Based Tuberculosis Activities into the Work of Nongovernmental and Other Civil Society Organizations: Operational Guidance." Tech. rep., World Health Organization, Geneva.

Heath, R. (forthcoming): "Why Do Firms Hire Using Referrals? Evidence from Bangladeshi Garment Factories." *Journal of Political Economy.*

Hoffman, M. (2017): "The Value of Hiring through Employee Referrals in Developed Countries." *IZA World of Labor.*

Hussam, R., N. Rigol, and B. Roth (2017): "Targeting High Ability Entrepreneurs Using Community Information: Mechanism Design in the Field." Working Paper.

Jackson, M. O. (2011): "An Overview of Social Networks and Economic Applications." *Handbook of Social Economics. North-Holland*, 1, 511–585.

Joshi, D., R. Sthapit, and M. Brouwer (2017): "Peer-Led Active Tuberculosis Case-Finding among People Living with HIV: Lessons from Nepal." *Bulletin of the World Health Organization*, 95.

Kelly, P. (1999): "Isolation and Stigma: The Experience of Patients with Active Tuberculosis." *Journal of Community Health Nursing*, 16.

Kohler, H. P. and R. L. Thornton (2011): "Conditional Cash Transfers and HIV/AIDS Prevention: Unconditionally Promising?" *World Bank Economic Review*, 26, 165–190.

Kranzer, K., S. Lawn, G. Meyer-Rath, A. Vassall, E. Raditlhalo, D. Govindasamy, N. van Schaik, R. Wood, and L.-G. Bekker (2012): "Feasibility, Yield, and Cost of Active Tuberculosis Case Finding Linked to a Mobile HIV Service in Cape Town, South Africa: A Cross-Sectional Study." *PLoS Medicine*, 9.

Kremer, M., E. Miguel, and R. L. Thornton (2009): "Incentives to Learn." *Review of Economics and Statistics*, 91, 437–456.

Kugler, A. (2003): "Employee Referrals and Efficiency Wages." *Labour Economics*, 10, 531–556.

Kumar, V., J. A. Petersen, and R. P. Leone (2010): "Driving Profitability by Encouraging Customer Referrals: Who, When, and How." *Journal of Marketing*, 74, 1–17.

Laurence, Y. V., U. K. Griffiths, and A. Vassall (2015): "Costs to Health Services and the Patient of Treating Tuberculosis: A Systematic Literature Review." *Pharmacoeconomics*, 33, 939–955.

Miller, G., R. Luo, L. Zhang, S. Sylvia, Y. Shi, P. Foo, Q. Zhao, R. Martorell, A. Medina, and S. Rozelle (2012): "Effectiveness of Provider Incentives for Anaemia Reduction in Rural China: A Cluster Randomised Trial." *BMJ*.

Munyanga Mukungo, S. and B. B. Kaboru (2014): "Intensive TB Case Finding in Unsafe Settings: Testing an Outreach Peer Education Intervention for Increased TB Case Detection among Displaced Populations and Host Communities in South-Kivu Province, Democratic Republic of Congo." *Journal of Tuberculosis Research*, 2, 160–167.

Oster, E. and R. Thornton (2012): "Determinants of Technology Adoption: Peer Effects in Menstrual Cup Take-Up." *Journal of the European Economic Association*, 10, 1263–1293.

Pope, D. G. (2009): "Reacting to Rankings: Evidence from America's Best Hospitals." *Journal of Health Economics*, 28, 1154–1165.

Shangani, S., D. Escudero, K. Kirwa, A. Harrison, B. Marshall, and D. Operario (2017): "Effectiveness of Peer-Led Interventions to Increase HIV Testing among Men Who Have Sex with Men: A Systematic Review and Meta-Analysis." *AIDS Care*, 29, 1003–1013.

Sorensen, A. T. (2006): "Social Learning and Health Plan Choice." *The Rand Journal of Economics*, 37, 929–945.

Thornton, R. L. (2008): "The Demand for, and Impact of, Learning HIV Status." *American Economic Review*, 98, 1829–1863.

Walque, D. D., W. H. Dow, R. Nathan, R. Abdul, F. Abilahi, E. Gong, Z. Isdahl, J. Jamison, B. Jullu, S. Krishnan, and A. Majura (2012): "Incentivising Safe Sex: A Randomised Trial of Conditional Cash Transfers for HIV and Sexually Transmitted Infection Prevention in Rural Tanzania." *BMJ Open*, 2.

Wang, S. Y. (2013): "Marriage Networks, Nepotism, and Labor Market Outcomes in China." *American Economic Journal: Applied Economics*, 5, 91–112.

World Health Organization (2017): "Global Tuberculosis Report 2017." Tech. rep., Geneva.

——— (2019): "Global Tuberculosis Report 2019." Tech. rep., Geneva.

Figures

Figure 1: Sample referral card (English translation)

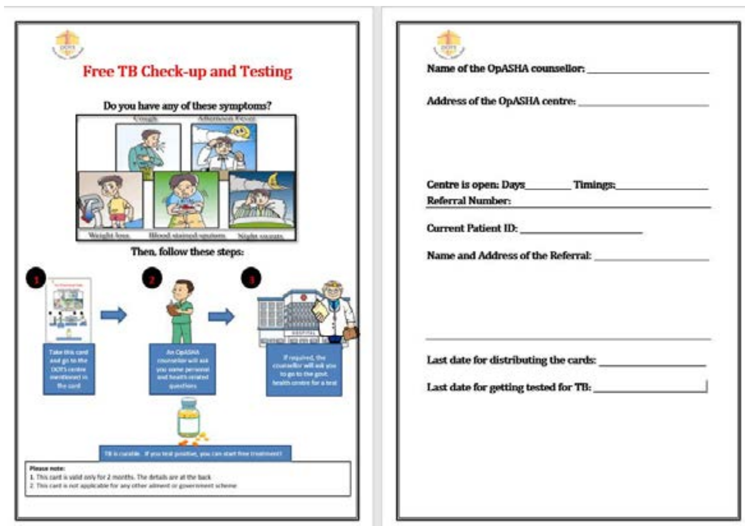

Figure 2: Experimental design and sample sizes

	Pure control 10 clinics 189 patients	**Outreach type**		
		Health worker outreach (anonymous)	Health worker outreach (identified)	Peer outreach
Incentive type	Encouragement	11 clinics 331 patients	13 clinics 300 patients	14 clinics 361 patients
Incentive type	Rs. 150 unconditional	11 clinics 336 patients	13 clinics 436 patients	14 clinics 252 patients
Incentive type	Rs. 100 + Rs. 150 if TB positive	10 clinics 259 patients	13 clinics 352 patients	13 clinics 360 patients

Tables

Table 1: Summary statistics, by incentive type

	(1) Control	(2) Conditional incentive	(3) Encouragement	(4) Unconditional incentive	(5) Overall
Female respondent	0.413	0.390	0.403	0.406	0.401
	(0.036)	(0.016)	(0.016)	(0.015)	(0.009)
Hindu respondent	0.831	0.826	0.812	0.823	0.821
	(0.027)	(0.012)	(0.012)	(0.012)	(0.007)
Muslim respondent	0.153	0.128	0.153	0.150	0.145
	(0.026)	(0.011)	(0.011)	(0.011)	(0.006)
Respondent has some literacy	0.688	0.668	0.703	0.700	0.690
	(0.034)	(0.015)	(0.015)	(0.014)	(0.008)
Respondent has secondary education	0.307	0.294	0.288	0.311	0.298
	(0.034)	(0.015)	(0.014)	(0.014)	(0.008)
Asset index	0.289	0.000	0.055	-0.081	0.008
	(0.125)	(0.055)	(0.060)	(0.053)	(0.031)
Respondent has bank account	0.640	0.588	0.633	0.613	0.613
	(0.035)	(0.016)	(0.015)	(0.015)	(0.009)
Number of social contacts	3.087	2.650	2.249	2.654	2.554
	(0.425)	(0.208)	(0.139)	(0.204)	(0.105)
Previously treated for TB	0.159	0.173	0.185	0.166	0.174
	(0.027)	(0.012)	(0.012)	(0.012)	(0.007)
Tested within 1 month of symptoms	0.878	0.852	0.794	0.816	0.824
	(0.024)	(0.011)	(0.013)	(0.012)	(0.007)
Observations	189	971	992	1024	3176

Table 2: Summary statistics, by outreach type

	(1) Control	(2) Peer outreach	(3) Health worker outreach, anonymous	(4) Health worker outreach, identified	(5) Overall
Female respondent	0.413	0.414	0.371	0.412	0.401
	(0.036)	(0.016)	(0.016)	(0.015)	(0.009)
Hindu respondent	0.831	0.830	0.810	0.821	0.821
	(0.027)	(0.012)	(0.013)	(0.012)	(0.007)
Muslim respondent	0.153	0.142	0.160	0.132	0.145
	(0.026)	(0.011)	(0.012)	(0.010)	(0.006)
Respondent has some literacy	0.688	0.674	0.681	0.713	0.690
	(0.034)	(0.015)	(0.015)	(0.014)	(0.008)
Respondent has secondary education	0.307	0.284	0.285	0.321	0.298
	(0.034)	(0.014)	(0.015)	(0.014)	(0.008)
Asset index	0.289	-0.088	-0.034	0.080	0.008
	(0.125)	(0.056)	(0.057)	(0.055)	(0.031)
Respondent has bank account	0.640	0.595	0.630	0.611	0.613
	(0.035)	(0.016)	(0.016)	(0.015)	(0.009)
Number of social contacts	3.087	2.575	2.432	2.545	2.554
	(0.425)	(0.191)	(0.182)	(0.186)	(0.105)
Previously treated for TB	0.159	0.163	0.170	0.189	0.174
	(0.027)	(0.012)	(0.012)	(0.012)	(0.007)
Tested within 1 month of symptoms	0.878	0.811	0.825	0.825	0.824
	(0.024)	(0.013)	(0.013)	(0.012)	(0.007)
Observations	189	973	926	1088	3176

Table 3: Effects of financial incentives on TB detection

	(1) Patients screened	(2) Tests recommended	(3) Patients tested	(4) Positive tests
Encouragement	0.044	0.030	0.024	0.003
	(0.018)	(0.015)	(0.014)	(0.003)
	[0.090]	[0.194]	[0.247]	[0.410]
Unconditional incentive	0.096	0.080	0.057	0.013
	(0.025)	(0.020)	(0.015)	(0.006)
	[0.002]	[0.001]	[0.002]	[0.107]
Conditional incentive	0.102	0.078	0.058	0.005
	(0.031)	(0.028)	(0.021)	(0.006)
	[0.013]	[0.044]	[0.053]	[0.410]
Observations	3176	3176	3176	3176
R-squared	0.01	0.01	0.02	0.02
Mean of dep. var. in control group	0.00	0.00	0.00	0.00
P-value: treatments jointly 0	0.00	0.00	0.00	0.07
Point estimate of differences between treatment arms:				
Encouragement-Unconditional	0.052	0.050	0.032	0.011
	(0.024)	(0.020)	(0.014)	(0.006)
Encouragement-Conditional	0.058	0.048	0.034	0.003
	(0.035)	(0.031)	(0.022)	(0.007)
Conditional-Unconditional	0.007	-0.002	0.001	-0.008
	(0.033)	(0.028)	(0.019)	(0.008)

"Patients screened" (column 1) is the number of new suspects who meet with an Operation ASHA counselor after receiving a referral card. "Tests recommended" (column 2) is the number of new suspects who are observed by Operation ASHA counselors to have symptoms of active TB and are therefore told to report to a government center for testing. "Patients tested" is the number of new suspects who obtain a test at a government testing center. "Positive tests" is the number of new suspects who have a positive sputum test result. The unit of observation is the existing patient. Linear models estimated by OLS, including city fixed effects. Standard errors are clustered at the clinic level and reported in parentheses. The sample includes all current patients. The omitted category is patients in pure control clinics. False discovery rate corrected q-values (based on Benjamini and Hochberg (1995)) in square brackets in the top panel; standard errors for point estimates of differences between treatment arms in parentheses in the bottom panel.

Table 4: Effects of outreach type on TB detection

	(1) Patients screened	(2) Tests recommended	(3) Patients tested	(4) Positive tests
Peer outreach	0.124	0.092	0.058	0.010
	(0.030)	(0.025)	(0.018)	(0.004)
	[0.001]	[0.011]	[0.003]	[0.061]
Health worker outreach, identified	0.054	0.042	0.035	0.004
	(0.016)	(0.014)	(0.013)	(0.004)
	[0.004]	[0.021]	[0.011]	[0.302]
Health worker outreach, anonymous	0.056	0.049	0.043	0.005
	(0.020)	(0.019)	(0.018)	(0.005)
	[0.053]	[0.053]	[0.061]	[0.302]
Observations	3176	3176	3176	3176
R-squared	0.02	0.01	0.02	0.02
Mean of dep. var. in control group	0.00	0.00	0.00	0.00
P-value: treatments jointly 0	0.00	0.00	0.01	0.09
Point estimate of differences between treatment arms:				
Peer-Identified	0.070	0.050	0.024	0.006
	(0.027)	(0.023)	(0.014)	(0.006)
Peer-Anonymous	0.068	0.043	0.015	0.005
	(0.031)	(0.027)	(0.019)	(0.006)
Anonymous-Identified	0.002	0.007	0.008	0.001
	(0.018)	(0.017)	(0.014)	(0.007)

"Patients screened" (column 1) is the number of new suspects who meet with an Operation ASHA counselor after receiving a referral card. "Tests recommended" (column 2) is the number of new suspects who are observed by Operation ASHA counselors to have symptoms of active TB and are therefore told to report to a government center for testing. "Patients tested" is the number of new suspects who obtain a test at a government testing center. "Positive tests" is the number of new suspects who have a positive sputum test result. The unit of observation is the existing patient. Linear models estimated by OLS, including city fixed effects. Standard errors are clustered at the clinic level and reported in parentheses. The sample includes all current patients. The omitted category is patients in pure control clinics.False discovery rate corrected q-values (based on Benjamini and Hochberg (1995)) in square brackets in the top panel; standard errors for point estimates of differences between treatment arms in parentheses in the bottom panel.

Table 5: Complementarities between peer outreach and financial incentives on TB detection

	(1) Patients screened	(2) Tests recommended	(3) Patients tested	(4) Positive tests
Peer outreach, no financial incentive	0.036	0.023	0.017	-0.001
	(0.023)	(0.020)	(0.016)	(0.003)
	[0.623]	[0.623]	[0.623]	[0.846]
Health worker outreach, no financial incentive	0.048	0.034	0.028	0.005
	(0.020)	(0.017)	(0.016)	(0.004)
	[0.169]	[0.381]	[0.562]	[0.623]
Peer outreach, financial incentive	0.178	0.135	0.084	0.017
	(0.044)	(0.038)	(0.026)	(0.007)
	[0.001]	[0.008]	[0.017]	[0.170]
Health worker outreach, financial incentive	0.063	0.054	0.046	0.006
	(0.017)	(0.016)	(0.015)	(0.004)
	[0.006]	[0.011]	[0.030]	[0.623]
Observations	3176	3176	3176	3176
R-squared	0.02	0.02	0.02	0.02
Mean of dep. var. in control group	0.00	0.00	0.00	0.00
P-value:	0.01	0.02	0.04	0.05
Peer encouragement = Peer incentives				
P-value:	0.40	0.23	0.23	0.85
Health worker outreach encouragement = Health worker outreach incentives				
P-value:	0.64	0.61	0.50	0.30
Health worker outreach encouragement = Peer encouragement				
P-value:	0.01	0.03	0.10	0.14
Health worker outreach incentives = Peer incentives				

"Patients screened" (column 1) is the number of new fsuspects who meet with an Operation ASHA counselor after receiving a referral card. "Tests recommended"(column 2) is the number of new suspects who are observed by Operation ASHA counselors to have symptoms of active TB and are therefore told to report to a government center for testing. "Patients tested" is the number of new suspects who obtain a test at a government testing center. "Positive tests" is the number of new suspects who have a positive sputum test result. Health worker outreach includes both identified and anonymous health worker outreach. Financial incentives includes both conditional and unconditional incentives. The unit of observation is the existing patient. Linear models estimated by OLS, including city fixed effects. Standard errors are clustered at the clinic level and reported in parentheses. The sample includes all existing patients. The omitted category is patients in pure control clinics. False discovery rate corrected q-values (based on Benjamini and Hochberg (1995)) in square brackets in the top panel;standard errors for point estimates of differences between treatment arms in parentheses in the bottom panel.

Table 6: Heterogeneous effects of financial incentives on the number of referrals

	(1)	(2)	(3)	(4)	(5)
Outcome:			**Patients screened**		
Heterogeneity by:	Asset ownership	Social contacts	No treatment delay	Intensive phase	Female
Above median	-0.001	0.023	-0.007	0.004	-0.001
	(0.006)	(0.012)	(0.013)	(0.007)	(0.014)
Encouragement	0.060	0.064	0.014	0.046	0.040
	(0.021)	(0.023)	(0.024)	(0.022)	(0.018)
Financial incentive	0.102	0.095	0.104	0.097	0.102
	(0.024)	(0.022)	(0.030)	(0.027)	(0.024)
Above median * Encouragement	-0.033	-0.034	0.037	-0.005	0.012
	(0.020)	(0.023)	(0.017)	(0.019)	(0.026)
Above median * Financial incentive	-0.012	0.005	-0.006	0.004	-0.015
	(0.023)	(0.019)	(0.037)	(0.028)	(0.035)
Observations	3174	3046	3167	3176	3047
R-squared	0.01	0.01	0.01	0.01	0.01

Linear models estimated by OLS, including city fixed effects. Standard errors are clustered at the clinic level. The sample includes all existing patients. The omitted category is patients in pure control clinics. "Above median" is an indicator set to 1 for patients with above-median asset scores (column 1); above-median social contacts (column 2); who did not delay seeking treatment for their own TB symptoms (column 3); in the first two months of treatment (column 5); and who are female (column 6).

Table 7: Heterogeneous effects of outreach strategies on the number of referrals

	(1)	(2)	(3)	(4)	(5)
Outcome:			**Patients screened**		
Heterogeneity by:	Asset ownership	Social contacts	No treatment delay	Intensive phase	Female
Above median	-0.002	0.021	-0.007	0.005	0.001
	(0.005)	(0.012)	(0.013)	(0.006)	(0.013)
Peer outreach	0.125	0.117	0.078	0.120	0.126
	(0.029)	(0.030)	(0.039)	(0.038)	(0.034)
Health worker outreach	0.062	0.064	0.060	0.058	0.055
	(0.019)	(0.018)	(0.027)	(0.017)	(0.016)
Above median * Peer	-0.013	0.012	0.057	0.010	-0.005
	(0.042)	(0.037)	(0.054)	(0.049)	(0.066)
Above median * Health worker	-0.015	-0.015	-0.007	-0.008	-0.012
	(0.015)	(0.016)	(0.023)	(0.015)	(0.021)
Observations	3174	3046	3167	3176	3047
R-squared	0.02	0.02	0.02	0.02	0.01

Linear models estimated by OLS, including city fixed effects. Standard errors are clustered at the clinic level. The sample includes all existing patients. The omitted category is patients in pure control clinics. "Above median" is an indicator set to 1 for patients with above-median asset scores (column 1); above-median social contacts (column 2); who did not delay seeking treatment for their own TB symptoms (column 3); in the first two months of treatment (column 5); and who are female (column 6).

Table 8: Comparison of existing patients and new symptomatics

	(1) Current patients	(2) New symptomatics	(3) Difference	(4) P-value (1) = (2)
Female respondent	0.401	0.366	0.035	0.368
	(0.009)	(0.037)	(0.038)	
Respondent has some literacy	0.690	0.448	0.243	0.000
	(0.008)	(0.038)	(0.036)	
Asset Index	0.031	-0.144	0.175	0.425
	(0.051)	(0.124)	(0.220)	
Number of social contacts	2.554	1.413	1.141	0.010
	(0.105)	(0.266)	(0.445)	
Observations	3176	172	3348	

Table 9: Effects of financial incentives on characteristics of referred patients

	(1) Female	(2) Some literacy	(3) Asset index	(4) Social contacts
Financial incentive	-0.007	0.022	-0.676	-0.208
	(0.087)	(0.85)	(0.305)	(0.553)
Observations	172	172	172	172
R-squared	0.12	0.15	0.18	0.07
Mean of dep. var. in encouragement group	0.37	0.49	0.21	1.37

Linear models estimated by OLS, including city fixed effects. Standard errors are clustered at the clinic level. The sample includes new patients who were screened because of a referral. The omitted category is new patients referred under the encouragement condition.

Table 10: Effects of outreach type on characteristics of referred patients

	(1) Female	(2) Some literacy	(3) Asset index	(4) Social contacts
Peer outreach	0.096	-0.174	-0.269	-1.772
	(0.097)	(0.102)	(0.370)	(0.873)
Observations	172	172	172	172
R-squared	0.13	0.17	0.16	0.11
Mean of dep. var. in health worker outreach groups	0.34	0.55	0.04	2.12

Linear models estimated by OLS, including city fixed effects. Standard errors are clustered at the clinic level. The sample includes new patients who were screened because of a referral. The omitted category is new patients referred via health worker outreach.

Table 11: Cost of detection

Panel A: Costs by Incentive Type

	Encouragement		Conditional		Unconditional	
	Cost per current patient	Total cost	Cost per current patient	Total cost	Cost per current patient	Total cost
Incentive payments	n/a	n/a	11	10500	12	12600
Referral card printing	30	29880	31	29840	21	21496
Training for existing patients	14	13542	14	13542	13	13542
Payments to health workers	144	143200	147	143200	140	143200
Total cost		186622		197082		190838
Cost per symptomatic screened	4552		2119		2327	
Cost per TB case detected	26660		16423		11927	
Cost per symptomatic screened ($US)	70		33		36	
Cost per TB case detected ($US)	410		253		183	

Panel B: Costs by Outreach Type

	Peer		Health worker, identified		Health worker, anonymous	
	Cost per current patient	Total cost	Cost per current patient	Total cost	Cost per current patient	Total cost
Incentive payments	13	12400	5	5300	6	5400
Referral card printing	80	77840	1	1408	2	1968
Training for existing patients	14	13542	12	13542	15	13542
Payments to health workers	n/a	n/a	197	214800	232	214800
Total cost		103782		235050		235710
Cost per symptomatic screened	887		4897		4622	
Cost per TB case detected	7413		26117		19642	
Cost per symptomatic screened ($US)	14		75		71	
Cost per TB case detected ($US)	114		402		302	

Panel A: Estimated number of detections correspond to outcome variables in Table 3, columns 1 and 7.
Panel B: Estimated number of detections correspond to outcome variables in Table 4, columns 1 and 7.
All costs in Indian rupees, except where indicated. Exchange rate is Rs. 65 to $US 1.

Appendix A (For online publication only)

Table A1: Testing whether attrition was associated with experimental condition

	Y = 1 if the patient was surveyed, 0 otherwise	
	(1)	(2)
Encouragement	-0.023	
	(0.030)	
Unconditional incentive	-0.005	
	(0.029)	
Conditional incentive	-0.025	
	(0.030)	
Peer outreach		-0.016
		(0.031)
Health worker outreach, identified		-0.038
		(0.029)
Health worker outreach, anonymous		0.005
		(0.028)
Observations	4,203	4,203
R-squared	0.029	0.030

Linear models estimated by OLS, including city fixed effects. The dependent variable is equal to 1 if the existing patient was surveyed, and 0 otherwise. Standard errors are clustered at the clinic level. The sample includes all baseline patients. The omitted category is patients in pure control clinics.

Table A2: Testing whether the size of OpASHA centers was associated with experimental condition

	Y = Number of original patients in a center	
	(1)	(2)
Encouragement	6.467	
	(4.922)	
Unconditional incentive	7.219	
	(5.129)	
Conditional incentive	7.078	
	(4.595)	
Peer outreach		5.321
		(4.842)
Health worker outreach, identified		8.102
		(4.982)
Health worker outreach, anonymous		7.633
		(4.803)
Observations	122	122
R-squared	0.520	0.523

Linear models estimated by OLS, including city fixed effects. The dependent variable is the number of original patients in each center. Robust standard errors are in parentheses. The sample includes all 122 OpASHA centers in the study.

Table A3: P-values for pairwise omnibus balance tests

	Control	Unconditional incentive	Conditional incentive
Encouragement	0.108	0.390	0.001
Unconditional incentive	0.237		0.120
Conditional incentive	0.512		

	Control	Identified health worker outreach	Anonymous health worker outreach
Peer outreach	0.386	0.025	0.613
Health worker outreach, identified	0.167		0.183
Health worker outreach, anonymous	0.475		

Each cell reports the p-value of the F-test that the coefficients on the variables listed in Table 1 are jointly zero, in an LPM specification where the sample includes respondents in the respective pairs of treatment conditions, and the outcome is a binary for assignment to one of the treatment conditions instead of the other. Each specification includes city fixed effects.

Table A4: Number of referrals named by existing patients

	Peer outreach	
N. names given	**No incentive**	**Incentive**
None	345 (95.57%)	565 (92.32%)
1 name	13 (3.6%)	36 (5.88%)
2 names	3 (0.83%)	7 (1.14%)
3 names	0 (0%)	2 (0.33%)
4 names	0 (0%)	0 (0%)
5 names	0 (0%)	2 (0.33%)
6 names	0 (0%)	0 (0%)
Total	19	66
Per patient	0.05	0.11

	Health worker outreach	
N. names given	**No incentive**	**Incentive**
None	561 (88.91%)	1226 (88.65%)
1 name	41 (6.5%)	91 (6.58%)
2 names	20 (3.17%)	32 (2.31%)
3 names	6 (0.95%)	15 (1.08%)
4 names	2 (0.32%)	9 (0.65%)
5 names	0 (0%)	7 (0.51%)
6 names	1 (0.16%)	3 (0.22%)
Total	113	289
Per patient	0.18	0.21

Note: Distribution of existing patients according to the number of names given to the enumerators, by experimental condition.

Table A5: Number of returned cards, by experimental condition (peer outreach only)

Panel A

	(1)
Dep. var. = number of cards returned	
Unconditional incentive	0.283
	(0.305)
Conditional incentive	0.235
	(0.315)
Observations	869
R-squared	0.043
Mean in no-incentive group	7.24

Linear model estimated by OLS, including city fixed effects. The dependent variable is the number of cards returned by the patient at endline. Standard errors clustered by center are in parentheses. The sample includes patients in the peer outreach arms only.

Panel B

Number of cards returned	(1) No incentive	(2) Unconditional incentive	(3) Conditional incentive
0	73 (23.1%)	47 (20.43%)	75 (23.22%)
1	3 (0.95%)	2 (0.87%)	1 (0.31%)
2	4 (1.27%)	1 (0.43%)	4 (1.24%)
3	0 (0%)	2 (0.87%)	1 (0.31%)
4	1 (0.32%)	2 (0.87%)	5 (1.55%)
5	3 (0.95%)	3 (1.3%)	4 (1.24%)
6	2 (0.63%)	4 (1.74%)	2 (0.62%)
7	5 (1.58%)	10 (4.35%)	6 (1.86%)
8	7 (2.22%)	9 (3.91%)	10 (3.1%)
9	25 (7.91%)	24 (10.43%)	20 (6.19%)
10	193 (61.08%)	126 (54.78%)	195 (60.37%)
Per-patient average	7.24	7.29	7.17

Table A6: Effects of financial incentives on the probability of TB screening, testing, and detection

Indicator:	(1) Any patients screened	(2) Any tests recommended	(3) Any patients tested	(4) Any positive tests
Encouragement	0.038	0.029	0.022	0.004
	(0.010)	(0.008)	(0.009)	(0.003)
Unconditional incentive	0.061	0.054	0.041	0.011
	(0.013)	(0.012)	(0.010)	(0.005)
Conditional incentive	0.049	0.042	0.034	0.004
	(0.013)	(0.012)	(0.012)	(0.004)
Observations	3176	3176	3176	3176
R-squared	0.02	0.01	0.02	0.02
Mean of dep. var. in control group	0.00	0.00	0.00	0.00
P-value: treatments jointly 0	0.00	0.00	0.00	0.05
Point estimates of differences between treatment arms:				
Encouragement-Unconditional	0.023	0.025	0.019	0.007
	(0.013)	(0.012)	(0.009)	(0.005)
Encouragement-Conditional	0.012	0.013	0.012	0.000
	(0.013)	(0.012)	(0.010)	(0.005)
Conditional-Unconditional	-0.012	-0.012	-0.007	-0.007
	(0.015)	(0.014)	(0.011)	(0.006)

Linear probability models estimated by OLS, including city fixed effects. Standard errors are clustered at the clinic level. The sample includes all existing patients. The omitted category is patients in pure control clinics.

Table A7: Effects of outreach strategies on the probability of TB screening, testing, and detection

Indicator:	(1) Any patients screened	(2) Any tests recommended	(3) Any patients tested	(4) Any positive tests
Peer outreach	0.065	0.053	0.038	0.009
	(0.012)	(0.011)	(0.009)	(0.003)
Health worker outreach, identified	0.035	0.027	0.023	0.003
	(0.010)	(0.008)	(0.009)	(0.003)
Health worker outreach, anonymous	0.046	0.043	0.036	0.007
	(0.014)	(0.013)	(0.013)	(0.005)
Observations	3176	3176	3176	3176
R-squared	0.02	0.02	0.02	0.02
Mean of dep. var. in control group	0.00	0.00	0.00	0.00
P-value: treatments jointly 0	0.00	0.00	0.00	0.03
Point estimates of differences between treatment arms:				
Peer-Identified	0.030	0.026	0.015	0.006
	(0.013)	(0.012)	(0.008)	(0.004)
Peer-Anonymous	0.019	0.010	0.002	0.003
	(0.015)	(0.014)	(0.011)	(0.005)
Anonymous-Identified	0.011	0.015	0.013	0.004
	(0.013)	(0.012)	(0.011)	(0.006)

Linear probability models estimated by OLS, including city fixed effects. Standard errors are clustered at the clinic level. The sample includes all existing patients. The omitted category is patients in pure control clinics.

Table A8: Effects of financial incentives on TB screening, testing, and detection (including baseline covariates)

	(1) Patients screened	(2) Tests recommended	(3) Patients tested	(4) Positive tests
Encouragement	0.043	0.031	0.026	0.003
	(0.017)	(0.014)	(0.014)	(0.003)
Unconditional incentive	0.093	0.078	0.055	0.009
	(0.025)	(0.020)	(0.014)	(0.004)
Conditional incentive	0.091	0.073	0.056	0.004
	(0.029)	(0.024)	(0.020)	(0.004)
Observations	3031	3031	3031	3031
R-squared	0.02	0.02	0.02	0.02
Mean of dep. var. in control group	0.00	0.00	0.00	0.00
P-value: treatments jointly 0	0.00	0.00	0.00	0.10
Point estimates of differences between treatment arms:				
Encouragement-Unconditional	0.049	0.046	0.029	0.007
	(0.024)	(0.019)	(0.013)	(0.005)
Encouragement-Conditional	0.048	0.042	0.030	0.001
	(0.030)	(0.026)	(0.019)	(0.005)
Conditional-Unconditional	-0.001	-0.005	0.001	-0.005
	(0.031)	(0.025)	(0.016)	(0.005)

Linear models estimated by OLS, including city fixed effects. Standard errors are clustered at the clinic level. The sample includes all existing patients. The omitted category is patients in pure control clinics. Includes all covariates from Table 1.

Table A9: Effects of outreach strategies on TB screening, testing, and detection (including baseline covariates)

	(1) Patients screened	(2) Tests recommended	(3) Patients tested	(4) Positive tests
Peer outreach	0.115	0.090	0.058	0.008
	(0.030)	(0.024)	(0.017)	(0.003)
Health worker outreach, identified	0.049	0.037	0.031	0.001
	(0.016)	(0.013)	(0.013)	(0.003)
Health worker outreach, anonymous	0.059	0.052	0.046	0.006
	(0.020)	(0.018)	(0.017)	(0.004)
Observations	3031	3031	3031	3031
R-squared	0.02	0.02	0.02	0.02
Mean of dep. var. in control group	0.00	0.00	0.00	0.00
P-value: treatments jointly 0	0.00	0.00	0.00	0.04
Point estimates of differences between treatment arms:				
Peer-Identified	0.067	0.053	0.027	0.007
	(0.027)	(0.022)	(0.013)	(0.004)
Peer-Anonymous	0.057	0.038	0.012	0.002
	(0.030)	(0.026)	(0.018)	(0.005)
Anonymous-Identified	0.010	0.014	0.016	0.005
	(0.017)	(0.015)	(0.013)	(0.006)

Linear models estimated by OLS, including city fixed effects. Standard errors are clustered at the clinic level. The sample includes all existing patients. The omitted category is patients in pure control clinics. Includes all covariates from Table 1.

Table A10: Effects of financial incentives on TB screening, testing, and detection (covariates selected by double lasso)

	(1) Patients screened	(2) Tests recommended	(3) Patients tested	(4) Positive tests
Encouragement	0.034	0.022	0.021	0.002
	(0.018)	(0.016)	(0.014)	(0.004)
Unconditional incentive	0.091	0.077	0.056	0.012
	(0.023)	(0.018)	(0.014)	(0.005)
Conditional incentive	0.095	0.072	0.057	0.004
	(0.027)	(0.023)	(0.018)	(0.005)
Observations	3171	3171	3171	3176
R-squared	0.04	0.04	0.04	0.04
Mean of dep. var. in control group	0.00	0.00	0.00	0.00
P-value: treatments jointly 0	0.00	0.00	0.00	0.04
Point estimates of differences between treatment arms:				
Encouragement-Unconditional	0.058	0.055	0.035	0.010
	(0.025)	(0.021)	(0.014)	(0.006)
Encouragement-Conditional	0.061	0.050	0.036	0.002
	(0.032)	(0.029)	(0.021)	(0.006)
Conditional-Unconditional	0.004	-0.005	0.001	-0.008
	(0.031)	(0.026)	(0.017)	(0.008)

Linear models estimated by OLS, including city fixed effects. Standard errors are clustered at the clinic level. The sample includes all existing patients. The omitted category is patients in pure control clinics. Covariates selected by the double-lasso procedure described by Belloni et al. (2014) and implemented in Stata 15 using the command pdslasso, a user-written command provided by Ahrens et al. (2018). Summary statistics for corresponding covariates provided in Appendix Table 5.

Table A11: Effects of outreach strategies on TB screening, testing, and detection (covariates selected by double lasso)

	(1) Patients screened	(2) Tests recommended	(3) Patients tested	(4) Positive tests
Peer outreach	0.119	0.089	0.059	0.010
	(0.028)	(0.023)	(0.016)	(0.004)
Health worker outreach, identified	0.050	0.038	0.034	0.004
	(0.016)	(0.014)	(0.013)	(0.004)
Health worker outreach, anonymous	0.053	0.047	0.043	0.005
	(0.021)	(0.019)	(0.018)	(0.005)
Observations	3171	3171	3171	3176
R-squared	0.03	0.03	0.03	0.02
Mean of dep. var. in control group	0.00	0.00	0.00	0.00
P-value: treatments jointly 0	0.00	0.00	0.00	0.08
Point estimates of differences between treatment arms:				
Peer-Identified	0.070	0.050	0.025	0.006
	(0.026)	(0.022)	(0.014)	(0.006)
Peer-Anonymous	0.067	0.042	0.016	0.005
	(0.030)	(0.027)	(0.019)	(0.006)
Anonymous-Identified	0.003	0.008	0.009	0.001
	(0.018)	(0.017)	(0.015)	(0.007)

Linear models estimated by OLS, including city fixed effects. Standard errors are clustered at the clinic level. The sample includes all existing patients. The omitted category is patients in pure control clinics. Covariates selected by the double-lasso procedure described by Belloni et al. (2014) and implemented in Stata 15 using the command pdslasso, a user-written command provided by Ahrens et al. (2018). Summary statistics for corresponding covariates provided in Appendix Table 5.

Table A12: Effects of financial incentives on TB screening, testing, and detection (weighted regressions)

	(1) Patients screened	(2) Tests recommended	(3) Patients tested	(4) Positive tests
Encouragement	0.046	0.034	0.029	0.005
	(0.021)	(0.017)	(0.016)	(0.004)
Unconditional incentive	0.090	0.075	0.053	0.011
	(0.029)	(0.024)	(0.017)	(0.006)
Conditional incentive	0.100	0.075	0.054	0.005
	(0.029)	(0.024)	(0.019)	(0.005)
Observations	3176	3176	3176	3176
R-squared	0.01	0.01	0.02	0.02
Mean of dep. var. in control group	0.00	0.00	0.00	0.00
P-value: treatments jointly 0	0.00	0.00	0.00	0.13
Point estimates of differences between treatment arms:				
Encouragement-Unconditional	0.044	0.041	0.025	0.006
	(0.029)	(0.025)	(0.015)	(0.006)
Encouragement-Conditional	0.055	0.041	0.025	0.000
	(0.032)	(0.028)	(0.019)	(0.007)
Conditional-Unconditional	0.011	0.000	0.000	-0.006
	(0.035)	(0.030)	(0.016)	(0.007)

Linear models estimated by OLS, including city fixed effects and weighting each observation by the the inverse of the number of original patients per center. Standard errors are clustered at the clinic level. The sample includes all current patients. The omitted category is patients in pure control clinics.

Table A13: Effects of outreach strategies on TB screening, testing, and detection (weighted regressions)

	(1) Patients screened	(2) Tests recommended	(3) Patients tested	(4) Positive tests
Peer outreach	0.134	0.103	0.062	0.010
	(0.029)	(0.024)	(0.017)	(0.004)
Health worker outreach, identified	0.047	0.034	0.032	0.003
	(0.020)	(0.016)	(0.015)	(0.004)
Health worker outreach, anonymous	0.057	0.050	0.044	0.008
	(0.020)	(0.018)	(0.018)	(0.006)
Observations	3176	3176	3176	3176
R-squared	0.02	0.02	0.02	0.02
Mean of dep. var. in control group	0.00	0.00	0.00	0.00
P-value: treatments jointly 0	0.00	0.00	0.00	0.05
Point estimates of differences between treatment arms:				
Peer-Identified	0.087	0.069	0.030	0.007
	(0.026)	(0.023)	(0.012)	(0.005)
Peer-Anonymous	0.077	0.052	0.018	0.002
	(0.027)	(0.024)	(0.015)	(0.006)
Anonymous-Identified	0.010	0.016	0.012	0.005
	(0.015)	(0.014)	(0.011)	(0.007)

Linear models estimated by OLS, including city fixed effects and weighting each observation by the the inverse of the number of original patients per center. Standard errors are clustered at the clinic level. The sample includes all current patients. The omitted category is patients in pure control clinics.

Table A14: Complementarities between peer outreach and financial incentives on TB detection (weighted regressions)

	(1) Patients screened	(2) Tests recommended	(3) Patients tested	(4) Positive tests
Peer outreach, no financial incentive	0.030	0.022	0.018	-0.001
	(0.030)	(0.026)	(0.021)	(0.005)
Health worker outreach, no financial incentive	0.054	0.040	0.034	0.008
	(0.022)	(0.018)	(0.017)	(0.005)
Peer outreach, financial incentive	0.194	0.149	0.087	0.016
	(0.037)	(0.032)	(0.022)	(0.006)
Health worker outreach, financial incentive	0.062	0.051	0.043	0.006
	(0.019)	(0.016)	(0.016)	(0.005)
Observations	3176	3176	3176	3176
R-squared	0.03	0.02	0.02	0.02
Mean of dep. var. in control group	0.00	0.00	0.00	0.00
Point estimates of differences between treatment arms:				
Peer encouragement = Peer incentives	0.00	0.01	0.02	0.04
Health worker outreach encouragement = Health worker outreach incentives	0.64	0.49	0.52	0.78
Health worker outreach encouragement = Peer encouragement	0.44	0.52	0.42	0.20
Health worker outreach incentives = Peer incentives	0.00	0.00	0.01	0.06

Linear models estimated by OLS, including city fixed effects and weighting each observation by the the inverse of the number of original patients per center. Health worker outreach includes both identified and anonymous health worker outreach. Financial incentives includes both conditional and unconditional incentives. Standard errors are clustered at the clinic level. The sample includes all current patients. The omitted category is patients in pure control clinics.

Table A15: Effects of financial incentives on TB detection (p-values obtained by wild bootstrap)

	(1) Patients screened	(2) Tests recommended	(3) Patients tested	(4) Positive tests
Encouragement	0.044	0.030	0.024	0.003
	[0.019]	[0.046]	[0.077]	[0.365]
Unconditional incentive	0.096	0.080	0.057	0.013
	[0.001]	[0.002]	[0.002]	[0.024]
Conditional incentive	0.102	0.078	0.058	0.005
	[0.002]	[0.008]	[0.010]	[0.405]
Observations	3176	3176	3176	3176
R-squared	0.01	0.01	0.02	0.02
Mean of dep. var. in control group	0.00	0.00	0.00	0.00
P-value: treatments jointly 0	0.00	0.00	0.00	0.07
Point estimate of differences between treatment arms:				
Encouragement-Unconditional	0.052	0.050	0.032	0.011
	[0.030]	[0.014]	[0.015]	[0.100]
Encouragement-Conditional	0.058	0.048	0.034	0.003
	[0.103]	[0.130]	[0.155]	[0.733]
Conditional-Unconditional	0.007	-0.002	0.001	-0.008
	[0.863]	[0.952]	[0.953]	[0.419]

"Patients screened" (column 1) is the number of new suspects who meet with an Operation ASHA counselor after receiving a referral card. "Tests recommended" (column 2) is the number of new suspects who are observed by Operation ASHA counselors to have symptoms of active TB and are therefore told to report to a government center for testing. "Patients tested" is the number of new suspects who obtain a test at a government testing center. "Positive tests" is the number of new suspects who have a positive sputum test result. The unit of observation is the existing patient. Linear models estimated by OLS, including city fixed effects. P-values are obtained by Wild bootstrap clustering at the clinic level and reported in square brackets. The sample includes all existing patients. The omitted category is patients in pure control clinics.

Table A16: Effects of outreach type on TB detection (p-values obtained by wild bootstrap)

	(1) Patients screened	(2) Tests recommended	(3) Patients tested	(4) Positive tests
Peer outreach	0.124	0.092	0.058	0.010
	[0.001]	[0.001]	[0.003]	[0.016]
Health worker outreach, identified	0.054	0.042	0.035	0.004
	[0.002]	[0.003]	[0.006]	[0.308]
Health worker outreach, anonymous	0.056	0.049	0.043	0.005
	[0.005]	[0.007]	[0.011]	[0.308]
Observations	3176	3176	3176	3176
R-squared	0.02	0.01	0.02	0.02
Mean of dep. var. in control group	0.00	0.00	0.00	0.00
P-value: treatments jointly 0	0.00	0.00	0.01	0.09
Point estimate of differences between treatment arms:				
Peer-Identified	0.070	0.050	0.024	0.006
	[0.021]	[0.042]	[0.108]	[0.357]
Peer-Anonymous	0.068	0.043	0.015	0.005
	[0.036]	[0.126]	[0.435]	[0.456]
Anonymous-Identified	0.002	0.007	0.008	0.001
	[0.876]	[0.661]	[0.561]	[0.888]

"Patients screened" (column 1) is the number of new suspects who meet with an Operation ASHA counselor after receiving a referral card. "Tests recommended" (column 2) is the number of new suspects who are observed by Operation ASHA counselors to have symptoms of active TB and are therefore told to report to a government center for testing. "Patients tested" is the number of new suspects who obtain a test at a government testing center. "Positive tests" is the number of new suspects who have a positive sputum test result. The unit of observation is the existing patient. Linear models estimated by OLS, including city fixed effects. p-values are obtained by Wild bootstrap clustering at the clinic level and reported in square brackets. The sample includes all existing patients. The omitted category is patients in pure control clinics.

Table A17: Effects of financial incentives on TB screening, testing, and detection (clinic-level specification)

	(1) Patients screened	(2) Tests recommended	(3) Patients tested	(4) Positive tests
Encouragement	0.056	0.039	0.030	0.004
	(0.072)	(0.062)	(0.044)	(0.008)
Unconditional incentive	0.112	0.096	0.061	0.013
	(0.072)	(0.063)	(0.044)	(0.008)
Conditional incentive	0.139	0.110	0.084	0.008
	(0.073)	(0.063)	(0.045)	(0.008)
Observations	122	122	122	122
R-squared	0.13	0.14	0.17	0.34
Mean of dep. var. in control group	0.00	0.00	0.00	0.00
P-value: treatments jointly 0	0.17	0.21	0.17	0.28
Point estimates of differences between treatment arms:				
Encouragement-Unconditional	0.056	0.056	0.031	0.009
	(0.046)	(0.040)	(0.028)	(0.005)
Encouragement-Conditional	0.083	0.071	0.054	0.004
	(0.047)	(0.040)	(0.029)	(0.005)
Conditional-Unconditional	0.026	0.015	0.023	-0.005
	(0.047)	(0.040)	(0.029)	(0.005)

Linear models estimated by OLS, including city fixed effects. The unit of analysis is the clinic. Outcomes are averages of existing patient-level outcomes within clinic. The omitted category is pure control clinics. Regressions include the clinic-level baseline number of patients as control. Standard errors are in parentheses.

Table A18: Effects of outreach strategies on TB screening, testing, and detection (clinic-level specification)

	(1) Patients screened	(2) Tests recommended	(3) Patients tested	(4) Positive tests
Peer outreach	0.151	0.116	0.073	0.012
	(0.071)	(0.062)	(0.044)	(0.008)
Health worker outreach, identified	0.063	0.052	0.040	0.004
	(0.072)	(0.063)	(0.045)	(0.008)
Health worker outreach, anonymous	0.069	0.061	0.052	0.007
	(0.073)	(0.064)	(0.046)	(0.008)
Observations	122	122	122	122
R-squared	0.14	0.13	0.15	0.34
Mean of dep. var. in control group	0.00	0.00	0.00	0.00
P-value: treatments jointly 0	0.08	0.19	0.35	0.29
Point estimates of differences between treatment arms:				
Peer-Identified	0.088	0.063	0.033	0.008
	(0.045)	(0.039)	(0.028)	(0.005)
Peer-Anonymous	0.082	0.055	0.021	0.006
	(0.048)	(0.042)	(0.030)	(0.005)
Anonymous-Identified	0.006	0.008	0.012	0.002
	(0.048)	(0.042)	(0.030)	(0.005)

Linear models estimated by OLS, including city fixed effects. The unit of analysis is the clinic. Outcomes are averages of existing patient-level outcomes within clinic. The omitted category is pure control clinics. Regressions include the clinic-level baseline number of patients as control. Standard errors are in parentheses.

Table A19: Complementarities between peer outreach and financial incentives on TB screening, testing, and detection (clinic-level specification)

	(1) Patients screened	(2) Tests recommended	(3) Patients tested	(4) Positive tests
Peer outreach, no financial incentive	0.040	0.024	0.018	0.001
	(0.081)	(0.071)	(0.051)	(0.009)
Health worker outreach, no financial incentive	0.060	0.045	0.035	0.006
	(0.074)	(0.065)	(0.047)	(0.008)
Peer outreach, financial incentive	0.210	0.164	0.103	0.018
	(0.072)	(0.063)	(0.046)	(0.008)
Health worker outreach, financial incentive	0.069	0.063	0.052	0.005
	(0.069)	(0.061)	(0.044)	(0.008)
Observations	122	122	122	122
R-squared	0.19	0.18	0.19	0.38
Mean of dep. var. in control group	0.00	0.00	0.00	0.00
P-values: Peer encouragement = Peer incentives	0.01	0.01	0.04	0.02
Health worker outreach encouragement = Health worker outreach incentives	0.84	0.68	0.59	0.92
Health worker outreach encouragement = Peer encouragement	0.77	0.72	0.68	0.51
Health worker outreach incentives = Peer incentives	0.00	0.02	0.09	0.02

Linear models estimated by OLS, including city fixed effects. The unit of analysis is the clinic. Outcomes are averages of existing patient-level outcomes within clinic. The omitted category is pure control clinics. Regressions include the clinic-level baseline number of patients as control. Standard errors are in parentheses.

Table A20: New patients enrolled at Operation ASHA clinics (clinic-level data)

	(1)	(2)	(3)	(4)
	new patients enrolled / baseline patients			
Any treatment	0.124			
	(0.283)			
Encouragement		0.139		
		(0.305)		
Financial incentive		0.116		
		(0.291)		
Peer outreach			0.303	
			(0.298)	
Health worker outreach			0.006	
			(0.288)	
Peer outreach, no financial incentive				0.296
				(0.352)
Health worker outreach, no financial incentive				0.035
				(0.322)
Peer outreach, financial incentive				0.307
				(0.316)
Health worker outreach, financial incentive				-0.010
				(0.300)
Observations	122	122	122	122
R-squared	0.10	0.10	0.13	0.13
Mean of dep. var. in control group	0.44	0.44	0.44	0.44

Linear models estimated by OLS, including city fixed effects. The unit of analysis is the clinic. The outcome variable is the number of new patients enrolled at Operation ASHA clinics during the study period divided by the baseline number of patients at the start of the study period. The omitted category is pure control clinics. Regressions include the clinic-level baseline number of patients as control. Standard errors are in parentheses.

Table A21: Cost of detection: reduced-cost scenario

Panel A: Costs by Incentive Type

	Encouragement		Conditional		Unconditional	
	Cost per current patient	Total cost	Cost per current patient	Total cost	Cost per current patient	Total cost
Incentive payments	n/a	n/a	11	10500	12	12600
Referral card printing	16	15440	16	15440	11	11416
Training of existing patients	14	13542	14	13542	13	13542
Payments to health workers	69	68400	70	68400	67	68400
Total cost		97382		107882		105958
Cost per symptomatic screened	2375		1160		1292	
Cost per TB case detected	13912		8990		6622	
Cost per symptomatic screened ($US)	37		18		20	
Cost per TB case detected ($US)	214		138		102	

Panel B: Costs by Outreach Type

	Peer		Health worker, identified		Health worker, anonymous	
	Cost per current patient	Total cost	Cost per current patient	Total cost	Cost per current patient	Total cost
Incentive payments	13	12400	5	5300	6	5400
Referral card printing	40	38920	1	1408	2	1968
Training of existing patients	14	13542	12	13542	15	13542
Payments to health workers	n/a	n/a	94	102600	111	102600
Total cost		64862		122850		123510
Cost per symptomatic screened	554		2559		2422	
Cost per TB case detected	4633		13650		10292	
Cost per symptomatic screened ($US)	9		39		37	
Cost per TB case detected ($US)	71		210		158	

This scenario assumes distribution of 5 cards instead of 10 and reduces health worker stipends by 50% to Rs. 900/month.
Panel A: Estimated number of detections correspond to outcome variables in Table 3, columns 1 and 7.
Panel B: Estimated number of detections correspond to outcome variables in Table 4, columns 1 and 7.
All costs in Indian rupees, except where indicated. Exchange rate is Rs. 65 to $US 1.

Appendix B (For online publication only)

Table B1: Summary statistics: variables selected by double-lasso procedure for analysis of incentive conditions

Variable	Mean	SD	Minimum	Maximum	Observations	Used in
Seek advice for a cough - no	0.250	0.433	0	1	3176	1, 2, 3
Seek advice on children's school - maybe	0.025	0.156	0	1	3176	1, 2, 3
Seek advice on medical care for TB - maybe	0.026	0.158	0	1	3176	1, 2, 3
Attended wedding with friend	0.617	0.487	0	1	533	1, 2, 3
Last amount borrowed from Self Help Group	23490.155	40487.383	0	400000	161	1, 2, 3
Trust enough to borrow from - relative not in household	0.099	0.299	0	1	3176	1, 2, 3, 4
Cooking fuel - cow dung cake	0.059	0.235	0	1	3176	1, 2, 3, 4
No cooking fuel	0.002	0.043	0	1	3176	1, 2, 3
Delay in starting treatment - family problems	0.009	0.095	0	1	438	1, 2, 3
Delay in starting treatment - treated for something else	0.290	0.454	0	1	438	1, 2, 3
Delay in starting treatment - not know treatment place	0.078	0.268	0	1	438	1, 2, 3
Delay in starting treatment - no time	0.130	0.337	0	1	438	1, 2, 3
Condition diagnosed - paralysis	0.008	0.087	0	1	3176	1, 2, 3
Relative died of TB - aunt/uncle	0.196	0.398	0	1	397	1, 2, 3
Relative died of TB - cousin	0.025	0.157	0	1	397	1, 2, 3
Relative died of TB - son/daughter in law	0.010	0.100	0	1	397	1, 2, 3
Electricity at home	0.933	0.251	0	1	3176	1, 2, 3, 4
Household member condition diagnosed - BP	0.057	0.232	0	1	3176	1, 2, 3
Household member condition diagnosed - paralysis	0.008	0.090	0	1	3176	1, 2, 3
Household member condition diagnosed - pneumonia	0.081	0.272	0	1	3176	1, 2, 3
Health advice from boss/employer	0.006	0.079	0	1	3176	1, 2, 3
Health advice from relatives in household - aunt/uncle	0.008	0.090	0	1	3176	1, 2, 3
Health advice from relatives in household - all family members	0.002	0.043	0	1	3176	1, 2, 3
Health advice from relatives not in household - sister/brother in law	0.009	0.097	0	1	3176	1, 2, 3
Health advice from doctor	0.002	0.040	0	1	3176	1, 2, 3
Health complaints in past week - none	0.360	0.480	0	1	3176	1, 2, 3
Discuss health problems with boss/employer	0.011	0.103	0	1	3176	1, 2, 3
Discuss health problems with relatives not in household - grandparents	0.003	0.056	0	1	3176	1, 2, 3
Discuss health problems with parents	0.331	0.471	0	1	3176	1, 2, 3
Know baseline patient being treated for TB - customer	0.161	0.368	0	1	323	1, 2, 3
Know baseline patient being treated for TB - employee	0.299	0.458	0	1	421	1, 2, 3
Trust enough to lend to - boss/employer	0.013	0.114	0	1	3176	1, 2, 3
Trust enough to lend to - co-worker	0.014	0.116	0	1	3176	1, 2, 3
Trust enough to lend to - employee	0.001	0.035	0	1	3176	1, 2, 3
Trust enough to lend to - parents	0.013	0.113	0	1	3176	1, 2, 3
Trust enough to lend to - relatives not in household	0.065	0.247	0	1	3176	1, 2, 3, 4
Source of light - battery	0.019	0.136	0	1	214	2, 4
Source of light - kerosene	0.888	0.316	0	1	214	1, 2, 3, 4
Source of light - no electricity	0.014	0.118	0	1	214	2, 4
Source of light - other oil	0.009	0.096	0	1	214	2, 4
Source of light - solar energy	0.047	0.212	0	1	214	2, 4
Last transaction - one year ago	0.127	0.333	0	1	1948	1, 2, 3
Careful that customer does not find out about TB treatment	0.845	0.363	0	1	271	1, 2, 3
Careful that spouse does not find out about TB treatment	0.781	0.416	0	1	105	1, 2, 3
Own a radio/transistor	0.070	0.329	0	8	3174	1, 2, 3
Recommended treatment location type - public hospital	0.867	0.340	0	1	218	1, 2, 3
Has bank account	0.613	0.487	0	1	3176	1, 2, 3
Number of social contacts	2.554	5.772	0	99	3042	1, 2, 3
Socialize with customer	0.006	0.079	0	1	3176	1, 2, 3
Socialize with relatives not in household - children	0.004	0.066	0	1	3176	1, 2, 3
Socialize with spouse	0.116	0.320	0	1	3176	1, 2, 3
Symptom noticed first - don't know	0.011	0.103	0	1	3176	1, 2, 3
Symptom noticed first - swollen glands	0.122	0.327	0	1	3176	1, 2, 3
Symptom noticed in - July	0.065	0.247	0	1	3041	1, 2, 3
Symptom noticed in - June	0.060	0.237	0	1	3041	1, 2, 3, 4
Symptom noticed in - March	0.078	0.268	0	1	3041	1, 2, 3
Symptom noticed in - May	0.058	0.234	0	1	3041	1, 2, 3
Symptom noticed first - body pain	0.007	0.081	0	1	3176	1, 2, 3
Symptom noticed first - chest pain	0.024	0.153	0	1	3176	1, 2, 3
Symptom noticed first - stomach pain	0.021	0.143	0	1	3176	1, 2, 3
Symptom noticed first - vomiting	0.015	0.122	0	1	3176	1, 2, 3, 4
Test type - fluid test	0.060	0.238	0	1	3176	1, 2, 3
Test type - MRI	0.005	0.073	0	1	3176	1, 2, 3
No test	0.001	0.031	0	1	3176	1, 2, 3, 4
Test revealed TB	0.992	0.088	0	1	3176	1, 2, 3
Choice of test location - health card for facility	0.011	0.103	0	1	3176	1, 2, 3
Choice of test location - recommended by friend	0.030	0.169	0	1	3176	1, 2, 3
Choice of test location - trustworthy	0.220	0.414	0	1	3176	1, 2, 3
Primary water source - well	0.051	0.221	0	1	3176	1, 2, 3, 4

Numbers in column 6 indicate the columns from Table A10 in which the relevant covariate was selected by the double-lasso procedure and included in the corresponding regression.

Table B2: Summary statistics: variables selected by double-lasso procedure for analysis of outreach conditions

Variable	(1) Mean	(2) SD	(3) Minimum	(4) Maximum	(5) Observations	(6) Used in
Seek advice for a cough - no	0.250	0.433	0	1	3176	1, 2, 3
Seek advice on children's school - maybe	0.025	0.156	0	1	3176	1, 2, 3
Seek advice on medical care for TB - maybe	0.026	0.158	0	1	3176	1, 2, 3
Attended wedding with friend	0.617	0.487	0	1	533	1, 2, 3
Last amount borrowed from Self Help Group	23490.155	40487.383	0	400000	161	1, 2, 3
Trust enough to borrow from - relative not in household	0.099	0.299	0	1	3176	1, 2, 3, 4
Cooking fuel - cow dung cake	0.059	0.235	0	1	3176	1, 2, 3, 4
No cooking fuel	0.002	0.043	0	1	3176	1, 2, 3
Delay in starting treatment - family problems	0.009	0.095	0	1	438	1, 2, 3
Delay in starting treatment - treated for something else	0.290	0.454	0	1	438	1, 2, 3
Delay in starting treatment - not know treatment place	0.078	0.268	0	1	438	1, 2, 3
Delay in starting treatment - no time	0.130	0.337	0	1	438	1, 2, 3
Condition diagnosed - paralysis	0.008	0.087	0	1	3176	1, 2, 3
Relative died of TB - aunt/uncle	0.196	0.398	0	1	397	1, 2, 3
Relative died of TB - cousin	0.025	0.157	0	1	397	1, 2, 3
Relative died of TB - son/daughter in law	0.010	0.100	0	1	397	1, 2, 3
Household member condition diagnosed - BP	0.057	0.232	0	1	3176	1, 2, 3
Household member condition diagnosed - paralysis	0.008	0.090	0	1	3176	1, 2, 3
Household member condition diagnosed - pneumonia	0.081	0.272	0	1	3176	1, 2, 3
Health advice from boss/employer	0.006	0.079	0	1	3176	1, 2, 3
Health advice from relatives in household - aunt/uncle	0.008	0.090	0	1	3176	1, 2, 3
Health advice from relatives in household - all family members	0.002	0.043	0	1	3176	1, 2, 3, 4
Health advice from relatives not in household - sister/brother in law	0.009	0.097	0	1	3176	1, 2, 3
Health advice from doctor	0.002	0.040	0	1	3176	1, 2, 3
Health complaints in past week - none	0.360	0.480	0	1	3176	1, 2, 3
Discuss health problems with boss/employer	0.011	0.103	0	1	3176	1, 2, 3
Discuss health problems with all family members in household	0.010	0.098	0	1	3176	1, 2, 3, 4
Discuss health problems with relatives not in household - grandparents	0.003	0.056	0	1	3176	1, 2, 3
Discuss health problems with parents	0.331	0.471	0	1	3176	1, 2, 3
Know baseline patient being treated for TB - customer	0.161	0.368	0	1	323	1, 2, 3
Know baseline patient being treated for TB - employee	0.299	0.458	0	1	421	1, 2, 3
Trust enough to lend to - boss/employer	0.013	0.114	0	1	3176	1, 2, 3
Trust enough to lend to - co-worker	0.014	0.116	0	1	3176	1, 2, 3
Trust enough to lend to - employee	0.001	0.035	0	1	3176	1, 2, 3
Trust enough to lend to - parents	0.013	0.113	0	1	3176	1, 2, 3
Trust enough to lend to - relatives not in household	0.065	0.247	0	1	3176	1, 2, 3, 4
Last transaction - one year ago	0.127	0.333	0	1	1948	1, 2, 3
Careful that customer does not find out about TB treatment	0.845	0.363	0	1	271	1, 2, 3
Careful that spouse does not find out about TB treatment	0.781	0.416	0	1	105	1, 2, 3
Own a radio/transistor	0.070	0.329	0	8	3174	1, 2, 3
Recommended treatment location type - public hospital	0.867	0.340	0	1	218	1, 2, 3
Recommended specific place for treatment	0.592	0.492	0	1	368	3
Has bank account	0.613	0.487	0	1	3176	1, 2, 3
Number of social contacts	2.554	5.772	0	99	3042	1, 2, 3
Socialize with customer	0.006	0.079	0	1	3176	1, 2, 3
Socialize with relatives not in household - children	0.004	0.066	0	1	3176	1, 2, 3
Socialize with spouse	0.116	0.320	0	1	3176	1, 2, 3
Symptom noticed first - don't know	0.011	0.103	0	1	3176	1, 2, 3
Symptom noticed first - swollen glands	0.122	0.327	0	1	3176	1, 2, 3
Symptom noticed in - July	0.065	0.247	0	1	3041	1, 2, 3
Symptom noticed in - March	0.078	0.268	0	1	3041	1, 2, 3
Symptom noticed in - May	0.058	0.234	0	1	3041	1, 2, 3
Symptom noticed first - body pain	0.007	0.081	0	1	3176	1, 2, 3
Symptom noticed first - chest pain	0.024	0.153	0	1	3176	1, 2, 3
Symptom noticed first - stomach pain	0.021	0.143	0	1	3176	1, 2, 3
Test type - fluid test	0.060	0.238	0	1	3176	1, 2, 3
Test type - MRI	0.005	0.073	0	1	3176	1, 2, 3
No test	0.001	0.031	0	1	3176	1, 2, 3, 4
Test revealed TB	0.992	0.088	0	1	3176	1, 2, 3
Choice of test location - health card for facility	0.011	0.103	0	1	3176	1, 2, 3
Choice of test location - recommended by friend	0.030	0.169	0	1	3176	1, 2, 3
Choice of test location - trustworthy	0.220	0.414	0	1	3176	1, 2, 3
Primary water source - water truck	0.013	0.112	0	1	3176	3

Numbers in column 6 indicate the columns from Table A11 in which the relevant covariate was selected by the double-lasso procedure and included in the corresponding regression.