An Analysis of the Implementation of the Revised National Tuberculosis Control Programme in India

by

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ABSTRACT:

This thesis examines the socioeconomic and political characteristics of districts in India which account for the timing of implementation of the Revised National Tuberculosis Control Programme (RNTCP). I draw extensively on the existing literature concerning the political economy of allocation of publicly provided goods in India and other developing nations. I assemble a data set including district and state level data on Indian socioeconomic, demographic, and political variables. This data set is used to empirically explain the timing of the implementation of the RNTCP. There are three important findings of this analysis. The first is the systematic and robust result that growth of per capita State Domestic Product (SDP) in the 1993-1997 period is an important determinant of the timing of implementation. The second is that the centrally administered Union territories experienced significant delays in the implementation of the RNTCP. The third finding is that other observable factors contribute to the timing of implementation of the RNTCP, although these results are less robust. These factors include faster implementation with increased population size, increased urbanization of districts, better state governance, and greater political representation per capita, but increased delays in heavily Muslim districts. These results are supported by theory on the impacts of these variables drawn from the literature.

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CHAPTER 1: INTRODUCTION

Tuberculosis (TB) is a serious global health threat, infecting more than 8 million people with the active form of the disease and killing almost 2 million people each year. TB control and treatment has become a growing concern in developing countries, particularly in India, where more than 20 percent of new TB cases occur annually (World Health Organization, 2005a). The public health sector of India is ill equipped to deal with this burden, having a shortage of functioning public health infrastructure (Bajpai and Goyal, 2004). This shortage leads to further economic and health consequences for those infected with TB as they often go into debt to seek treatment from the ill-regulated private sector; they use the private sector as an alternative to seeking care from the public sector, which is often perceived to be of poor quality (Bajpai and Goyal, 2004; Gupta, 2005; Rajeswari et al., 1999). Previous national TB control programs in place in India since the advent of drugs to treat the disease in the 1960s were proven inefficient and ineffective at properly detecting and treating TB.

Globally, national governments and international aid organizations have joined forces to combat this epidemic by implementing functioning public health care programs using the Directly Observed Treatment, Short-Course (DOTS) strategy. In India, this effort has taken the form of the Revised National Tuberculosis Control Programme (RNTCP), one of the two largest programs of its kind in the world both in terms of population coverage and number of patients treated (World Health Organization, 2005a). The RNTCP, first tested at a pilot level in 1993, was implemented in almost all districts of India through the existing public health infrastructure by 2005 (Agarwal and Chauhan, 2005). Financed primarily as a centrally funded (with assistance from external loans and grant aid) disease control program, the RNTCP also requires state initiative and inputs for its implementation. The program is implemented at the district level, which is the lowest level of administrative division in India. The program has been phased in over the last 14 years in states and districts across India; the timing of this implementation is important for many reasons.

The need for increased TB control in India is apparent, as evidenced by the fact that there are almost 2 million new cases of active TB each year in India alone (World Health Organization, 2005a). The potential economic benefits of implementing a well-functioning DOTS program in India have been estimated at $750 million (in 1993-1994 prices) annually (Dholakia and Almeida, 1996). The authors of this study compare estimates of the estimated economic benefits under different time tables and economic conditions and determine that accelerating the implementation of such a program can increase the economic returns by as much as 0.3% of the Indian GDP per year. Thus, it is important to analyze the timing of implementation of the RNTCP to determine which districts are able to accrue the economic and social benefits from earlier implementation.

Disease control programs such as the RNTCP are becoming increasingly important subjects of international aid decisions and government policy in developing nations. In the case of India, there is a large ill-regulated private health care system that provides much of the care for TB patients due to the perceived poor quality of the public health care sector. Increased public provision of this treatment at zero cost to patients could act as an important redistributive policy without suffering from the problems of corruption or moral hazard that plague many redistributive transfers. The provision of in-kind TB treatment avoids these problems because there is no incentive for those not infected with TB to seek the benefits of this treatment (Jack, 2001).

The principal goal of this thesis is to determine the effects of district and state characteristics on the allocation of the RNTCP to districts in India. My analysis will attempt to determine the impact of need, economic development, governance, political power, existing health care infrastructure, and other observable characteristics on the timing of implementation. There have been few, if any, studies of the allocation of a centrally funded disease control scheme; although other studies have addressed the role of these programs in the international aid context, none examine the determinants of the implementation of such a program. There is a growing body of literature focused on explaining the allocation of public education and health services. In this literature, there is a focus on explaining the inputs to these services, such as doctors and teachers, as well as the outcomes produced by the provision of and access to these services, such as increased treatment in public clinics. In this case, the RNTCP functions as an input to public health care services, augmenting existing physical and staff infrastructure.

Characteristics of the Indian governmental structure, historical norms of discrimination in the provision of public services, and recent diverging economic growth among the regions of India are important factors in my analysis of the RNTCP. India is a federalist nation where the obligation to provide public health and education services has been made primarily the responsibility of the state governments (Betancourt and Gleason, 2000); basically, the only exception is in the funding of centrally funded disease control programs. As demonstrated in the case of the RNTCP, even such a program requires significant financial and political support at the state level. I attempt to explain the implementation of the RNTCP in terms of allocation mechanisms attributable to state government decisions as well as local district characteristics. This governmental structure provides a framework for my analysis, which involves accounting for the variation in implementation both across states and among districts within states.

Using three different regression models, I examine the timing of the implementation of the RNTCP at both the district and state levels. These ordinary least squares (OLS) and maximum-likelihood ordered Probit models use observable economic, demographic, and political variables to explain the timing. I use economic growth as an explanatory variable in my analysis, although I am not able to determine the specific qualities of this variable that are driving the results. With the inclusion of this variable, I indirectly examine the goal of international aid organizations that attempt to promote human development (in this case, the reduction of disease) by sponsoring programs to encourage economic growth. I also examine whether there is evidence of discrimination against historically marginalized groups (i.e., Scheduled Castes, Scheduled Tribes, and Muslims) in the provision of public health services. I draw upon literature suggesting that better governance increases the socioeconomic conditions of Indian states (Basu, 2004), and attempt to determine the effects of various proxies for the effectiveness of state governance.

The plan of the thesis is the following: in the next chapter, I will provide necessary background on the Indian public health care system and the organizational structure of the RNTCP. In Chapter 3, I draw on different aspects of the literature on the economics of TB control and the political economy of allocation of public services to create a framework in which to interpret the implementation of the RNTCP. In Chapter 4, I describe the empirical methods that will be used to estimate my models of allocation mechanisms and discuss the details of the data set. In Chapter 5, I describe the results of these empirical investigations and examine their robustness. In Chapter 6, I conclude by offering a summary of and context for the results along with directions for further research.

CHAPTER 2: BACKGROUND

TB is a growing global threat to public health, particularly in developing countries. India is no exception, despite programs in place since the early 1900s. Since 1993, India has been implementing the RNTCP, which uses the DOTS strategy for TB diagnosis and treatment. This chapter provides extensive background on TB, the public health care system of India, and the specifics of the RNTCP and its implementation.

2.1: TB DISEASE AND TREATMENT

TB is caused by *Mycobacterium tuberculosis* and is spread through airborne droplets (Frieden et al., 2003). More than 80% of people with active TB have pulmonary TB (World Health Organization, 2005a), which can be infectious or noninfectious. There are two steps that are associated with the development of TB. The first is infection by *M. tuberculosis*, which usually occurs through close exposure to persons with infectious TB. This first step leads to latent TB infection, which is asymptomatic and noninfectious (Global Alliance for TB Drug Development, 2001). Nearly one-third of the world's population has latent infection by *M. tuberculosis* and could develop active TB at any time (World Health Organization, 2003).

Within months to years after the initial infection with the TB bacteria, approximately 10% of infected people develop active TB (Global Alliance for TB Drug Development, 2001). Untreated, a person with active TB disease will infect 10-15 people annually (World Health Organization, 2005b). Conditions that increase the likelihood of active infection include HIV, malnutrition, vitamin D or A deficiency, underlying malignant disease, or other medical conditions (Frieden et al., 2003).

The primary mechanism currently in place under WHO guidelines for the global control of TB is the worldwide implementation of functioning DOTS programs. DOTS, originally an acronym for "directly observed therapy, short-course," is now used to describe a broader WHO public health strategy for TB control (Onyebujoh et al., 2005). There are five aspects that comprise the DOTS strategy: "sustained political commitment; access to quality assured TB sputum microscopy; standardized short-course chemotherapy for all cases of TB under proper case management conditions, including direct observation of treatment; uninterrupted supply of quality-assured drugs; [and a] recording and reporting system enabling outcome assessment of all patients and assessment of overall programme performance" (World Health Organization, 2003). The DOTS strategy requires the use of sputum smear microscopy for the diagnosis of pulmonary TB (Global Alliance for TB Drug Development, 2001). Treatment programs are given under intermittent conditions (preferably three times per week) and must be directly observed by a health care provider or trained community member (World Health Organization, 2003).

The standard treatment regimen is for a duration of six months and costs as little as $11-$17 in developing nations (World Health Organization, 2005a). DOTS has been shown to be an extremely cost-effective treatment strategy; some studies claim that DOTS is the most cost-effective of all health interventions available. Others indicate that it costs as little as $1-$4 per discounted year of life saved (Ahlburg, 2000). In India, 'conservative' estimates show that the potential tangible benefits of DOTS implementation are on the order of US$750 million per year (Dholakia and Almeida, 1996).

2.2: Economic consequences of TB

The economic burden of TB is especially high due to the number of people infected and the fact that more than 75 percent of TB morbidity and mortality occurs in the most economically active segment of the population, those between 15 and 54 years of age (Ahlburg, 2000). Additionally, there is a vicious cycle between poverty and TB disease. The poor are more likely to contract TB due to crowded living conditions. The probability of infection as well as the probability of developing active TB from this infection is correlated with malnutrition, crowding, poor sanitation, and poor air circulation; these factors are all associated with poverty. Those who develop active TB are then more likely to fall into or remain in poverty due to the economic costs of the illness. There is inadequate diagnosis and treatment among the poor, which leads to more ill-health and death, which ultimately increases poverty. Although TB is not exclusively a disease of the poor, the poor are less likely to seek and receive quality care, and are two to three times more likely to self-medicate than higher income groups. This lack of adequate treatment aggravates the health and economic effects of the disease (Ahlburg, 2000).

2.3: Infectious disease in the public health care system of India

The health status of the population is particularly important in India, where many people earn their living through physical power. Disease and poor health can push people into extreme poverty, making it impossible for them to pull themselves out of this state (Bajpai and Goyal, 2004). Some studies indicate that a third of those who had to borrow or sell assets to meet health care costs fell below the poverty line, and these studies suggest that out of pocket medical costs may push as much as 2.2 percent of the population below the poverty line each year (Gupta, 2005). Much of India's disease burden is comprised of infant and maternal morbidity and mortality, infectious diseases, and nutritional deficiencies. Many of these problems could be severely reduced through the use of low cost interventions and prevention undertaken by the public health structure of the government (Bajpai and Goyal, 2004).

In India, there is a large public health care system, which consists of the provision of care through a network of sub-centers, primary health care centers (PHC), community health centers (CHC), family welfare centers (FWC), and district hospitals. Coverage by government health services varies widely across the states of India, although almost all states were still inadequate according to the specific guidelines set by the Indian government. In addition to the lack of physical infrastructure, there is a severe lack of qualified staff in the health centers. This is a problem particularly in rural areas, where staff recruitment is a serious problem (Bajpai and Goyal, 2004). This leads to health services being severely skewed towards urban areas (Seshadri, 2003). These shortages in the public health care system disproportionately affect the poor, who are the predominant users of primary health care services. The absence of adequate public services means that many people either entirely do without medical care or seek expensive and unregulated care in the private sector. Spending in the private sector accounts for almost eighty percent of expenditure on health (Bajpai and Goyal, 2004). Many of the problems with public health services are caused by inadequate funding by the central and state governments, whose expenditure on health (combined) accounts for three percent of government spending, or less than one percent of India's GDP (Mahal et al., 2002). Governments of other developing nations spend about three percent of their GDP on health, while governments of developed nations spend about five percent of their GDPs (Bajpai and Goyal, 2004). In India, government spending on health is a responsibility of the state and national governments.

2.4: Political structure of India in providing health services

The political structure of India is a federal system in which political authority is shared by national and state governments. The lowest (sub-state) administrative level is that of the district (Bajpai, 2003). The fundamental responsibility for the planning and delivery of public health care lies with state governments. The central government has a large role in the allocation of budget support for these services, however, and helps develop the shape and content of health policy at the state level (Bajpai and Goyal, 2004). The central government is responsible for developing and monitoring national standards and regulations, acting as a liaison between state governments and international and bilateral aid agencies, and sponsoring disease control programs, such as those for TB, malaria, and AIDS. The states are almost entirely financially responsible for hospitals, public health, and administration; they also have large financial responsibilities in the areas of insurance and family welfare. The states and central government share responsibility for medical education and capital investment. The only component the central government is entirely financially responsible for is primary care in the form of disease control programs, such as the RNTCP (Narayana, 2003). Decisions on these programs are theoretically undertaken by state and central governments together (Das Gupta et al., 2003).

Although these disease control programs are financed and administered entirely by the central government, government programs and health interventions are all implemented at the district level and rely on infrastructure from the state level. This leads to variation in outcomes and services not only at the state level, but at the district level as well (Bajpai, 2003). There is extreme variation between states in India in health and social outcomes, as can be seen in the cases of Kerala and Uttar Pradesh. These states have similar economic and poverty levels, but Kerala has a human development index (HDI) that is almost on par with that of developed nations, while Uttar Pradesh has an HDI similar to that of nations in sub-Saharan Africa. This is owing in large part to differences in political participation, competition, credibility, and information access (Keefer and Khemani, 2005).

2.5: A History of TB and TB Control in India

Although India has renewed its commitment to TB control with the RNTCP, the TB situation is still dire. There are an estimated 1.8 million new cases each year, giving India the dubious distinction as the global leader in new cases (World Health Organization, 2005a). As of 1999, TB causes more deaths each year in India than malaria, hepatitis, meningitis, nutritional deficiencies, sexually transmitted diseases, leprosy, and tropical diseases combined (Bajpai and Goyal, 2004). Estimates through various studies show that 40 percent of the Indian population has either latent or active TB infection. The annual risk of TB infection in India is between 1 and 2 percent (World Health Organization, 2000). The magnitude of the problem and the inadequacies of previous attempts at TB control are the inspirations for the development of the RNTCP (Bajpai and Goyal, 2004).

The history of TB control in India includes the creation of sanatoria for isolation (1906), a nationwide vaccination and testing campaign (1951), and the establishment of a national treatment program (NTP) (1961). Despite 30 years of the NTP being in place and major improvements in drug regimens, the epidemiological indicators of TB in India showed no signs of improvement. In fact, the emergence of the HIV/AIDS epidemic in the late 1980s and the increase in Multi-drug Resistant Tuberculosis (MDR-TB) threaten to exacerbate the problem further (Agarwal and Chauhan, 2005).

In 1992, an external review of the NTP was conducted; it indicated that only 30 percent of TB infections were diagnosed, and of these, only 30 percent were successfully treated (Agarwal and Chauhan, 2005). Reviews of the NTP identified causes of poor program performance including limitations of the general health services, poor infrastructural and governmental support, inadequate budgetary expenditure, and poorly functioning staff (Singh and Mittal, 2003). The poor review of the NTP occurred at the same time as a change in environment for international aid to developing nations; with increasing aid, there was also an increased focus on the control of infectious disease. The nature, scale, and concentration of donor aid to health changed markedly beginning in 1992 as World Bank programs began to provide lending assistance for HIV/AIDS, leprosy, cataract blindness, malaria, and TB (Singh and Mittal, 2003).

2.6: The Revised National Tuberculosis Control Programme

In 1993, the RNTCP was conceived both as a solution to many of the problems plaguing the NTP and to comply with the WHO-recommended DOTS strategy for TB control. It was pilot-tested in 1993 through funding by the Government of India and Swedish International Development Agency (SIDA) in a population of 2.35 million at five pilot sites in the states of Delhi, Gujarat, Kerala, Maharashtra, and West Bengal (Agarwal and Chauhan, 2005). Phase II pilot testing was conducted in 1994 in several states and city corporations. The success of these pilots led to the launch of the RNTCP in 1997, which was assisted by World Bank funding. Although there were significant financial and administrative obstacles to this program, causing huge delays in implementation, there was a push for expansion beginning in the year 2000 and total coverage[1] of the population by 2005. Researchers expected that this goal would be reached by the end of 2005 (Gupta, 2005).

The organization of the RNTCP is a hierarchical structure headed by the central government, with specifically designated roles at each level. The program is organized through the decreasing levels of the Central TB Division (CTD), the State TB Cells (STC), District TB Centres (DTC), and sub-district Tuberculosis Units (TU), which are the lowest reporting unit under the RNTCP. The program is vast, with many components at each of these levels (Agarwal and Chauhan, 2005). The CTD is responsible for the development of technical policies, drug procurement and funding, preparation of training materials, program and financial monitoring, quality control, advocacy, prioritization of operational research, and mobilization of funds to the appropriate levels (Agarwal and Chauhan, 2005). The CTD acts as a liaison on technical and financial matters to other agencies, including international and bilateral aid programs (Central TB Division, 2000). At the state level, the RNTCP is incorporated with the general healthcare delivery system. The STC is responsible for the monitoring and supervision of the RNTCP within the state. Many of the STCs receive technical support from one of 17 State TB Training and Demonstration Centres (STDC), although the level of involvement of the STDCs with the STCs varies widely across states (Agarwal and Chauhan, 2005).

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[1] Coverage at the national level is defined by the WHO as “the percentage of the national population living in areas where health services have adopted DOTS. ‘Areas’ are the lowest administrative or management units in the country” (World Health Organization, 2005a).

The DTC is the fundamental organizational unit which is responsible for the implementation of the RNTCP in the respective districts. The activities of the DTC are supported by the TUs. There is one TU established for every 500,000 people (or every 250,000 people in hilly/tribal districts) to serve as a link between the district level and the periphery clinics (Agarwal and Chauhan, 2005; Central TB Division, 2000). For further decentralization and access of diagnostic and treatment services, there is an RNTCP Microscopy Centre (MC) for every 100,000 people (or every 50,000 people in tribal/hilly areas) (Agarwal and Chauhan, 2005). For the supervision and administration of treatment, DOTS centers are designed to be easily accessible. Treatment observation can occur either in the PHC or CHC where the patient was diagnosed or at a location mutually convenient for the Peripheral Health Worker (PHW) or community volunteer in charge of the treatment (Central TB Division, 2000).

The central government, in conjunction with international and bilateral aid organizations, provides funding for implementation, policy direction and supervision, drugs, and microscopes (Agarwal and Chauhan, 2005; Gupta, 2005; Khatri and Frieden, 2002). These program funds are released from the central level to the state level to the district level through state and district TB control societies, which are formed upon the decision to implement the program in an area. These societies include private physicians, representatives from community organizations, and government officials. These state and district control societies are responsible for budget formulation; hiring of contractual staff; purchasing of necessary supplies; overseeing program planning, implementation, and monitoring; and various other functions crucial to program implementation (Agarwal and Chauhan, 2005). The responsibility of the hiring of general health staff as well as specialized staff of the DTCs, clinics, and hospitals falls to the state governments (Khatri and Frieden, 2002).

The central budget allocation for TB control increased from US$7 million in 1989 to US$22 million in 1999 (Singh and Mittal, 2003). The budget has continued to increase, reaching an expected budget of $46 million for 2005 (World Health Organization, 2005a).

2.7: RNTCP Implementation

After the decision is made to implement the RNTCP in a district, a TB control society is formed to plan for this implementation with assistance from the central and state governments. Before the district can begin service delivery, they must train, with assistance from the state, at least 80 percent of doctors and lab technicians and at least 50 percent of paraprofessional staff of public health services. The state must post a full time doctor as the District TB Control Officer, trained for 10-12 days at a central institution. The district society is responsible for hiring Senior Treatment Supervisors (STS) and Senior Tuberculosis Laboratory Supervisors (STLS) for each TU. Additionally, MCs and drug storage areas are brought to defined architectural standards. When the district meets the planning and treatment criteria, it is reviewed and approved for service delivery by a committee of central, state, and district government staff (Khatri and Frieden, 2002).

There is great variation among the states and districts of India in terms of health, social, and economic indicators. This has developed in India through sluggish and uneven social mobilization. Economic inequality among states and districts has arisen from variation in caste and social polarization, educational levels, distribution of natural resources, the role of governmental leadership, and the degree of corruption (Deogaonkar, 2004). There are significant discrepancies among the districts in their infrastructure and capacities for development. This variation makes the implementation of such a comprehensive program difficult (Seshadri, 2003).

The RNTCP is implemented through several different mechanisms. In the earliest stages of the project, the districts for implementation were chosen as a part of pilot programs. The scaling up of the project using funding from the World Bank had proposed coverage of 102 districts, primarily state capitals and some districts while planning to fully cover the states of West Bengal, Kerala, Gujarat, and Himachal Pradesh, representing different geographic regions of the country. Due to delays in implementation resulting from differences in timing of preparatory activities, the government was unable to fully implement the program as planned and had trouble distributing all of the money it had available under this grant. A plan for rapid expansion was then proposed in 2000, which involved allowing all selected areas to proceed with preparatory activities concurrently. The selection of states at this point became a "first-come, first-served policy". The proposal was to implement all districts within a state simultaneously to avoid problems with inter-district patient transfers (Gupta, 2005). When the RNTCP is implemented in a district, its population is considered 'covered' according to WHO guidelines.

Some of the implementation decisions were made by the central government in collaboration with external aid sources. The World Bank provided funding for the pilot programs, in conjunction with SIDA. In 2002, a grant was approved by the Global Fund to Fight AIDS, TB, and Malaria (GFATM) to cover the three new states of Jharkhand, Chattisgarh, and Uttaranchal, which were significantly lagging in coverage. In Round II, with approval in mid 2003 and signing in February 2004, the remaining uncovered areas of Uttar Pradesh and Bihar were proposed. Assistance from United States Agency for International Development (USAID) was used to cover the entire state of Haryana, with approval in early 2003. A project sponsored by the Danish International Development Agency (DANIDA) was in place to cover the 14 tribal districts of Orissa for the period 1997 to 2003; this program was extended to cover the entire state with a Phase II project (Gupta, 2005).

This background on TB and the development of the RNTCP in India provides a starting point for my analysis of the implementation of this program. A further review of the economic literature relating to the political economy of allocation of public services and the economic benefits of TB treatment is provided in the following chapter.

Chapter 3: Literature Review

My examination of the implementation of the RNTCP draws on the growing body of literature concerning the political economy of allocation of publicly provided goods, such as health and education, in developing countries. Much of this literature attempts to empirically determine the effects of political power, ethnic divisions, governance, and economic well-being on the provision of public services. My analysis also draws on literature discussing factors influencing the regional economic growth of India and the relationship between governance and socioeconomic indicators. The literature concerning the allocation of publicly provided goods is set in the context of the economic motivation for and benefits of increased TB control.

Jack (2004) discusses the rationale for public intervention in TB control, identifies specific sources of market failures, and evaluates the role of the government in using TB treatment as a redistributive policy instrument. His study on the benefits of public intervention in TB control supports examining the RNTCP as an important redistributive policy in India. The empirical analysis of RNTCP implementation is important in determining whether its redistributive effects are focused on those regions that most need the transfers. Jack analyzes the limitations of some approaches used to estimate the economic consequences of disease and the benefits of disease eradication. These limitations include the exclusion of intermediary choices of governments in improving TB control methods without total eradication of the disease and the paradox of why eradication has not been pursued by private individuals acting in their own self-interest. To explain the latter, he argues that credit market failures limit the ability of governments and individuals in poor countries to finance the expenses of disease eradication. Limits to the efficiency of private agents in the provision and use of treatment due to externalities help explain the contradiction between the efficient outcome and the reality. On the basis of these barriers to eradication, he proposes policy responses of international aid and policies to reduce the inefficiencies inherent to the markets for TB treatment (Jack, 2001).

The inefficiencies Jack addresses include the global public good nature of TB control, consumption externalities, and supply side failures. He claims that because of the nature of TB transmission and knowledge of the effectiveness of TB interventions, the socially desirable level of intervention on the global scale can be reached only through coordinated actions of all countries. He relies on economic models based on approximations of epidemiological data concerning length of treatment, cure rates, and treatment delay, as well as extensive study of literature concerning TB patient behavior. With these models, he demonstrates the externalities associated with diagnosis, completion of treatment, and drug resistance; these externalities occur because individuals do not consider the threat of infecting others when considering when to seek treatment and whether to complete the drug regimen. Jack shows that treatment delays occur because of the length of time it takes for personal benefits of treatment to exceed personal costs; the social benefits of this treatment exceed the personal costs at a much earlier point in the disease. He estimates that the marginal social benefits from the completion of treatment are higher than the marginal personal benefits. Using data based on others' empirical findings, he further estimates that completion of six months of treatment[2] could be achieved with a 65% government subsidy of the treatment costs. Due to the development of drug resistant strands of the TB bacteria, private decisions

[2] This is the length of the WHO-recommended course of drug treatment.

concerning the length of treatment will almost always be sub-optimal in achieving the socially beneficial course (Jack, 2001).

After analyzing demand side market failures, Jack examines supply-side failures of public intervention, estimating the efficiency gains that could occur through the provision of better "quality-adjusted treatment." The access to better diagnostic and treatment methods can be encouraged both through the direct provision[3] of high quality services by the government and through increasing competition between government services and private providers. This increased competition will serve the dual purpose of creating a supply of better quality treatment and decreasing the price of these services by reducing monopoly power of private practitioners. A public sector monopoly must also be avoided to ensure that consumers have choice so that they can get good quality services through competitive discipline. (Jack, 2001).

Jack argues that one must examine whether governmental intervention should focus on ensuring the equality of health outcomes or health inputs. He reasons that a broad view of equity and redistribution of resources from the rich to the poor can be implemented by transferring TB services for diagnosis and treatment. Since TB is heavily concentrated among the poor, public TB services could be used as a redistributive policy for increased equity. The transfer of TB services is a cost-effective way of raising the well-being of the poor without introducing problems of self-selection or the large distortionary effects that are sometimes associated with in-kind transfers. These problems are avoided because there is no incentive to claim the treatment if one does not suffer from TB. Although transferring resources to the public sector is sometimes costly

[3] Governments provide these services instead of merely funding them to ensure their quality and affordability.

through the distortionary effects of taxation policy, it is necessary in the case of TB to achieve better control of the disease. This increased control could ultimately serve as a method of poverty reduction (Jack, 2001).

Although Jack claims that the appropriate policy responses are independent of the total economic cost of the disease, these costs should not be discounted when considering the importance of pursuing such a response. In India, Dholakia and Almeida (1996) estimate that the present value of the entire future stream of direct tangible economic benefits of a functioning DOTS system is US$8.3 billion in 1993-1994, which is about 4% of Indian GDP.[4] These economic benefits are likely to be several times higher than the government spending on TB control necessary to implement such a DOTS program. This indicates that a well-functioning TB control program could lead to future economic growth.

Dholakia and Almeida consider the direct tangible effects of DOTS to include reduction in the prevalence of TB leading to increased productivity of workers by reducing absenteeism due to ill health, reduction of the number of TB deaths adding to the productive capacity of the Indian economy, and the release of hospital beds currently occupied by TB patients. Their analysis uses data on population, work force, GDP, labor productivity, deaths due to TB, the regional prevalence of TB, existing TB patients, and the difference in productivity between workers with TB and those without. Using these indicators, they estimate the benefits that are possible from improved TB control. They

[4] This figure is for the most conservative set of estimates involving implementation, discount rates, death rates, and growth of the TB patient population.

discount these future economic benefits of a functioning DOTS system to the 1993-1994 base year using different discount rates (Dholakia and Almeida, 1996).[5]

Dholakia and Almeida use these data sets to estimate the potential tangible economic benefits of DOTS implemented in five different time periods and speeds of implementation[6]: instantaneous full coverage[7], 5 years with 18% effective coverage every year, 10 years with 9% effective coverage every year, 15 years with 6% effective coverage every year, 10 years with effective coverage of 5%, 10%, 15%, 15%, 15%, 10%, 5%, 5%, 5%, and 5% respectively in successive years. Although it is dependent on the discount rate, the difference in the potential benefits in these different scenarios is significant; the difference between instantaneous implementation and 15 year linear coverage is as much as Rs. 19 billion per year at 1993-1994 prices, or 0.3 percent of the Indian GDP (Dholakia and Almeida, 1996).

This analysis of the economic benefits of implementing a functioning DOTS program shows the importance of analyzing RNTCP implementation. Based on Dholakia and Almeida's study, it is clear that districts which implement the RNTCP more quickly can accrue more economic gains during the additional years in which they are able to reduce the costs of TB through more widespread diagnosis and treatment. In addition, such districts may benefit from substantial decreases in TB morbidity and mortality. While it is clear that rapid implementation is beneficial to a district's population, it is less clear why particular districts were chosen for quick implementation while others faced substantial delays.

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[5] Dholakia and Almeida emphasize the importance of discount rates in making policy decisions.
[6] Full implementation is considered to be when 90% of a "covered" population gets effective DOTS services.
[7] Coverage is when a functioning DOTS system is implemented in an area.

Questions such as these have been addressed in the literature on the political economy of the allocation of public goods. Much of this literature concerns political mechanisms for the allocation of funding for public services. Authors examine many characteristics and failures of these mechanisms in explaining allocations of health and education services in developing countries. They also study the use of these funding allocations. Some find that funding is mishandled by corrupt politicians, while others show that when funding leads to increased service provision, there is increased access and use of these services.

Public expenditure is used to correct market failures that exacerbate poverty, although the misallocation of this public spending can cause further detriment to disadvantaged populations. Distortions in allocations caused by imperfections of the political process can have a particularly large impact on the broad public services in health and education that are most important to the poor. Through their examination of these distributions, Keefer and Khemani (2005) find that these distortions can occur through a number of political market failures. These failures include the lack of information about the performance of politicians, 'identity-based voting' caused by social fragmentation of the electorate along ethnic lines, and lack of credibility for political promises to voters (Keefer and Khemani, 2005).

The misallocation of resources is evident in developing countries, as the median-voter hypothesis[8] often fails. Despite the fact that the income distribution is skewed, the median voter in these nations is poor and would be expected to demand more public services. Governments in these nations are smaller and have less extensive social services than the hypothesis predicts. The problem lies in the fact that no matter the

[8] This hypothesis states that the policy preferred by the median voter will prevail.

preferences of the electorate, politicians often choose targeted spending on public infrastructure and government jobs over improvements in broad social services, from which the welfare gains would be much larger. This problem of 'pork-barrel' spending is exacerbated in developing nations; service delivery in these jobs is often severely lacking, with high rates of teacher and health worker absenteeism (Keefer and Khemani, 2005).

An examination of the political determinants of intergovernmental grants by Porto and Sanguinetti (2001) show that in Argentina, horizontal redistribution of tax revenue (i.e., intergovernmental grants) between provinces mandated by the central government is dependent on political representation per capita. The authors develop a partial equilibrium model based on the preferences of homogeneous individuals for public and private goods. In their model, they determine the budget constraints of these individuals and then determine the utility maximizing conditions. From these conditions, they find the maximum level of the social welfare of the province by transfers from the federal government. This simple model suggests that at the optimal level of federal transfers, the net gain to a province receiving the transfer will be equal to the social cost of the reduction in transfers to other provinces. The model also suggests that transfers to a given jurisdiction will increase relative to the national average if this jurisdiction is relatively poor. Under specific conditions, these transfers will also increase if the costs to the jurisdiction of producing public goods are relatively high. Porto and Sanguinetti then adjust the model to account for the effects of unequal political representation per capita; this model shows that an increase in the per capita representatives in a region relative to the country average implies a rise in the transfer to this region relative to others in the country (Porto and Sanguinetti, 2001).

Porto and Sanguinetti test this model with a regression where per capita central government transfers to a province is the dependent variable. Using regression, they model transfers per capita as a function of income level, population density (serving as a proxy to measure the per capita cost of providing local public goods), indicators of socioeconomic structures within jurisdictions, year effects, and representation per capita in the senate and lower chamber. They find that overrepresented provinces receive higher resources from the national government; this finding is aligned with results from similar studies in developed nations (Porto and Sanguinetti, 2001).

Drawing on Jack's theory of TB treatment as a type of redistributive policy, the implementation of the RNTCP can be considered a form of intergovernmental grant. Although many of the decisions for the RNTCP involve the distribution of external funds, which are not dependent on the taxation policies of individual states, they are still intergovernmental transfers from the central government. These funds could be considered to have been collected evenly across all states and then redistributed based on policy choices of the central government.

Official governmental allocation to funding of public goods is not necessarily an indicator of the effectiveness of these monetary transfers, as the ability of local governments to use the allocations of public expenditure given by central and state governments is influenced by political economic characteristics of the localities. Reinikka and Svensson (2004) show that for education spending in Uganda, the share of central government transfers to schools that actually reaches the schools (as opposed to being stolen by corrupt local politicians) is dependent on the bargaining power of the schools as indicated by the socioeconomic status of the users. This finding is particularly important because it implies the necessity of studying outcomes of public expenditure instead of the allocations themselves in determining the equity of government spending (Reinikka and Svensson, 2004).

The authors base their empirical results on data collected from a survey of 250 schools regarding the amount of funding they received as grants from the central government; they compare this information to data on official government expenditure. Using several econometric models controlling for fixed district effects, time effects, school effects, and several other related variables (e.g. student-teacher ratio), they found that the degree of local capture was dependent on the income level of the district. In higher income districts, more of the grants went to their intended educational uses. The implication is that, in contrast to the intended distribution, the actual distribution of these education grant transfers was regressive. Reinikka and Svensson repeat their analysis with different data sets on similar education programs in other countries in sub-Saharan Africa, and find similar results in the degree of local capture and the percentage of funding that reaches the school level (Reinikka and Svensson, 2004).

This study has two implications for my analysis of RNTCP implementation. First, while it would be desirable to study the outcomes of the RNTCP post-implementation, the indicators of the performance of the RNTCP (e.g. detection rate and treatment success rate) must be regarded cautiously as they are endogenous to the implementation of the program. Intuitively, reporting mechanisms are more likely to be deficient in districts which are not implementing the program very effectively. Studying the allocation of the RNTCP is similar to studying the capture of grants from the central government, as the implementation for the program was done by a method where (theoretically) all states had equal access to the funds available from the central government. Consequently, the effectiveness of state and district governments in transferring the promise of these funds and supplies to the actual implementation of the RNTCP within the districts of the state is the subject of the empirical analysis described in Chapter 4.

The second implication is that the RNTCP should not be subject to the same problems of corruption that plague the education grants in Africa because of Jack's (2004) argument that TB treatment can act as an instrument of redistribution minimizing both the distortionary effects of taxation and the moral hazard problem of monetary grants. The latter problem may be avoided in the RNTCP by requiring state inputs to the program and by providing mostly in-kind assistance in the form of technical assistance, drugs, microscopes, and computers for monitoring outcomes. The requirement of state inputs to the program, however, is a limitation to the equal implementation of the RNTCP and further underscores the importance of understanding its allocation mechanism.

Betancourt and Gleason (2000) aim to explain the allocation of public services to rural areas in India. They choose to measure inputs to these services, such as doctors, nurses, and teachers, as an indicator of the political decisions made for the provision of public services. Ideally, they would measure the inputs to public services in terms of "efficiency units, i.e., corrected for the efficiency with which they are provided," but there is no such data available. Instead of measuring substitutes for a corrected measure of provision such as child mortality or literacy rates, they choose to measure inputs to public health services. The substitute outcomes reflect the "availability, efficiency and intervening household decisions," whereas the inputs are clearly the results of agents within the political arena. Using district level data for rural districts in India, mostly from the 1981 time period, they examine the effects of unobservable state political mechanisms and observable district socioeconomic and political characteristics on the availability of these inputs (Betancourt and Gleason, 2000).

Betancourt and Gleason find that for doctors and nurses, formal and informal allocation mechanisms that are common to all districts within a state are highly significant and account for much of the variation in the health care inputs. Other results of their analysis for health care inputs are that there is statistically significant discrimination on the basis of caste and religion and that there are biases in allocations due to other demographic characteristics. There is statistically and systematically robust evidence of discrimination against Scheduled Castes and Muslims who live in the rural areas of districts across all of their estimations. They find that rural districts bigger in area per person receive greater allocations, although at a diminishing rate. They also find an urban bias towards the greater provision of services to rural areas of more urbanized districts in relation to rural areas of less urbanized districts (Betancourt and Gleason, 2000).

The political indicators Betancourt and Gleason use show weakly significant results across their models, and the results suggest that states may not be able to adequately respond to local political participation calling for greater provision of health inputs. A higher female-to-male voting ratio appears to increase the allocation of doctors, although it has little impact on the allocation of nurses. This is consistent with the idea that Indian women demand greater public services, a finding consistent with other studies in developing nations. The final political indicator, the numbers of constituencies per district (based on the non-overlap of these electoral and administrative divisions) seem to produce an urban bias to the political mechanism (Betancourt and Gleason, 2000).

Mobarak, et al. (2004) use county-level electoral data in Brazil to determine the impacts of local politics and government structure on the allocation of publicly subsidized health care services. The results of their empirical analysis, which uses a two party voting model, show that the provision of health service inputs (i.e., doctors, nurses, and clinics) rises with increases in the proportion of the uninsured and poor in the population, the political participation rate of the poor, and the proportion who vote leftist. They find that there is greater availability of these health services in counties where the county mayor and state governor are of the same party and where the elected mayor is very popular,[9] due to the fact that these factors increase government transfers to the county. These results, although based on a limited sample, show that political alliance may lead state governments to make larger grants to particular counties. Using the winner's share of the vote in local elections, an increase in a mayor's popularity increases health care inputs; this is likely due to the greater political capital these leaders have to expend in their negotiations with state legislators over fund transfers (Mobarak et al., 2004).

Using a data set on the use of health care services by the uninsured in the population, the authors test the correlation between the use of public health services and the supply of public health service inputs that they analyzed in the first part of their study. They find that an increase in doctors and clinic consultation rooms in the public sector increases the probability of receiving health care at a statistically significant level. Also in this analysis, they observe that decentralization of health service delivery actually

[9] Popularity is defined as the winner's share vote in local elections.

reduces the receipt of health care unless this decentralization is accompanied by a good governing capacity of the local government, as evidenced by the presence of a governance plan (Mobarak et al., 2004).[10]

The results of this empirical study in Brazil are important for my analysis of the RNTCP because they indicate that variables indicating the political bargaining power of local administrative divisions are important in determining the inputs from the federal level. This particular study was looking at the Brazilian governmental structure of decentralized funding for health services; this structural difference could have an impact on the outcomes. However, Mobarak, et al.'s study gives insight into the importance of good governance in determining the provision of health services at a local level. The second part of their analysis, showing that increasing the level of inputs to the health care system will increase the probability of the poor of receiving health care, is particularly important to the RNTCP. This shows that if inputs to the health care system increase, in this case as a well-functioning DOTS program, there is evidence to suggest that the use of these services will also increase.

Mobarak, et al showed no evidence of crowding out of private treatment among the poor (Mobarak et al., 2004), which is particularly applicable in India, where the private sector constitutes 80% of health expenditure. This relates to Jack's claim that it is important to use public provision of high quality, low cost TB treatment to supplement private supply to correct consumption externalities (Jack, 2001). The avoidance of crowding out is particularly important in India where increased competition from this improved public sector campaign may encourage the use of better diagnostic and

[10] These results are robust to several different indicators of governance, including whether the county has a strategic plan and whether it has a health policy council.

treatment techniques in the large private sector of India as well. Evidence that there is increased use of health services with increased inputs suggests the importance of the allocation mechanisms for the RNTCP in relation to Dholakia and Almeida's claims of economic growth from a DOTS program in India (Dholakia and Almeida, 1996). If Mobarak, et al. had shown that there was no increased use of the services with increased provision, it might have implied that implementing the RNTCP would not ultimately create the economic gains Dholakia and Almedia show are possible. Thus, knowing the allocation of the RNTCP may demonstrate which regions stand to benefit for longer time periods from the gains associated with better TB control.

From the results of Mobarak, et al. (2004), it is apparent that good governance is an important factor in determining levels of public services. In addition, good governance is likely to determine overall economic performance of a state. Basu (2004) examines the relationship between governance and economic growth and well-being for Indian states. In this empirical analysis, he attempts to explain the differential development performances of Indian states during the period from 1980-2001 using a composite indicator of the quality of state governance. To do this, he constructs a quality of governance index (QGOI)[11] including such variables as rule of law, government functioning, public services, and press freedom, as well as an economic well-being index including socio-economic variables such as education, infrastructure, technological progress, and income. Drawing on literature that states that economic growth alone may not be an appropriate yardstick to development, Basu constructs this economic well-being index to bring together five different socio-economic dimensions, in which he includes

[11] The indicators included in this variable, along with the multivariate statistical measures used to construct it, will be discussed in further detail in Chapter 4.

15 separate indicators. The five dimensions are health, knowledge, income, technological progress, and infrastructure. These dimensions are seen as essential elements of growth and development and the index attempts to be a "comprehensive composite measurement to capture the quality of life of the people" (Basu, 2004).

Basu empirically determines that this economic well-being is dependent on the quality of governance within a state using the QGOI he develops. Using panel regression over four time periods with the economic well-being index as the dependent variable, Basu finds a positive and statistically significant coefficient on quality of governance, even when controlling for population, urbanization, fiscal decentralization, agricultural productivity, and time effects. His results show a systematic and robust positive dependence of economic well being on urbanization and agricultural productivity. The results also indicate that larger populations are statistically significant in decreasing the economic well being index; he suggests that this may be because larger populations make it more difficult for states to effectively implement policies and administer public works (Basu, 2004).

The results of Basu's analyses are important for studying the allocation of the RNTCP because they show the importance of the quality of governance in creating this overall sense of 'economic well-being,' which includes better health outcomes. I will test empirically whether the quality of governance of Indian states affects the speed of the implementation of the RNTCP. This governance index may be an indicator of a state's political commitment to the implementation of the RNTCP and other public health services and campaigns.

Sachs, et al. (2002) attempt to explain regional economic growth among Indian states in the 1980-1998 period, and in the sub periods before and after economic reform (i.e., 1980-1990 and 1992-1998). They find empirical evidence of divergence among states for these periods, although they concede that there may be some convergence of the states in the Northeastern region with the rest of the country. Sachs, et al. find that this divergence is greater in the 1992-1998 period than in the other periods they examine. To explain this divergence, they look to influences on the marginal productivity of investments in various sub sectors of the economy. The authors examine poverty ratios, agricultural productivity growth and export, the manufacturing sector and its entrance into the global economy, tourism, the influence of port cities, high-tech services, and foreign investment. Through their analyses of these sub-sectors, they find that urbanization is a key determinant of economic growth in the 1980s and 1990s. The degree of urbanization is dependent on underlying geographical factors and is positively related to the presence of a major port and having a dry steppe climate suitable for the production of wheat. During the period 1991-1998, they use cross state regressions to show that urbanization accounts for 71 percent of the variation in economic growth. Their results support other literature suggesting that the benefits of economic growth accrue to a greater degree in urban areas, enlarging the urban-rural divide (Sachs et al., 2002).

The implementation of the RNTCP relies on this analysis of the economic performance of Indian states in relating the benefits of economic growth to human development. The divergence evidenced among the Indian states in terms of per capita Gross State Domestic Product may also be evident in their provision of public services, if public services are dependent on the economic performance of the state. This may occur because increased tax revenue collected during periods of growth may be redistributed to the poor by means of the provision of better health services.

This literature concerning the political economy of allocation creates a context for my analysis of the RNTCP. It provides a framework for the inclusion of proxies for political mechanisms, demographic variables, and economic growth. These proxies and methods for my analysis will be discussed at length in the following chapter.

CHAPTER 4: ANALYTICAL METHODS

My analysis of the implementation of the RTNCP examines the political economy of allocation including the intersecting influences of central health policy, state sector health care, and external funding sources. The literature concerning the political economy of allocation of public services and factors affecting economic and social growth has identified several factors that may be influential in my analysis of the RNTCP. These include ethnic heterogeneity, urbanization, states' mechanisms for allocating resources to districts, indicators of the quality of governance and political bias, and the growth trajectories of administrative regions. My analysis of the timing of the implementation of the RNTCP as a function of district and state characteristics will provide insight into the nature of the collaboration of these forces in a centrally administered disease control program.

4.1: REGRESSION MODELS

To analyze the timing of RNTCP implementation, I construct three basic sets of econometric models: OLS models at the district level (with and without dummies for state effects), OLS models to explain the coefficients of the state dummy variables, and maximum-likelihood ordered Probit models.

The OLS model to explain timing of implementation at the district level is of the basic form:

$$y_i = \beta_0 + \beta_1 * political\ effectiveness_i + \beta_2 * need\ for\ RNTCP_i + \beta_3 * health\ infrastructure_i + \alpha_s + \varepsilon_i \quad (1)$$

where y_i indicates the year of RNTCP implementation in a district *i*, and political effectiveness, need for RNTCP, and health infrastructure are examined using a variety of district level proxies. Dummies are included in the model to control for state effects, indicated by α_s. Heteroskedasticity across districts is expected, so I use robust estimates for the standard errors throughout all my OLS estimations, i.e., the Huber/White/sandwich estimator of variance is used in place of the traditional calculation.

The equation for the OLS models at the state level is of the form:

$$\hat{\alpha}_s = \gamma_0 + \gamma_1 * political\ effectiveness_s + \gamma_2 * need\ for\ RNTCP_s + \varepsilon_s \qquad (2)$$

The dependent variable, $\hat{\alpha}_s$, is the estimated coefficient of the state dummy variable for each state created in Table 3, Column 1 (according to the model in Equation (1)). The proxies for political effectiveness and need for the RNTCP included in equation (2) are variables for which I only have variation at the state level. Since some aspects of political effectiveness and need for the RNTCP have already been included in the district level model, this model (as indicated by Equation (2)) is attempting to explain portions of the allocation mechanisms of the RNTCP that occur at the state level. Again, heteroskedasticity is expected across states, therefore robust estimates of standard errors are used. I use this method of separating the district and state level variables because once I include state dummies, I am confident I have accounted for all state-level variables that do not change over time. This is important to do because other authors describe 'unobservable allocation mechanisms at the state level.'

I also estimated an OLS model on the district level data where state dummies were omitted, and variables that only vary at the state level were included directly. It is of the form:

$$y_i = \delta_0 + \delta_1 * political\ effectiveness_i + \delta_2 * need\ for\ RNTCP_i + \delta_3 * health\ infrastructure_i + \varepsilon_I \qquad (3)$$

where y_i is the year of implementation in a district i, and the proxies for political effectiveness, need for the RNTCP, and health infrastructure are at either the district or state level. Unlike equation (1), the coefficients on the district level variables in equation (3) will not be consistently estimated if there are omitted time-invariant state-level influences on implementation that are correlated with the district level variables. If we do not have any omitted state level variables, this model should yield similar results as the two-step approach described above. In equation (3), ε_i is assumed to be correlated for all districts within a state; therefore, the errors are clustered by the 2001 state. This statistical correction assumes that the errors are independent across states, but are not necessarily independent within each state.[12]

Despite its ease of use and interpretation, the OLS may not be the most appropriate method to use because it treats implementation in one year relative to another the same, regardless of what those years are. This is particularly problematic for the first and last years of my sample, since $y^* = 2000$ indicates implementation in 2000 or earlier and $y^* = 2006$ indicates 3rd quarter 2005 or later. To account for these problems, I construct a maximum-likelihood ordered Probit model for comparison.[13] Since the ordered Probit model uses categories for the dependent variable instead of linear values, this model corrects somewhat for these limitations. The maximum-likelihood ordered Probit model used at the district level has the same general form as equation (3), although the dependent variable is now of the form

$$
\begin{aligned}
y &= 0 \text{ if } y^* \leq 0 \\
&= 1 \text{ if } 0 < y^* \leq \mu_1 \\
&= 2 \text{ if } \mu_1 < y^* \leq \mu_2 \\
&\;\;. \\
&\;\;. \\
&= J \text{ if } \mu_{J-1} \leq y^*
\end{aligned}
$$

[12] These statistical estimation methods are also true for the OLS regressions containing district and state level parameters in the robustness checks presented in Table 9.

[13] Both models suffer limitations; they are compared to ensure that there are no significant differences between the two.

where the μ's are unknown cut points in the distribution to be estimated with β. The error, ε_i, is assumed to be independent and identically distributed (iid) across observations, and the mean and variance of ε_i are normalized to 0 and 1, respectively. Although this assumption can be modified by clustering the errors by state, the assumption of iid errors is still necessary for the estimation of the coefficients.[14] To interpret this model, the marginal effects must be calculated. These marginal effects indicate the effect of a change in the specified explanatory variable on the probability of being in each category; these marginal changes are calculated holding all other variables constant at their means.

4.2: Model specifications and hypotheses

The rationale for the inclusion of a variety of proxies for political effectiveness and the need for the RNTCP are theorized from the literature review in the previous chapter. Some variables may serve as proxies for both of these general indicators, as will be explained more specifically for these variables. The hypotheses for the inclusion of these variables in my models are explained in the context of the previous literature.

Demographic variables indicating the presence of historically marginalized groups are included as indicators of political effectiveness. If Betancourt and Gleason's results suggesting discrimination against Scheduled Castes and Muslim populations carry over to a centrally funded disease program, the effect of these variables on the implementation of the RNTCP will be positive.[15] The income level of states is included

[14] This assumption is often violated in a practical sense, but it simplifies the underlying mathematics of the statistical model.

[15] Positive effects indicate that it took longer in these places for the RNTCP to be implemented because the dependent variable (i.e., year of RNTCP implementation in the district) is larger with longer delays.

as a proxy for political effectiveness.[16] Although it is often suspected that wealthier states will have better development outcomes, there are cases in India of low-income states that have exceptional social outcomes. It is still expected, however, that wealthier states will have more money to implement the program and will thus do it more rapidly. The state income level is measured using the Net State Domestic Product.

The information concerning State Domestic Product (SDP) per capita growth is included as another proxy for political effectiveness based on the idea that states that are on a trajectory to growth may have both increasing resources and better incentives to fund investments in public services. Sachs et al. find that states in India are growing at significantly different rates, but they do not find that development indicators such as health outcomes play a large role in explaining this variation in economic growth. They provide no insight into whether greater economic growth will translate into better health and social outcomes (Sachs et al., 2002). The optimistic view of the relationship between economic growth and development outcomes would find that higher growth rates of states are transferred into better provision of social services for the poor, in this case, faster implementation of the RNTCP. A negative coefficient to this variable might indicate that economic growth does cause 'development' in a broader sense.

The Quality of Governance Index is a clear indicator for political effectiveness. Basu shows that good governance has a positive effect on the economic well-being index, which includes health and development outcomes (Basu, 2004). It is therefore expected that better governance will cause better provision of health care services, indicated in this case by earlier implementation of the RNTCP. Since the responsiveness of the political

[16] Although TB is more prevalent among the poor, indicating that wealthier states might need the program less, I do not account for this in this hypothesis as I will be simultaneously controlling for TB prevalence rates.

system for health care expenditure (in which funding for the necessary RNTCP state inputs would be included) may be dependent on representation in the legislature, I use another variable indicating political effectiveness as measured by the representation per 100,000 people in the Lok Sabha ("House of the People") to indicate this effect. If greater per capita representation is likely to draw more funding from the central government for health expenditure (as suggested by Mobarak, et al.), then we would expect the coefficient of this variable to be negative.

Total population is examined as an explanatory variable for both political effectiveness and need for the RNTCP. The use as an indicator of political effectiveness is based on Basu's finding that larger populations cause problems in policy implementation and public work administration. These results would indicate that more populous districts would have greater delays in program implementation. Population is also a proxy for need, however, as the method for RNTCP expansion suggests that it was the goal of the central government to cover the maximum population in the shortest period of time. Although the sign of the expected coefficient is ambiguous, population is expected to have a significant effect.

Greater urbanization of a district is expected to cause earlier implementation of the RNTCP. This hypothesis draws on the theory of the urban-rural divide in which there is higher governmental expenditure in urban areas than rural ones (Sachs et al., 2002). Betancourt and Gleason's results support this hypothesis, as their results show an urban bias even for rural parts of districts. They theorize two reasons for this urban bias: the relative ease of implementation of public health services in urban areas and political mechanisms that favor more urbanized districts. TB prevalence rates are also higher in urban areas, indicating a greater need for the RNTCP, and therefore, earlier implementation.

Since the RNTCP is designed to be implemented through the augmentation of existing health infrastructure with additional staff, training, and consumable inputs, it suggests that districts with more extensive physical infrastructure will have fewer barriers to entry, and will thus claim the program more quickly. The other side of this, however, is that the previous NTP may be somewhat adequate for TB control in districts with extensive health infrastructure, meaning they would have less incentive to implement the RNTCP. This would imply that greater health infrastructure would lead to a decrease in the delay in implementation. Based on the perceived inadequacy of the previous program, however, this is unlikely to be the case, and the effects of these infrastructure variables as measures of both political effectiveness and need are expected to be negative.

The only clear indicator I am able to use for need for the RNTCP is self reported data on TB prevalence in 1992 (before the RNTCP was implemented anywhere).[17] Although not as reliable as specific TB morbidity data, this survey data allows me to control for regional variations in TB prevalence. If the RNTCP was implemented in a way that accounted for the need for TB treatment based on regional differences in infection rates, then higher 1992 prevalence of TB would be associated with earlier implementation.

There are several other proxies used at points in my analysis. They include HDI, public expenditure on health, and literacy rates, all as alternate proxies for political effectiveness in providing public health services. HDI is a composite indicator of the three dimensions of human development: economic, educational, and health. It is

[17] See data section for further details.

expected that the coefficient on HDI will be negative, as higher levels of human development are expected to be correlated with better provision of disease control services. Public expenditure on health as a proportion of SDP is incorporated into the indicator for the quality of governance. It is intuitively the part of the governance indicator that is having the most direct effect on the implementation of the RNTCP. When incorporated into the implementation models, the coefficient of this variable is expected to be negative. Literacy rates are used as a district level indicator of development and access to public services (as indicated by access to education). The use of literacy rates as an indicator of availability of public services is limited by their being the joint outcome of availability of education, efficiency of education provision, and individual decisions in seeking education (Betancourt and Gleason, 2000). It is expected that the coefficient on this will be negative.

Additionally, in some of the regressions,[18] I am able to examine the political power of the Union territories, which are administered by the central government. I introduce a dummy to control for this difference in their political nature from that of the states. Since the central government is responsible for both the Union territories and the RNTCP, I expect the coefficient on this dummy to be negative.

These hypotheses will be tested using the models described in the previous section to examine RNTCP implementation at both the district and state levels. The results of these estimations are presented in Chapter 5.

4.3: Data

My empirical investigation uses data on district and state characteristics from a variety of sources. Table 2 presents summary statistics for these variables. Information

[18] These models are estimated in Chapter 5, Section 2 on the robustness of the results.

on the year of implementation of the RNTCP in each district is obtained from the 2001-2005 *RNTCP Status Reports* and the 2005 *RNTCP Performance Report, 2nd Quarter 2005*. If the RNTCP was implemented in any part of a district for that year, it is assumed that the RNTCP was fully implemented in that district. It should be noted that these data are only available for districts where the program was implemented between 2000 and 2005. Coding of the variable for the year of implementation with the year 2000 indicates that the RNTCP was in place in the district by the end of 2000; I am unable to make a distinction between those districts that were implemented in the 1994 and 1997 pilot studies and those that were implemented in the year 2000. The variable for implementation in each year takes a value of 1 indicating implementation, while 0 indicates the program is not yet in place in the district. The means for RNTCP implementation by year show the proportion of districts with the program, which varies from 0.27 in the year 2000 to 0.90 by the year 2005.

The explanatory variables include demographic, economic, infrastructure, development, health, and governance indicators. The demographic variables obtained from the 2001 Census of India at the district level include the total population, urbanization, literacy rate, proportion of Scheduled Castes, and proportion of Scheduled Tribes. The mean of population in each district is 2,070,000. Data on the proportion of Muslims were obtained from the 1991 Census and reported in Bose's *Population Profile of Religion in India* (Bose, 1997).[19] Information on the public health care infrastructure in each district including the number of PHCs per 100,000 rural population, the number of subcentres per 100,000 population, and the number of FWCs per 100,000 urban

[19] Data for the proportion of Muslims were not available for the state of Jammu and Kashmir for 1991; data from the 1981 census were used in its place.

population is obtained from the secondary data reports contained in the *Human Development Report* of each region in India.[20]

Estimates of the Human Development Index (HDI) for each state are reported for 1991 in the *National Human Development Report 2001*. The economic, educational, and health dimensions of the HDI are measured by per capita monthly expenditure adjusted for inequality; a combination of literacy rate and intensity of formal education; and a combination of life expectancy at age 1 and infant mortality rate, respectively. Estimates of TB prevalence are obtained at the state level from self reported data in the National Family Health Survey-II (1992-1993). This prevalence information is determined through survey results to the question "Does anyone in your household have tuberculosis?" The mean prevalence of TB is 0.53 percent of the population.

The economic level of each state is determined using the per capita Net State Domestic Product (NSDP) in 1000s of rupees at 1993-1994 constant prices for the year 1997. The growth of per capita NSDP over the period 1993-1997 was calculated by finding the total percentage change between the 1997 NSDP and the 1993 NSDP[21]. The source of this NSDP data is the Government of India Ministry of Statistics and Programme Implementation.

The quality of state governance is measured by a Quality of Governance Index (QGOI) calculated by Basu for the period 1992-1996. This variable is calculated using a latent variable model where the QGOI is assumed to be linearly dependent on a set of

[20] The original data for these reports was obtained from various state Directorates of Health and Family Welfare, Bureaus of Health Intelligence and Vital Statistics, and similar state governmental organizations. See National Council of Applied Economic Research (2001, 2002, 2003, 2004) for specifics. This data was not available for all states, and was not given for any of the Union territories, including Delhi.

[21] To eliminate any problem of reverse causality of the timing of the implementation of the RNTCP on economic growth implied by Dholakia and Almedia's argument, I use data from a period prior to the expansion of the RNTCP. Additionally, this problem is eliminated in part due to the relatively small effects expected of TB reduction on SDP.

observable indicators plus a disturbance term to capture error. The QGOI is estimated as a weighted average of the principal components, which include 13 indicators of rule of law (measured by crime rates, riots, and police personnel), public service (measured by educational expenditure, health expenditure, and infrastructure expenditure), government functioning (measured by debt burdens of the government), worker's and people's participation (measured by trade union density and voting turnover), social participation (measured by women in the work force and women representation in parliament), and press freedom (measured by circulation of daily newspapers). The results of this principal component analysis are then normalized to be in the 0 to 1 interval for each state for each time period. This QGOI is available for 16 major states of India, which cover more than 90 percent of India's total population in the 2001 Census of India. The average QGOI for the 15 states in the selected sample is 0.25.

State level data concerning public spending on health as a proportion of Gross State Domestic Product (GSDP) are obtained from the *National Human Development Report 2001*. Political representation in the Lok Sabha is determined using state level data on the number of representatives per 100,000 population. This indicator is compiled using information from the Parliament of India on the number of seats per state and Union territory for the 2004 elections and population data from the 2001 census.

Although there are 28 states and 7 Union territories, containing 593 districts in the 2001 Census of India, I use a subset of 15 states and the 426 districts contained within for my analysis. These are the districts for which all data is available, thus the sample size is standard throughout all the models presented. This subset covers 89 percent of the Indian population in the 2001 Census, making it an adequate data set for analysis. I then test my results for robustness to the entire sample set. These results can be seen in Chapter 5, Section 2.

Chapter 5: Results

Figure 2 shows a graph of the average year of implementation of the RNTCP in each state[22] versus their HDI values.[23] This chart is intended to give a picture of how the states relate to one another in terms of development and implementation; Union territories are indicated by an asterisk to note any systematic differences between these territories and the states of India, either in terms of their human development levels or in the speed of RNTCP implementation.[24]

5.1: Model estimations

Using the OLS regression based on equation (1) on the subset of districts which have data for all variables, Table 3 reports equations for the year of RNTCP implementation in a district as a function of district characteristics. To analyze district effects without the influences of state level characteristics and allocation mechanisms, I construct a model using state dummies (Table 3, Column 1). In this model, I include district level measurements of population, urbanization, historically marginalized groups (i.e., proportion Scheduled Caste, Scheduled Tribe, and Muslim), and public health infrastructure (indicated by FWCs, PHCs, and subcentres per 100,000 urban or rural population, respectively) as explanatory variables in addition to the state dummies.[25] Other socioeconomic and political variables must be omitted because they are only available at the state level.

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[22] This is calculated using the coefficient from the state dummy variables with reference to the omitted state of Kerala.
[23] The HDI for these purposes is assumed to be a rough indicator of the level of development and social services in each state.
[24] Since these Union territories are dropped from further analyses, I am not able to rigorously test for differences in their allocation of political mechanisms from those of states. This will be discussed further in the robustness section.
[25] The values for these dummies have been omitted in the interest of space; however, all are statistically significant from the omitted category of the state of Kerala at the 1% level with the exception of the dummies for the states of Himachal Pradesh and Rajasthan.

In this district level analysis, I find that total population, proportion of population in urban areas, and subcentres per 100,000 rural population are significant at the 1 percent, 1 percent, and 5 percent levels, respectively. The significant negative coefficient on total population suggests that although public services may be harder to implement in larger administrative divisions, this was outweighed by an effort to cover more populous districts more quickly to cover the maximum population in the shortest time period. A one standard deviation increase in population accelerates implementation in the district by 0.30 years. This model also shows that urbanization has a statistically significant accelerating effect. It indicates that there is an urban bias to the implementation of the program, further reinforcing the idea of an urban-rural divide in the provision of public services. Although the magnitude of this coefficient is small, an increase from the bottom 10% of districts in terms of urbanization (i.e., primarily rural districts) to the top 10% would mean implementing the RNTCP 0.96 years sooner in that district.

The positive significant coefficient on subcentres per 100,000 rural population is somewhat surprising. Although the effect in small, in that a one standard deviation increase in the number of subcentres per 100,000 population in a district would delay the RNTCP by 0.21 years, it was hypothesized that the program would be implemented more rapidly in districts with better existing infrastructure. This finding may suggest that the previous NTP was adequate enough in rural areas with more infrastructure, meaning that they would have fewer incentives to claim the RNTCP. It is more likely, however, that the subcentre variable is acting as a proxy for other variables which may make implementation more difficult. For instance, the Indian guidelines for public health infrastructure indicate that there should be one subcentre per 5,000 population in rural areas; this ratio should be increased to one subcentre per 3,000 population in hilly or tribal districts. Since the regression already controls for the presence of Scheduled Tribes in the population, it is possible that subcentres are serving as a proxy for hilly geography, which may make the program more difficult to implement. This district-level model with dummies for state effects accounts for 61 percent of the variation in the timing of implementation.

To determine the amount of variation explained at the state level after accounting for district characteristics, a new dependent variable is created that is the estimated coefficient of the state dummy variables from this district model (Table 3, Column 1) as described by Equation (2). The explanatory variables in the OLS regression that explains the majority of the variation in the implementation[26] by state are the quality of governance index, the SDP per capita for 1997, the growth of SDP per capita from 1993 to 1997, the TB prevalence, and the number of electoral constituencies per 100,000 population (Table 4, Column 2). Of these variables, SDP per capita growth (1993-1997) and number of electoral constituencies per 100,000 population are statistically significant.

This model indicates that the growth of SDP per capita is significant at the 1 percent level. The coefficient on SDP per capita growth shows that an increase of one standard deviation leads to RNTCP implementation 1.07 years earlier. There are several lines of reasoning for this effect of SDP per capita growth on the timing of implementation. The first argues that there is something inherently better about districts in states with rapid economic growth that make them both faster growing and more willing and ready to implement the RNTCP in a timely fashion; i.e., that the coefficient on this variable is picking up the effects of some unknown omitted variable. The second

[26] The R^2 for this model is 0.78.

is that economic growth is allowing states increasing resources to devote to the management of public services. The extension of this argument says that if the RNTCP is representative of broader public health care services, then economic growth will lead to human development. This is the ideal of policies designed to promote development in countries by raising their economic growth rates. The third rationale for this effect of SDP per capita growth on the timing of RNTCP implementation is that these states are better governed, which is raising the rates of economic growth; this higher growth is correlated with improvements of the provision of better public health services. It is interesting that the level of SDP per capita at the end of this time period (i.e., 1997) has very little effect on RNTCP implementation. The coefficient on this variable is not statistically significant in any of the state-level models.

The optimistic view of the implications of this finding regarding the growth of SDP per capita is that economic growth can transfer to better provision of public services, which may lead to further growth. The pessimistic viewpoint states that this fact may cause further divergence among the states. If Sachs, et al. and Dholakia and Almeida are all correct in their findings,[27] then the districts of India will exhibit greater divergence in both economic growth and TB control. This is because divergence due to variation in the economic growth rates leads to delays in implementation of TB control in the poorer states. This leads to the loss of the economic gains possible through the implementation of a DOTS program, which pushes these states even further behind economically. Although this may be an exaggeration of the reality of this finding from the model, there is statistical evidence that states that exhibit higher economic growth rates are timelier in

[27] This also implies that their findings are directly applicable to the RNTCP.

their implementation of this centrally funded disease control program. This finding may lead to better long term economic and development outcomes in these fast growing states.

This model also indicates that political representation in the Lok Sabha significantly reduces the delay in RNTCP implementation: an increase of one standard deviation in representation in government correlates with an acceleration in implementation of 0.69 years. This variable indicates that certain states, and the districts within, are overrepresented in Parliament, and this overrepresentation allows them to exert greater political influence in the allocation of public health services. A test for correlation at the state level between this measurement of political representation and urbanization indicates that they have a correlation coefficient of -0.02. This statistic indicates that this variable is not merely another proxy for political effectiveness through urban bias. The negative coefficient on this variable indicates that overrepresentation in Parliament is good for the timely implementation of the RNTCP.

This state level model is also estimated using alternate proxies for political effectiveness to the quality of governance index used in Table 4, Columns 1&2. The purpose of using these alternate proxies is to test whether the results are a consequence of the construction of this particular index or of the more general idea of political effectiveness in providing health services. When the state HDI is used as an explanatory variable in place of the QGOI (Table 4, Column 3), the significance of SDP per capita growth remains at the 1 percent level, but the significance of the electoral constituencies per 100,000 population is no longer present. I do not control for the level of SDP in this model, as a similar measure is already included as an input to the calculation of the HDI. A similar amount of variation is explained in this regression as in the regression containing the QGOI; the regression with HDI as a proxy for political effectiveness explains 79 percent of the variation among states.

A proxy for the quality of provision of public health services is public spending on health as a percent of GSDP (Table 4, Column 4). This is one of the indicators in the composite QGOI. With this proxy for political effectiveness (in addition to the explanatory variable of political representation) the model shows that again, the growth of per capita SDP has a statistically significant effect at the 1 percent level. Public expenditure on health significantly reduces the number of years before implementation. The coefficient indicates that a one standard deviation increase in spending accelerates implementation in the state by 0.48 years. This is consistent with the hypothesis that this indicator is accounting for most of the significance of the QGOI; this is the only measure within the index that pertains directly to the provision of public health services. This model indicates that 82 percent of the variation in the timing of implementation among states is accounted for by these variables; this shows that perhaps even more of the variation among states is explained by this expenditure variable than that of the governance indicator. All of these models explaining the state dummy coefficients indicate that much of the variation among states can be explained by observable state political and socioeconomic characteristics.

I now estimate district level implementation using a combination of district and state level characteristics (Table 5, Columns 1-4) as described by the model in equation (3). In my preferred model (Table 5, Column 4), the explanatory variables are population, urbanization, SDP per capita (1997), SDP per capita growth (1993-1997), QGOI, TB prevalence, presence of historically marginalized groups (i.e., proportion SC, ST, and

Muslim), public health infrastructure, and number of electoral constituencies per 100,000 population. These variables explain 52 percent of the variation in the timing of district implementation. In this model, the coefficients on population, growth of SDP per capita, and number of electoral constituencies per 100,000 population are negative and significant at the 5 percent, 1 percent, and 5 percent levels, respectively. The coefficients imply that a one standard deviation increase in population would accelerate implementation by 0.28 years, a one standard deviation increase in growth of per capita SDP would speed implementation by 1.00 years, and an increase of one standard deviation in the number of electoral constituencies per 100,000 population would lead to faster RNTCP implementation by 0.51 years. The effects of SDP per capita growth are robust and systematic across all model specifications. This variable seems to account for a large amount of the variation among districts in their implementation of the program. When the variable is added to the model, there is an increase in the amount of variation explained by the model of 12 percent. The rationale for the significance of these coefficients on the explanatory variables has been explained at length for other model specifications, but it should be noted that these effects are still present when the district and state variables are combined to explain district level implementation. In these specifications, however, the effects of public health infrastructure on the timing of implementation are not significant, as they were in the district level analysis. Higher TB prevalence at a state level is associated with timelier implementation of the RNTCP in these models combining district and state explanatory variables, although this effect is also not statistically significant.

In some combined district and state specifications, I estimate that better governance may lead to earlier implementation of the RNTCP, although this result is not robust across our models using our QGOI indicator. The OLS estimate without an indicator of SDP per capita growth (Table 5, Column 1) shows that better governance[28] leads to faster RNTCP implementation with a statistically significant negative coefficient on this explanatory variable. With the addition of other district and state level explanatory variables to the model, including other variables relating to the political system, this coefficient becomes increasingly less significant and less negative.[29] This quality of governance index is a composite of other governance indicators; it is unclear whether there is a particular one or several of these indicators driving these results. As previously discussed, the state expenditure on health may be the main influence of this indicator. I collected data for most of the other indicators contained within the index, but when I ran similar regressions using these alternate proxies for political effectiveness, I did not find any evidence of statistical significance. It may be that the overall idea of 'governance' at the state level indicated by the index is explaining the variation in the implementation of the RNTCP at the district level. It may also be that this governance variable is driving economic growth, which has been shown to have significant effects on the timing of RNTCP implementation.

Table 6 reports the equations estimated by a maximum-likelihood ordered Probit model using the same series of explanatory variables as Table 5, Columns 1-4. The purposes of estimating influences on implementation date using the ordered Probit model to correct for the unavailability of RNTCP data pre-2000 and the discrete nature of the

[28] Measured by the QGOI for the period 1992-1996 reported by Basu (2004).
[29] In the selected model (Table 5, Column 4), the coefficient on this variable is indeed slightly positive, although it cannot be said that the coefficient is significantly different from zero.

available data are described in detail in the previous chapter. The important things to note from the ordered Probit model are that the results of the preferred specification (Table 6, Column 4) exhibit similar patterns in the signs of coefficients and the statistical significance of the explanatory variables is the same as the OLS model using the same parameters (Table 5, Column 4). The results reported for the ordered Probit estimation are the coefficients of the model (Table 6) and the marginal effects of these coefficients for each group (Table 7). These marginal effects are used to interpret the model with practical meaning, as each marginal effect is the change in probability of the dependent variable moving to that group with a one unit change in the specified explanatory variable when all the other explanatory variables are held constant at their means.

The coefficient that is statistically significant across specifications and groups in the ordered Probit model is that of the SDP per capita growth (1993-1997), therefore I examine it more closely. In the plot of these marginal effects (Figure 3), the shape of the 'curve' of the changes in the probability of implementation with changing groups is shown. This shape is not entirely linear; the marginal effects as constrained by OLS would appear as a straight diagonal line through the corners of the bars. Although this is an indication that the ordered Probit may be a superior model to OLS, I rely on the OLS models (Tables 3, 4, and 5) for discussion due to the straightforward interpretation of their coefficients.

5.2: Robustness

All of the regressions presented thus far have been for the subset of 426 districts which contain data for all variables. This section will test for the robustness of these findings to the entire data set of 593 districts and attempt to determine any differences between the data sets.

I start my robustness check with an analysis of the differences between the full sample set and the subset used for analysis. Table 8 presents summary statistics for both the district-level (Panel A) and state-level (Panel B) data that can be used to estimate RNTCP implementation. This includes information from all 593 districts, located in 28 states and 7 Union territories in the 2001 Census of India. As indicated by the number of observations column in this table, however, not all variables contain information for all districts. The QGOI was only calculated for 16 major states in India and health infrastructure data was only available for a subset of 15 of these states. The excluded districts were in the Union territories and many of the smaller northeastern states.[30] After the exclusion of these districts due to lack of data, I was left with 426 districts in 15 states for my analysis. These districts cover 89 percent of India's population in the 2001 Census of India, making it an adequate data source. The summary statistics for this subset are shown in Table 2 and described in the data section of Chapter 4.

To ensure that the excluded districts did not vary significantly from the ones left in the data set, I report several OLS regressions, varying the included sample observations (Table 9, Columns 3-8). The models[31] proposed in Table 9, Columns 1 and 2 are repeated with the exclusion of the dummy variable for Union territories to compare

[30] There was not complete data for the following states and Union territories: A & N Islands, Arunachal Pradesh, Chandigarh, Chhatisgarh, Dadar & Nagar Haveli, Daman & Diu, Delhi, Goa, Haryana, Jammu & Kashmir, Jharkhand, Lakshadweep, Manipur, Meghalaya, Mizoram, Nagaland, Pondicherry, Sikkim, Tripura, and Uttranchal.

[31] There are two models, one which includes total population, proportion urban, proportion Scheduled Castes, proportion Scheduled Tribes, proportion Muslim, and state HDI; and a second model which contains the same set of explanatory variables, but replacing the inclusion of the state HDI with dummies for state effects.

the results across the sample subsets to be used for analysis.[32] These models include controls for total population, urbanization, literacy rates,[33] proportion Scheduled Castes, proportion Scheduled Tribe, proportion Muslim, and the HDI. The HDI was used as an indicator of political effectiveness because it is the proxy for this variable that was available for all states. The significance of the coefficients on these explanatory variables did not vary significantly when varying the sample size, with the exception of the proportion of Muslims in the population and the proportion urban. While the coefficients on urbanization (which changed from -0.001 to -0.021 with decreased sample size), proportion Scheduled Tribe (which changed from -0.004 to -0.026), and the HDI (which changed from -7.756 to -11.445) increased in magnitude, the coefficients on the other explanatory variables decreased in magnitude with the decreased sample size. The standard errors were the same or larger for all coefficients except that of total population (which went from 0.009 for all districts to 0.008 for the sample with 426 districts). All of the regressions at the district level[34] showed large decreases in the RNTCP implementation time with increases in the HDI. In the regressions which include state dummies, there were similar patterns in the changes in the coefficients and standard errors with the change in sample size as the models that did not include these dummies.

The amount of variation in RNTCP implementation explained by these variables (as indicated by the R squared values) was higher for the smaller data sets without the inclusion of the state dummies; these seven explanatory variables accounted for 25

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[32] This dummy for Union territories would be dropped in all of the subsets due to lack of data. The regressions without this dummy can be used for direct comparison of the subsets.
[33] Literacy rates were used in favor of child mortality estimates, which might seem more applicable to the provision of public health services, because of the availability of literacy rate data for all 2001 districts.
[34] These regressions include district level observations as well as data measured at the state level. Their errors are clustered to account for correlations within states.

percent of the variation in the total sample set (593 districts), while the same variables accounted for 34 percent of the variation in the smaller sample (426 districts) which has data for all explanatory variables. With the inclusion of dummies for state effects, each sample set had identical R-squared values. This likely indicates that the HDI explains an increased amount of the variation in the smaller sample set than the set of all districts. The coefficient on the HDI is increasingly negative with the smaller sample sets, although it is significant at the 1 percent level for all three subsets of the data. These regressions show some evidence of discrimination against Muslim populations in the full set of districts that is not present in the smaller sample sets. Nevertheless, the smaller sample set is largely representative of the country as a whole, shown by the similar patterns of the regression estimates.

After showing that the smaller sample set that includes data for all desired variables is highly similar to the entire data set, it is assumed that this sample is representative of the country as a whole for my analysis of the RNTCP. This sample of 426 districts in fifteen states serves as the basis for the regressions described in the previous section.

5.3: Estimations for Full Data Set

Table 9 (Columns 1 and 2) presents the results of a district level OLS regression specification with the inclusion of all districts in India indicated by the 2001 Census, although this requires omitting several variables due to lack of data. The results of the model that contains all districts but not state effects (Table 9, Column 1) shows that heavily Muslim districts experienced delays in the implementation of the RNTCP. Each increase of one standard deviation in the proportion of Muslims in the population means that the RNTCP is estimated to delay implementation by 0.30 years. This effect is statistically significant at the 5 percent level.

The other information that can be gleaned from the entire sample set (Table 9, Columns 1-2) is that there are significant delays in RNTCP implementation in the Union territories. This model on the entire sample set also shows results similar to the models on the smaller sample subset that show statistically significant effects of total population in a district and the state HDI. These effects are both significant at the 1 percent level for the entire sample set. These coefficients indicate that for every one standard deviation increase in district population, the RNTCP will be implemented 0.47 years earlier. A one standard deviation increase in the HDI leads to implementation 1.01 years sooner. The rationale for and implications of these results have been discussed for previous models. The coefficient on the dummy variable for Union territories indicates that these territories will get the RNTCP 2.7 years later than a state with the same characteristics. This may show that state financial and staff inputs to the program play a large role; in the Union territories the central government will have to administer these inputs as well. It is somewhat surprising, because often Union territories are considered to fare better in centrally administered programs.

These Union territories, with the exceptions of Chandigarh and Delhi, are either islands or coastal enclaves around the edges of India. These five Union territories[35] are administered by the central government and are put under the charge of either an administrator or lieutenant governor. Most have no 'state' governments, and only one representative each to the Lok Sabha. Pondicherry is the only one of these to elect a

[35] These are Andaman and Nicobar Islands, Dadra and Nagar Haveli, Daman and Diu, Lakshadweep, and Pondicherry.

government and to send representation to the upper house (Boland-Crewe and Lea, 2002). As a result of their low populations, all of these territories have high political representation per capita; however, this representation may not be adequate in this case, as there is no state party to lobby for RNTCP implementation. The populations of these five territories are all very small, and although the regression is already controlling for population, if the effect of population is non-linear, then the coefficient on Union territories might also be picking up the non-linear portion of the effect on population. It is apparent from Figure 2 that these 5 Union territories suffered significant delays in RNTCP implementation, as they were among the last areas to have the program in place.

The Union territories of Chandigarh and Delhi have very different outcomes in this respect; these two territories are fundamentally different from the other five in that they are both central cities. Although Chandigarh shares many of the characteristics of the five Union territories previously mentioned, in that it has only one representative to the Lok Sabha and no state legislature, it is distinct in that it is the shared capital city of Punjab and Haryana. In this, it is not on the outskirts of India, and it may be a factor in the faster implementation of the RNTCP in this territory than the other five. Delhi is the National Capital Territory, and as such is the richest of the territories and states of India. Aditionally, it has three seats in the upper house of Parliament and seven seats in the Lok Sabha. The RNTCP was implemented in all districts of Delhi by the year 2000 (Boland-Crewe and Lea, 2002). It is apparent from this discussion of the characteristics of the Union territories that they have many qualities separating them from comparable states in quantifiable demographic and economic characteristics. The small political representation and lack of state legislatures may lead to the significantly slower implementation of the RNTCP that is shown in my analysis. Without complete data on these territories, however, the rationales for this finding are still speculative and I am not able to examine them rigorously.

These checks for robustness indicate that the results of the analysis of RNTCP implementation are largely the same for the sample subset used for the analysis in the previous section as for the dataset of all districts in India. There are several differences that emerge from this robustness check and analysis of the full data set, however, including delayed implementation in heavily Muslim districts and the slow implementation of the RNTCP in the Union territories. Although delayed implementation in heavily Muslim districts may be evidence of discrimination, it may also indicate something fundamentally different about these districts that is not accounted for by the other controls in the model. Due to lack of further data, however, these results cannot be examined rigorously to determine the characteristics of heavily Muslim districts and the Union territories that are causing them to have slower implementation of the RNTCP.

CHAPTER 6: CONCLUSION

In this analysis, I use a data set of demographic, economic, and political characteristics of Indian districts and states to determine which districts and states implemented the RNTCP soonest. I analyze the characteristics that determine the allocation of such a centrally funded scheme to the district level and the role of quantifiable aspects of the political system and governance at the state level on this allocation process.

6.1: MAJOR FINDINGS AND IMPLICATIONS

There are three major findings of my analysis. The first is that economic growth, as measured by the change in per capita SDP during the 1993-1997 period, is a significant factor (both statistically and practically) in the timing of RNTCP implementation at both the district and state levels. This is the most important empirical regularity that I find to be robust and systematic across all model specifications. I propose several different mechanisms to explain this result. The first is that there are inherent, unobserved characteristics of districts within fast growing states[36] that make them both faster growing and more ready and willing to seek out and implement the RNTCP in a timely manner. The second possibility is that economic growth is providing the state with increasing financial resources to contribute to the management of public services; this result, broadly applied, is one of the ultimate goals of development policy designed to foster economic growth. It is notable, however, that I simultaneously control for the *level* of economic development in these states, meaning that there may be different incentives for spending tax revenue on health services when this revenue is

[36]In the model at the state level explaining the state dummy coefficients (Table 4), this reasoning applies to the fast growing states themselves.

increasing rapidly versus when it is maintaining a relatively constant value. The third explanation for the robust significance of this effect is that the more rapidly growing states are better governed, and this governance is serving to drive both the economic growth and the implementation of the RNTCP. I attempt to control for different proxies of governance in the regressions, although it is possible that this economic growth factor is contributing to or masking some of the effects of these proxies. Since fast growing states appear to be increasing investment in public health services (as evidenced by the RNTCP), and such public health services can improve worker health, an important implication of my finding is that the implementation of the RNTCP may contribute to further divergence of states in India.

A second finding is that the centrally administered Union territories experience significant delays in the implementation of the RNTCP. Due to a lack of data concerning many of the socioeconomic and political characteristics of these districts, I am unable to explain the reason for this delayed implementation. It is possible that it indicates the importance of state inputs and initiative in the implementation of the program; it may also indicate poor governance or administration of these territories. Without further data and analysis, it is impossible to support these hypotheses.

The third finding of my analysis is that other observable factors contribute to the timing of implementation of the RNTCP. These factors include faster implementation with increased population size, increased urbanization of districts, better state governance, and greater political representation per capita, but increased delays in heavily Muslim districts. These results are less robust and systematic across all models. The results for the implementation of the RNTCP based on 'need' (as measured by self-reported TB prevalence statistics) are ambiguous. Further data and analysis are needed to determine the reason for these findings with regards to the implementation of the RNTCP.

6.2: Future Directions

The original motivation for this thesis was to determine the economic impacts of the implementation of the RNTCP in India. Since the program was not randomly implemented, however, the allocation of the program itself first had to be analyzed to be able to eventually separate out any economic gains that arise from implementation of the RNTCP. Given adequate data, I would continue this analysis to determine if the RNTCP does, in fact, contribute to economic growth in the way that Dholakia and Almeida suggest that it can. The necessary data may not exist due to poor vital recordkeeping and the small estimated impacts of eradicating TB, although the wealth of epidemiological data from the RNTCP may be able to provide some of this information. There is also little evidence to determine if the findings for this program are generalizable to other centrally funded disease control programs in India, such as those for AIDS and malaria, or for other inputs to the public health care system. The policy implications for such findings could be substantial, as they could provide empirical evidence for the economic incentives necessary to spur investment in public health services.

6.3: Importance of Results

The final story of the RNTCP implementation in India suggests that national and international aid organizations charged with improving public health services in developing countries must pay careful attention to the methods by which they implement such services. The analysis of this centrally administered disease control program show some of the challenges countries face in making such decisions, but point to the necessity of ensuring that such programs reach the areas that are most in need of increased health services. If such questions are not addressed, it may lead to further divergence in health outcomes among countries and regions within these countries, which may ultimately further the economic gap that exists among these geographical and political units.

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APPENDIX A: TABLES AND FIGURES

Table 1 *Acronyms*

AIDS	Acquired Immunodeficiency Syndrome
CHC	Community Health Center
CTD	Central TB Division
DANIDA	Danish International Development Agency
DTC	District TB Centres
GDP	Gross Domestic Product
GFATM	Global Fund to Fight AIDS, TB, and Malaria
GSDP	Gross State Domestic Product
HDI	Human Development Index
HIV	Human Immunodeficiency Virus
MC	Microscopy Center
MDR-TB	Multi-drug Resistant TB
NFHS	National Family Health Survey
NTP	National Treatment Program
NSDP	Net State Domestic Product
OLS	Ordinary Least Squares
PHC	Primary Health Care Center
PHW	Peripheral Health Worker
RNTCP	Revised National Tuberculosis Control Programme
QGOI	Quality of Governance Index
SDP	State Domestic Product
SIDA	Swedish International Development Agency
STC	State TB Cells
STDC	State TB Training and Demonstration Centres
STLS	Senior Tuberculosis Laboratory Supervisor
STS	Senior Treatment Supervisors
TB	Tuberculosis
TU	Tuberculosis Unit
USAID	United States Agency for International Development
WHO	World Health Organization

Figure 1 *Map of India*

Table 2

PANEL A: *Summary statistics for variables at district level* (*SELECTED SAMPLE*)[37]

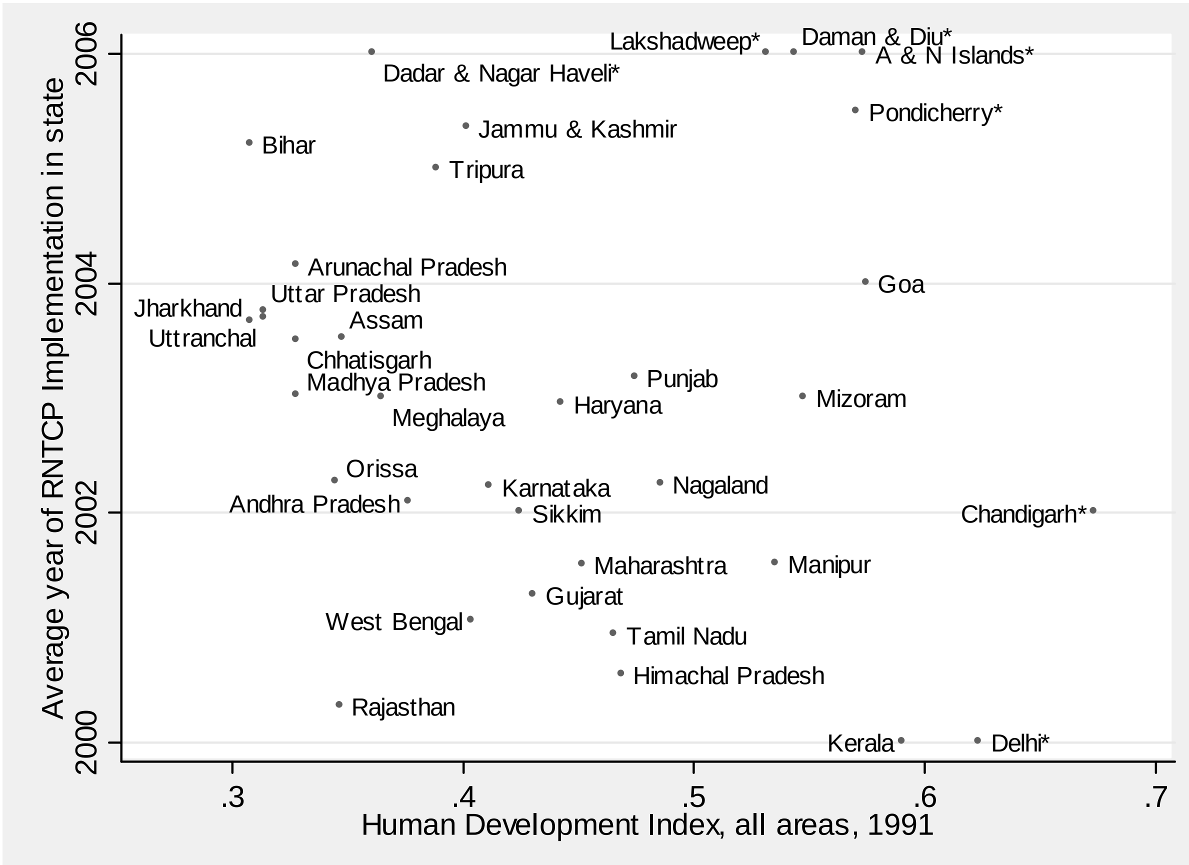
Variable	Mean	S. D.	Min.	Max.	# of obs.
Total population, 2001 (in 100,000)	20.7	13.1	0.33	96.1	426
Proportion urban, in %, 2001	22.2	16.4	0	100	426
Proportion Muslim, in %, 1991	11.2	11.4	0.07	70.45	426
Proportion scheduled caste, in %, 2001	16.8	7.7	0.5	50.1	426
Proportion Scheduled Tribe, in %, 2001	9.7	16.5	0	93.8	426
Family Welfare Centers per 100,000 urban population, 1991	3.59	6.2	0	37.96	426
Primary Health Centers per 100,000 rural population, 1991	3.1	1.3	0.43	12.78	426
Subcentres per 100,000 rural population, 1991	22.2	7.4	1	92.67	426
Literacy rate, in %, 2001	63.0	12.4	30.5	95.8	426
RNTCP Implementation, by year	2002.4	1.99	2000	2006	426
RNTCP Implementation, 2000	0.27	0.4	0	1	426
RNTCP Implementation, 2001	0.41	0.5	0	1	426
RNTCP Implementation, 2002	0.47	0.5	0	1	426
RNTCP Implementation, 2003	0.70	0.5	0	1	426
RNTCP Implementation, 2004	0.84	0.4	0	1	426
RNTCP Implementation, 2005[38]	0.90	0.3	0	1	426

PANEL B: *Summary statistics for variables at state level* [39] (*SELECTED SAMPLE*)

Variable	Mean	S. D.	Min.	Max.	# obs.
Prevalence of TB (% of total population) as reported in NFHS-II, 1992	0.53	0.18	0.2	0.7	15
Human Development Index, combined, 1991	0.40	0.08	0.308	0.591	15
Net State Domestic Product per capita, in 1000 of rupees at 1993-94 prices, 1997	8.84	3.20	3.1	13.93	15
Growth of SDP per capita, in %, 1993-1997	16.5	10.8	1.42	39.1	15
Number of electoral constituencies per 100,000 population, 2004	0.054	0.006	0.044	0.066	15
Public expenditure on health, in % of GSDP, 1998-1999	1.14	0.48	0.61	2.63	15
Quality of Governance Index, 1992-1996[40]	0.25	0.29	0	1	15

[37] These summary statistics are for the 15 states, and the 426 districts contained within, that have data for all indicators used. This is to standardize the sample set for the regression analyses. These 15 states cover 89% of the population from the 2001 Census of India. All Union territories have been excluded.
[38] RNTCP implementation data for year 2005 is for implementation available for 2nd quarter report.
[39] State-level indicators were summarized over the 2001 states.
[40] The data for the Quality of Governance Index is normalized for each time period between 0 and 1, per the specifications seen in Basu (2004). This Index is available for the sixteen major states in India (in the 2001 census), which are used for consistent data availability for the years and variables needed to construct the index.

Figure 2 *Average year of RNTCP Implementation versus level of development indicated by HDI*[41]



[41] Note: * indicates Union territory

Table 3 *OLS Regression results of RNTCP Implementation in district by year as a function of district characteristics*

	(1) [42]
Total population, 2001 (in 100,000)	-0.023
	(0.008)***
Proportion of population in urban areas, in %, 2001	-0.020
	(0.006)***
Proportion scheduled caste, in %, 2001	0.000
	(0.014)
Proportion Muslim, in %, 1991	-0.001
	(0.006)
Proportion scheduled tribe, in %, 2001	-0.008
	(0.007)
Subcentres per 100,000 rural population, 1991	0.028
	(0.012)**
Family Welfare Centers per 100,000 urban population, 1991	-0.030
	(0.032)
Primary Health Centers per 100,000 rural population, 1991	-0.055
	(0.072)
State Effects?	YES
R-squared	0.61
No. of observations = 426	

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

[42] Omitted state is Kerala, which is known for its good health and social outcomes; the RNTCP was implemented in all districts by the year 2000. The coefficients for these dummies are not displayed for reasons of space. These coefficients are used in later regressions for explaining implementation at the state level.

Table 4 *OLS Regression of State dummy coefficients for RNTCP Implementation* [43]

	(1)	*(2)*	*(3)*	*(4)*
Quality of Governance Index, 1992-96	-1.308	0.283		
	(1.050)	(0.895)		
State Domestic Product per capita, in 1000s of 1993-1994 rupees, 1997	-0.045	-0.039		-0.124
	(0.130)	(0.114)		(0.108)
Growth of State Domestic Product per capita, in %, 1993-1997	-0.088	-0.099	-0.098	-0.077
	(0.021)***	(0.028)***	(0.025)***	(0.022)***
Prevalence of TB (% of total population) as reported in NFHS-II, 1992	1.108	-0.475	-0.036	-1.221
	(3.017)	(1.744)	(1.203)	(1.320)
Number of electoral constituencies per 100,000 population, 2004		-115.050	-95.293	-56.759
		(45.509)**	(58.692)	(55.548)
Public spending on health, % of Gross State Domestic Product, 1998-1999				-1.002
				(0.483)*
Human Development Index, all areas, 1991			-1.946	
			(3.462)	
R-squared	0.63	0.78	0.79	0.82
No. of observations = 15				

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

[43] Omitted state was Kerala, which is known for its good health and social outcomes; the RNTCP was implemented in all districts by the year 2000. The coefficients are from the state dummy variables in the model estimated in Table 3, Column 1.

Table 5 *OLS Regression results of RNTCP Implementation in district by year as a function of district and state characteristics*

	(1) [44]	*(2)*	*(3)*	*(4)*
Total population, 2001 (in 100,000)	-0.019 (0.012)	-0.018 (0.010)	-0.023 (0.007)***	-0.021 (0.007)**
Proportion of population in urban areas, in %, 2001	-0.011 (0.008)	-0.011 (0.008)	-0.013 (0.010)	-0.014 (0.009)
State Domestic Product per capita, in 1000s of 1993-1994 rupees, 1997 (state-level)	-0.312 (0.110)**	-0.127 (0.081)	-0.134 (0.073)*	-0.090 (0.076)
Quality of Governance Index, 1992-96, (state-level)	-1.674 (0.847)*	-1.149 (0.931)	-1.187 (0.981)	0.079 (0.900)
Prevalance of TB (% of total population) as reported in NFHS-II, 1992 (state-level)	-1.162 (2.040)	-0.282 (1.346)	-0.619 (0.971)	-1.105 (0.956)
Growth of State Domestic Product per capita, in %, 1993-1997 (state-level)		-0.083 (0.015)***	-0.080 (0.014)***	-0.093 (0.018)***
Proportion scheduled caste, in %, 2001			-0.003 (0.017)	0.006 (0.015)
Proportion Muslim, in %, 1991			0.002 (0.009)	-0.003 (0.009)
Proportion scheduled tribe, in %, 2001			-0.012 (0.014)	-0.013 (0.013)
Subcentres per 100,000 rural population, 1991			-0.019 (0.029)	0.012 (0.019)
Family Welfare Centers per 100,000 urban population, 1991			0.014 (0.030)	0.021 (0.028)
Primary Health Centers per 100,000 rural population, 1991			0.135 (0.137)	0.005 (0.093)
Number of electoral constituencies per state per 100,000 population, 2004 (state-level)				-85.399 (31.400)**
State Effects?	NO	NO	NO	NO
R-squared	0.35	0.47	0.50	0.52
No. of observations = 426				

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

[44] Estimation uses robust standard errors clustered based on 2001 state.

Table 6 *Ordered Probit Model Results of RNTCP Implementation in district by Year*

	(1)	*(2)*	*(3)*	*(4)*
Total population, 2001 (in 100,000)	-0.013 (0.008)	-0.012 (0.008)	-0.015 (0.006)***	-0.015 (0.006)**
Proportion of population in urban areas, in %, 2001	-0.008 (0.006)	-0.009 (0.006)	-0.011 (0.008)	-0.012 (0.008)
State Domestic Product per capita, in 1000s of 1993-1994 rupees, 1997 (state-level)	-0.187 (0.070)***	-0.069 (0.057)	-0.076 (0.051)	-0.056 (0.052)
Quality of Governance Index, 1992-96, (state-level)	-1.128 (0.708)**	-0.627 (0.818)	-0.632 (0.872)	0.000 (0.801)
Prevalence of TB (% of total population) as reported in NFHS-II, 1992 (state-level)	-0.674 (1.309)	-0.407 (1.019)	-0.597 (0.873)	-0.747 (0.901)
Growth of State Domestic Product per capita, in %, 1993-1997 (state-level)		-0.070 (0.018)***	-0.070 (0.018)***	-0.076 (0.020)***
Proportion scheduled caste, in %, 2001			0.003 (0.011)	0.008 (0.011)
Proportion Muslim, in %, 1991			0.001 (0.007)	-0.002 (0.007)
Proportion Scheduled Tribe, in %, 2001			-0.008 (0.011)	-0.009 (0.011)
Subcentres per 100,000 rural population, 1991			-0.010 (0.020)	0.007 (0.015)
Family Welfare Centers per 100,000 urban population, 1991			0.009 (0.026)	0.011 (0.025)
Primary Health Centers per 100,000 rural population, 1991			0.091 (0.101)	0.026 (0.080)
Number of electoral constituencies per state per 100,000 population, 2004 (state-level)				-49.00 (24.291)*
Pseudo R-squared	0.11	0.17	0.18	0.19
Number of observations = 426				

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 7 *Marginal effects of Ordered Probit Model Coefficients*[45]

	≤2000	*2001*	*2002*	*2003*	*2004*	*2005*	*≥2006*
Total population, 2001 (in 100,000)	0.004 (0.002)**	0.002 (0.001)*	0.000 (0.000)*	-0.002 (0.001)***	-0.002 (0.001)**	-0.000 (0.000)	-0.001 (0.000)
Proportion of population in urban areas, in %, 2001	0.003 (0.002)	0.001 (0.001)*	0.000 (0.000)	-0.001 (0.001)	-0.002 (0.001)	-0.000 (0.000)	-0.001 (0.001)
State Domestic Product per capita, in 1000s of 1993-1994 rupees, 1997 (state-level)	0.014 (0.014)	0.006 (0.006)	0.001 (0.002)	-0.007 (0.007)	-0.009 (0.008)	-0.003 (0.004)	-0.003 (0.003)
Quality of Governance Index, 1992-96, (state-level)	-0.000 (0.206)	-0.000 (0.093)	0.000 (0.019)	0.000 (0.094)	0.000 (0.125)	0.000 (0.051)	0.000 (0.048)
Prevalence of TB (% of total population) as reported in NFHS-II, 1992 (state-level)	0.192 (0.245)	0.087 (0.101)	0.018 (0.022)	-0.087 (0.131)	-0.116 (0.147)	-0.048 (0.054)	-0.045 (0.046)
Growth of State Domestic Product per capita, in %, 1993-1997 (state-level)	0.020 (0.006)***	0.009 (0.004)**	0.002 (0.001)**	-0.009 (0.005)*	-0.012 (0.004)***	-0.005 (0.003)*	-0.005 (0.003)*
Proportion scheduled caste, in %, 2001	-0.002 (0.003)	-0.001 (0.001)	-0.000 (0.000)	0.001 (0.001)	0.001 (0.002)	0.001 (0.001)	0.000 (0.001)
Proportion Muslim, in %, 1991	0.000 (0.002)	0.000 (0.001)	0.000 (0.000)	-0.000 0.001	-0.000 (0.001)	-0.000 (0.000)	-0.000 (0.000)
Proportion Scheduled Tribe, in %, 2001	0.002 (0.003)	0.001 (0.001)	0.000 (0.000)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
Subcentres per 100,000 rural population, 1991	-0.002 (0.004)	-0.001 (0.002)	-0.000 (0.000)	0.001 (0.002)	0.001 (0.002)	0.000 (0.001)	0.000 (0.001)
Family Welfare Centers per 100,000 urban population, 1991	-0.003 (0.006)	-0.001 (0.003)	-0.000 0.000	0.001 (0.003)	0.002 (0.004)	0.001 (0.001)	0.001 (0.001)
Primary Health Centers per 100,000 rural population, 1991	-0.007 (0.020)	-0.003 (0.009)	-0.000 (0.001)	0.003 (0.009)	0.004 (0.012)	0.002 (0.005)	0.002 (0.005)
Number of electoral constituencies per state per 100,000 population, 2004 (state-level)	12.616 (7.917)	5.678 (3.742)	1.175 (1.057)	-5.738 (4.259)	-7.639 (5.314)	-3.136 (2.525)	-2.957 (2.160)

Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

[45] These are the marginal effects computed from the model presented in Table 6, Column 4.

Figure 3 *Plot of marginal effects of coefficient of SDP per capita growth versus timing of implementation*

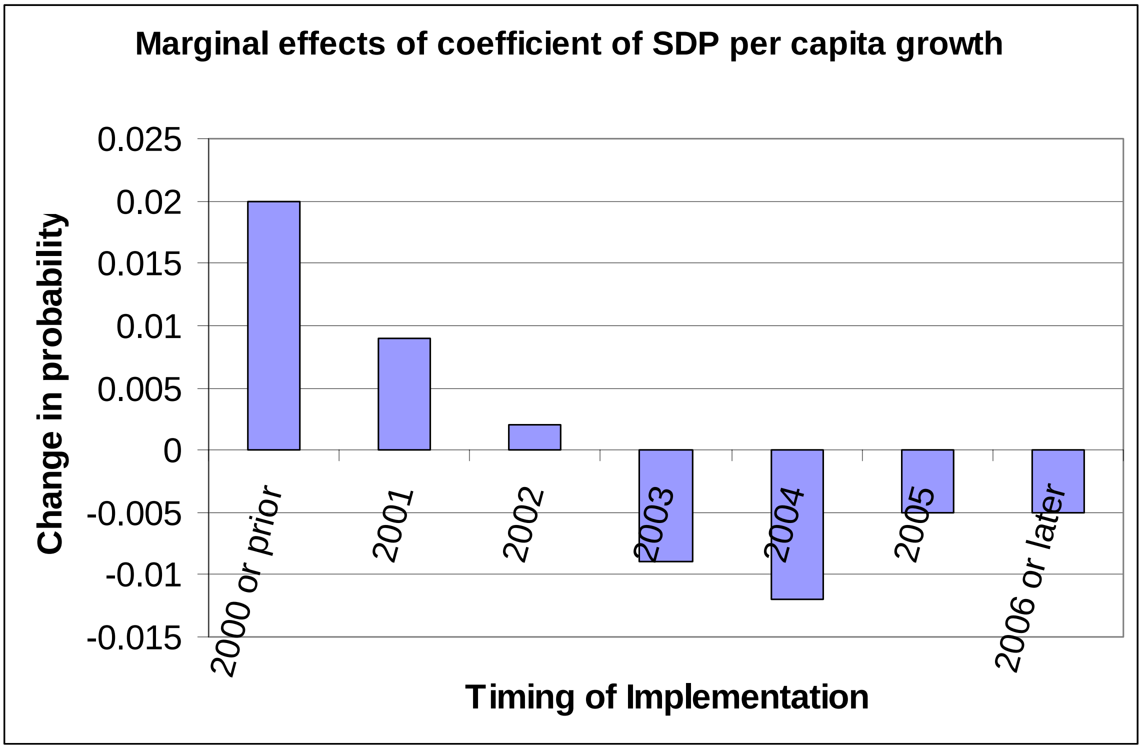


Table 8

PANEL A: *Summary statistics for variables with data available at district level*

Variable	Mean	S. D.	Min.	Max.	# of obs.[46]
Total population, 2001 (in 100,000)	17.3	13.3	0.31	96.1	593
Proportion urban, in %, 2001	23.7	19.7	0	100	593
Proportion Muslim, in %, 1991	11.3	15.2	0.04	97.53	593
Proportion scheduled caste, in %, 2001	14.7	8.7	0	50.1	593
Proportion Scheduled Tribe, in %, 2001	16.1	25.9	0	98.1	593
Family Welfare Centers per 100,000 urban population, 1991	3.95	7.1	0	37.99	514
Primary Health Centers per 100,000 rural population, 1991	3.1	1.3	0.43	12.78	553
Subcentres per 100,000 rural population, 1991	22.2	7.3	1	92.67	553
Literacy rate, in %, 2001	64.0	12.8	30.2	96.5	593
RNTCP Implementation, by year	2002.7	1.98	2000	2006	593
RNTCP Implementation, 2000	0.23	0.4	0	1	593
RNTCP Implementation, 2001	0.33	0.5	0	1	593
RNTCP Implementation, 2002	0.43	0.5	0	1	593
RNTCP Implementation, 2003	0.64	0.5	0	1	593
RNTCP Implementation, 2004	0.84	0.4	0	1	593
RNTCP Implementation, 2005[47]	0.88	0.3	0	1	593

PANEL B: *Summary statistics for variables with data available at the state or Union territory level*

Variable	Mean	S. D.	Min.	Max.	# obs.[48]
Prevalence of TB (% of total population) as reported in NFHS-II, 1992	0.54	0.21	0.2	1.1	28
Human Development Index, combined, 1991	0.44	0.10	0.308	0.674	35
Net State Domestic Product per capita, in 1000 of rupees at 1993-94 prices, 1997	10.53	5.33	3.1	25.47	31
Growth of SDP per capita, in %, over 1993-1997 period	17.6	14.9	-1.13	77.92	31
Number of electoral constituencies per 100,000 population, 2004	0.15	0.29	0.044	1.65	35
Public expenditure on health, in % of GSDP, 1998-1999	1.50	1.01	0.61	4.92	27
Quality of Governance Index, 1992-1996[49]	0.23	0.29	0	1	16

[46] Any district level data from 1991 census excludes data from Jammu & Kashmir, where census was not conducted. Data on the proportion Muslim for Jammu & Kashmir is from 1981 census. Health infrastructure data is not available for all states. 1991 census data has been expanded from state level to district level in Andaman & Nicobar Islands (2 districts); Arunachal Pradesh (9 districts); Goa, Daman, Diu (3 districts); Manipur (6 districts); Meghalaya (5 districts); Nagaland (7 districts); Pondicherry (4 districts); Tripura (3 districts); Sikkim (4 districts); and Mizoram (3 districts).

[47] RNTCP implementation data for year 2005 is for implementation available for 2nd quarter report.

[48] State-level indicators were summarized over the 2001 states and Union territories.

[49] The data for the Quality of Governance Index is normalized for each time period between 0 and 1, per the specifications seen in Basu (2004). This Index is available for the sixteen major states in India (in the 2001 census), which are used for consistent data availability for the years and variables needed to construct the index.

Table 9 *OLS Regression of RNTCP Implementation by year to compare samples*

	All districts[50]		*All districts*		*Districts with Governance Data*		*Districts with Governance and Health Infrastructure data*[51]	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Total population, 2001 (in 100,000)	-0.035 (0.009)***	-0.023 (0.010)**	-0.044 (0.009)***	-0.023 (0.010)**	-0.021 (0.009)**	-0.018 (0.010)*	-0.022 (0.008)**	-0.024 (0.008)***
Proportion urban, in %, 2001	-0.013 (0.009)	-0.014 (0.008)*	-0.001 (0.009)	-0.014 (0.008)*	-0.016 (0.009)	-0.018 (0.009)*	-0.021 (0.009)**	-0.022 (0.008)**
Literacy rate, in %, 2001	-0.004 (0.016)	0.008 (0.011)	-0.014 (0.017)	0.008 (0.011)	-0.015 (0.019)	0.016 (0.013)	-0.013 (0.019)	0.018 (0.012)
Proportion scheduled caste, in %, 2001	-0.010 (0.025)	0.001 (0.014)	-0.009 (0.025)	0.001 (0.014)	-0.009 (0.028)	0.006 (0.017)	-0.008 (0.029)	0.000 (0.016)
Proportion Scheduled Tribe, in %, 2001	-0.003 (0.009)	0.000 (0.008)	-0.004 (0.009)	0.000 (0.008)	-0.028 (0.018)	0.000 (0.013)	-0.026 (0.018)	-0.001 (0.012)
Proportion Muslim, in %, 1991	0.020 (0.009)**	0.000 (0.008)	0.021 (0.008)**	0.000 (0.008)	0.002 (0.013)	0.002 (0.011)	0.006 (0.013)	0.004 (0.010)
Human Development Index, all areas, 1991 (state-level)	-10.124 (2.225)***		-7.756 (1.971)***		-10.807 (2.845)***		-11.445 (3.042)***	
Union Territory	2.700 (1.107)**	5.776 (1.237)***						
State effects?	NO	YES	NO	YES	NO	YES	NO	YES
Observations	593	593	593	593	457	457	426	426
R-squared	0.29	0.61	0.25	0.61	0.30	0.57	0.34	0.61

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

[50] Includes dummy variable for Union Territory, which is excluded in other regressions due to lack of data for all sample subsets.
[51] This is the sample set that will be used in all regressions.