Political, Economic, and Health Determinants of Tuberculosis Incidence

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POLITICAL, ECONOMIC, AND HEALTH DETERMINANTS OF TUBERCULOSIS INCIDENCE

by

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ABSTRACT

The epidemiologic transition has shifted major causes of mortality from infectious disease to chronic disease; however, infectious diseases are again re-emerging as a major global concern (Diamond, 1997; Karlen, 1995; McNeil, 1976). This research aimed to identify potential areas of infectious disease influence that are not health-related in order to help governments and policymakers establish new policies, correct current policies, or further address these issues in order to effectively prevent and combat infectious disease. This study employed a retrospective, cross-sectional, non-experimental design via structural equation modeling (SEM) and examined tuberculosis incidence rates at the country-level. Secondary data from open-source, international databases like World Bank's World Development Indicators, World Governance Indicators, and World Health Organization for the year 2014 was utilized. Results revealed that the latent constructs of political stability, health system indicators, and detection policies directly affected tuberculosis incidence rates; they also exhibited an indirect effect due to covariation. Economic stability did not direct affect tuberculosis incidence, but it indirectly influenced incidence through the covariation of political stability, health system indicators, and detection policies. As a country's political stability increased, tuberculosis incidence decreased. As positive health system indicators increased, tuberculosis incidence decreased. Countries with more Xpert detection policies in place experienced an apparent increase in tuberculosis incidence.

This dissertation is dedicated to my parents, Lynn and Patricia Rutherford, who loved, encouraged, and motivated me during all my education pursuits. This study is also in loving memory of Robert Penn Mobley, my dearest friend, who was called away from us too soon. Your uplifting attitude, joyful laughter, and warm embrace will be forever loved and missed. Hope I made you all proud!

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LIST OF ACRONYMS AND ABBREVIATIONS

AIDS: acquired immunodeficiency syndrome
DPT: diphtheria pertussis tetanus
GDP: gross domestic product
GNI: gross national income
HIV: human immunodeficiency virus
MDR-TB: multidrug-resistant tuberculosis
MTB/RIF: mycobacterium tuberculosis/ resistance to rifampicin
SARS: severe acute respiratory syndrome
SEM: structural equation modeling
TB: tuberculosis
WHO: World Health Organization

CHAPTER ONE: INTRODUCTION

Background

The "age of pestilence"- when infectious diseases were the primary cause of mortality- has dominated the world for millenniums (McNeil, 1976). However, within the past few hundred years, infectious diseases have slowly waned as poor countries have transitioned into more economically stable and wealthy areas. This increase in wealth, coupled with the advent of antibiotics and vaccinations, has resulted in an epidemiologic transition: the major causes of mortality have shifted from infectious disease to chronic disease in developed nations (Diamond, 1997; Karlen, 1995). Behavior and individual choices now seem to overpower the microparasites of germs and acquirable infections, at least for the time being (McNeil, 1976). However, with recent technological advances, many scholars argue that infectious diseases will once again re-emerge as a major global concern as biological warfare, international commerce, and ecological mutations increase (Diamond, 1997; Karlen, 1995; McNeil, 1976). With recent infectious disease outbreaks, such as severe acute respiratory syndrome (SARS) and Ebola, the epidemiological transition may very well come full circle. It is therefore important not only to control and halt the spread of such diseases (via quarantine, restricted travel, and medications), but to predict and possibly prevent specific outbreak locations before an outbreak even occurs, thereby minimizing potential damage and losses.

In addition to the detrimental health effects that infectious diseases leave on societies, they also greatly burden economic systems. Such outbreaks have not only wiped out entire populations, but have also been shown to hinder and oftentimes destroy an area's basic economic system via a loss of producers, laborers, trade, and vital resources. Furthermore, the literature suggests that an outbreak in one area has the potential to directly influence the economy of

another area, specifically in terms of global trade and commerce (Chen, Chen, Tang, & Huang, 2009).

Tuberculosis (TB) is an example of an infectious disease that is making a come-back world-wide as it mutates into drug-resistant strains. Tuberculosis is caused by inhaling *Mycobacterium tuberculosis*. Bacteria are released into the air when an infected individual breathes, coughs, speaks, sneezes, or sings (Centers for Disease Control and Prevention, 2016; United States National Library of Medicine, 2016). The infection primarily affects the lungs, but it can also spread to other parts of the body such as the brain, spine, or kidneys. TB presents itself in one of two ways, as being either latent or active. Individuals with latent TB are infected with the bacteria, but are asymptomatic and do not spread the bacteria to others (Centers for Disease Control and Prevention, 2016; United States National Library of Medicine, 2016). Immune systems continuously work to fight off the bacteria and prevent further growth. However, if individuals are not able to fight off the bacteria, it can spread and become active. At this stage, symptoms arise such as chest pain and coughing. The bacterium is then able to be transmitted through the air to non-infected individuals (Centers for Disease Control and Prevention, 2016; United States National Library of Medicine, 2016). Over one-third of the world is infected with latent TB; within five years of initial infection, latent TB will progress to active TB when individuals are exposed to certain risk factors or have compromised immune systems (WHO, 2016a).

TB has been detected in people of all ethnicities and ages, it is more prevalent in certain sub-populations such as young children, the elderly, specific ethnic minorities, prison inmates, homeless individuals, health care professionals, and travelers. Tuberculosis is a major policy concern, especially for low- and middle-income areas. Over 95% of all TB deaths occur in

economically challenged nations. Furthermore, it is a top five cause of mortality for women between the ages of 15 and 44 (World Health Organization [WHO], 2015b). TB disease in children under 15 years of age and in the elderly is a significant public health concern (Figueroa-Munoz & Ramon-Pardo, 2008). In 2014, approximately one million children were diagnosed with TB and over 140,000 died from the disease.

Due to concerns of infectious disease re-emergence, and in particular the re-emergence of TB, it is imperative that nations be prepared for such crippling events. In order to protect against these outbreaks and inform policy decisions, countries need to know which specific indicators influence population health and disease.

Purpose

Traditionally, causes of infectious diseases are determined through health factors, yet in reality, a multitude of variables may influence a nation's vulnerability and response to an infectious disease outbreak. The aim of this research is to identify potential areas of infectious disease influence that are not obviously health-related in order to help governments and policymakers establish new policies, correct current policies, or further address these issues in order to effectively combat infectious disease. This study presents an uninvestigated perspective from which to gauge disease incidence at the country-level, using TB as a focal point.

Almost every country in the world reports some degree of TB annually. Six nations including, China, India, Indonesia, Nigeria, Pakistan, and South Africa, carry the highest encumbrance of tuberculosis and account for approximately 60% of the total tuberculosis burden (WHO, 2015b; Kanabus, 2016a). Over 82% of the tuberculosis burden is comprised of 22 countries. The lowest rates of TB are located in high-income nations like Australia, Canada, New Zealand, the United States, and Western Europe, where incidence rates are less than 10 cases per

100,000 individuals (Kanabus, 2016a; Kanabus 2016b). The level of incidence within a country influence differing goals; low incidence countries aim to eradicate the disease while high and moderate incidence countries aim to detect, treat, and prevent the further spread of disease (Kanabus, 2016a).

Tuberculosis is an ideal infectious disease to examine due to its high global prevalence, commonly misdiagnosed symptoms, and co-morbidity with HIV (human immunodeficiency virus). Approximately one-third of the world's population is infected with it (WHO, 2016c). Unlike other conditions with distinctive indicators, the symptoms of TB are often misdiagnosed as the common cold or flu. Because of this, many patients delay in seeking the appropriate medical care, thus resulting in further spread of the disease. On average, an active TB individual will usually infect ten to fifteen other individuals per year (WHO, 2015a).

While global rates of TB have steadily decreased over the years due to increased surveillance and treatment, multidrug-resistant strains are becoming an ever increasing problem. "Globally in 2014, an estimated 480,000 people developed multidrug-resistant TB (MDR-TB)" (WHO, 2015b). Tuberculosis strains mutate randomly, but can be enhanced when certain conditions or stressors arise. Drug resistant mutants arise when ineffective drug pressures rapidly destroy the myobacterium. Examples of this are when physicians prescribe the same pharmaceutical regimes over and over. They also mutate when patients skip dosages or stop treatment early (McKay, 2013). The third cause of resistance occurs from inappropriate or over-use of antibiotics that were prescribed for other medical reasons (Zhang et al., 2016). The MDR-TB strains are resistant to the two most common and most effective TB medications- isoniazid and rifampicin. Normal active TB requires a six-month treatment regimen while drug-resistant

TB requires up to two years of continuous treatment, usually with intensive chemotherapy (WHO, 2015a).

The final justification for choosing to examine TB instead of other infectious diseases concerns the heavily correlated association between TB and HIV. Due to their compromised immune systems, HIV-positive individuals are 26 to 31 times more susceptible to developing active TB disease than HIV-negative individuals (WHO, 2016c). If proper treatment is not available, “45% of HIV-negative people with TB on average and nearly all HIV-positive people with TB will die” (WHO, 2015a) either directly from TB or indirectly from medical complications such as include respiratory failure, heart failure, TB meningitis, hepatic failure, or malignancies (Kuba et al., 1996).

Study Significance

This research will build from previous determinants of health and population health models (Evans & Stoddart, 1990; Kindig & Stoddart, 2003; University of Wisconsin Population Health Institute, 2016) by examining potential correlations between political stability, tuberculosis policies, economic stability, and health system indicator constructs in hopes of identifying their potential relationship to infectious disease using a multivariate structural equation model (SEM) approach. The proposed study will contribute to current research because it employs a holistic view of tuberculosis incidence, examines potential pathways both directly and indirectly, and utilizes structural equation modeling.

Many scholars have examined infectious disease in relation to medical treatment, population health, and public health; however, a myriad of non-health factors that are not commonly studied also play an important role. The role of political stability, a non-health determinant, and factors like citizen voice and accountability, violence and terrorism, and

government corruption have not frequently been studied in tandem with economic constructs, tuberculosis policies, and health system indicators. Furthermore, many studies have linked health and non-health determinants in terms of infectious disease, but few to none have studied the direct and indirect pathways leading to tuberculosis specifically. For instance, Ceddia and colleagues (2013) examined the interaction and co-existence of ecological and economic factors on infectious disease. However, they did not consider the influence of political stability, relevant policies, or external measures, like population density and refugee populations.

A unique aspect to this proposed study is that it employs a multivariate analysis to examine the potential interactions of political stability, tuberculosis policies, economic stability, and health system indicator constructs both directly and indirectly on tuberculosis incidence. Most infectious disease studies examine the influence of several variables through univariate or bivariate correlation models, not structural equation models. Letendre and colleagues (2010) utilized a logistic regression analyses and zero-order correlations to examine armed conflict and civil war in relation to GDP, population, and pathogen severity. Other studies have utilized forecasting techniques and growth models in relation to disease outbreaks. For instance, Goenka, Liu, and Nguyen (2014) integrated a neo-classical growth model imitating disease susceptibility and infectiveness, which indicated a two-way interaction between the disease transmission and the economy.

Research Methods

This study employs a retrospective, cross-sectional, non-experimental design of country-level data via structural equation modeling (SEM). Secondary data is from open-source, international databases such as the World Bank's World Development Indicators, World

Governance Indicators, and International Disaster Database, as well as the World Health Organization (WHO) for the year 2014. This data comprises the observed variables used to measure 3 latent constructs, an observed explanatory variable, 3 control variables, and the final endogenous variable (tuberculosis incidence). The structural model and all of these variables are further discussed and specified in Chapters 2 and 3. The sample size for this study is 248 countries. Due to the global scale of this disease, a country-level unit of analysis will be employed. However, the term *country* may be used to refer both to independent nations and economies of "any territory for which authorities report separate social or economic statistics" (World Bank, 2016d).

Research Questions & Hypotheses

The research questions and hypotheses were developed after a thorough review of the literature and determination of the problem statement and study purpose. Each research question and hypothesis concerned one of the four latent constructs (*political stability*, *economic stability*, *detection policies*, and *health system indicators*) and the observed variable regarding tuberculosis *detection policies* on the outcome of *tuberculosis incidence*.

1) How is a country's political stability associated with health system indicators?
    a. H_A: Politically stable countries, with high voice and accountability, an absence of violence and terrorism, high control of corruption, high regulatory quality, and high rule of law will experience favorable health system indicators. [Note: Political stability variables are from World Bank, 2016c; World Bank, 2016m; World Bank 2016s. Health system indicator variables are from World Bank 2016f; World Bank 2016g; World Bank 2016h; World Bank 2016i; World Bank 2016j; World Bank 2016o.]
2) How is a country's economic stability associated with health system indicators?
    a. H_A: Economically stable countries, with high GDP, high exports, high GNI, and high total reserves will experience favorable health system indicators. [Note: Economic stability variables are from World Bank, 2016b; World Bank, 2016e; World Bank 2016r.]

3) How is a country's political stability associated with TB incidence when accounting for population density, precipitation, and refugee populations?
    a. H_A: Politically stable countries, with high voice and accountability, an absence of violence and terrorism, high control of corruption, high regulatory quality, and high rule of law will experience a lower incidence of tuberculosis. [Note: Tuberculosis incidence is from WHO 2016c. Control variables are from World Bank, 2016a; World Bank, 2016l; World Bank, 2016n; World Bank, 2016p.]
4) How is a country's economic stability associated with TB incidence when accounting for population density, precipitation, and refugee populations?
    a. H_A: Economically stable countries, with high GDP, high exports, high GNI, and high total reserves will experience a lower incidence of tuberculosis.
5) How are a country's health system indicators associated with TB incidence when accounting for population density, precipitation, and refugee populations?
    a. Countries with high tuberculosis case detection rates, high health expenditures, high measles immunization rates, high DTP immunization rates, increased access to clean water, and increased access to sanitation will experience a lower incidence of tuberculosis.
6) How are a country's policies regarding tuberculosis detection associated with TB incidence when accounting for population density, precipitation, and refugee populations?
    a. H_A: Countries with tuberculosis detection policies in place will experience a lower incidence of tuberculosis. [Note: Variables regarding TB detection policies are from WHO, 2016c.]
7) Is there a reciprocal relationship between a country's political stability & economic stability**?**
    a. H_A: Countries that are politically stable have more economic stability than countries with political instability and vice versa.

CHAPTER TWO: THEORETICAL FRAMEWORK AND LITERATURE REVIEW

Theoretical Framework

Infectious Disease as a Health System Indicator

Because societal functioning is dependent upon the physical well-being of both individuals and populations, governments heavily invest in health policies. However, most of these policies are predominately cure-based and not preventative in nature. Because of this, the provision of healthcare implies a negative concept—the absence of injury or disease. As a result, most healthcare systems are accurately labeled as "sickness care systems" (Evans & Stoddart, 1990, p. 1347). Cure-based provisions, such as diagnostics, technology, and treatments, are costlier than preventative care and therefore consume the majority of national healthcare budgets. This definition of health, as the absence of disease or injury, conflicts with the World Health Organizations' (WHO) view that health is comprised of mental, physical, and societal well-being (Evans & Stoddart, 1990; WHO, 2016b). While this may be true, the WHO definition is almost impossible to use as a benchmark for healthcare policy.

Because of this broad definition and the difficulty in measuring the three unique aspects of health (mental, physical, and societal well-being), for the purpose of research and policies, many countries observe health from the population perspective. Population health examines specific outcomes from groups of individuals within a given geographic distribution, usually in communities, counties, states, provinces, or nations (Kindig & Stoddart, 2003; Kindig, 2007). It is important to note that population health is not simply the overall health of a population, but rather includes distributions of health. Overall population health can be good even if a minority of the population experiences poor health.

Frameworks for Population Health

Determinants of Health Model, Population Ecology Theory, & Behavior Norms & Modification

Evans and Stoddart (1990) comprised one of the early models of population health. In addition to basic health determinants, such as the delivery of care, presence or absence of disease, individual genetics, and health and function, they also examined the interrelationships of non-medical determinants such as well-being, prosperity, the physical environment, one's social environment, and individual response in terms of behaviors. This model was significant for its identification of non-medical determinants on health.

The notion of environmental influences on health described by Evans and Stoddart (1990) can be further explained by population ecology theory (Hannan & Freeman, 1977). This sub-theory of natural selection describes how an environment, be it physical or social, affects the structure, failures, and successes of an organization, market, or population. Put simply, population ecology is a game of chance in which the population chooses a strategy and the environment chooses an outcome. The way in which a population responds to its environmental pressures, in this case, disease outbreaks and decreased population health, will determine its future success or failure. If the environment responds to and produces a favorable state or outcome, then the organization survives and prospers. Otherwise, the organization may struggle or eventually die (Hannan & Freeman, 1977). As pressures increase, only the dominant, stronger populations will survive and thrive, while weaker groups will adapt to survive, but will not necessarily thrive, or will die (Shortell & Kaluzney, 2005).

The Evans and Stoddart model (1990) also notes the influence of individual behaviors as a determinant of health. Traditional economics consider tastes to be “predetermined and fixed rather than subject to the forces of change” (Rice & Unruh, 2009, p. 149). It is in chaotic or environment-altering situations that people modify their behaviors, tastes, and even their values and beliefs in order to survive (Drummond et al., 2005; Shortly & Kaluzney, 2005; Rice & Unruh, 2016). In terms of directly transmitted diseases, human behavior is adaptive in nature, has the potential to alter the progress and course of epidemics, and sensitively responds to changes in disease emergence and spread. The motivational states of individuals include their goals, values, desires, and cultural and spiritual beliefs; however, under certain conditions, individuals will not act according to these states. Individuals most likely alter their behavior as the probability of infection modifies (Ceddia et al., 2013). Some individuals will place the value of society above their own utility while others will value their own individual utility above the good of society. Infectious disease control is considered a public good since everyone in the community benefits as long as a particular level of disease containment is achieved, even if there is a monetary or opportunity cost involved (Ceddia et al., 2013).

Population Health Model & Complex Adaptive Systems Theory

Evans and Stoddart’s (1990) determinants of health model paved the way for future population health representations. Kingdig and Stoddart (2003) took the original model a step further by stating that population health outcomes are not solely defined by the sum of individual health determinates, but are also greatly influenced by societal interventions and policies. Many of these policies and interventions occur at the macro level of organization planning and response.

Complex adaptive systems theory is based on the interdependent interaction of people and activities whose outcomes are usually unpredictable. Such systems provide valuable insight for comprehending the complexity and functioning of healthcare systems (whether large or small in nature) that operate in highly unstable environments, such as during times of disease epidemics. In order to avoid chaos, rules, protocols, and policies must direct people's behaviors; furthermore, organizations must adapt and shape to fit their current environment (Shortell & Kaluzney, 2005). Healthcare planning for these frenzied incidents is constantly altered as unintended consequences occur. If a complex systems perspective is adapted, then the integration of economics and disease ecology can be utilized to better comprehend macro responses to the emergence and spread of diseases (Ceddia et al., 2013).

<u>County Health Rankings Model & Economic Theory</u>

More recently, the Kingdig and Stoddart (2003) model has been re-designed into one of the most noted population health models used today. The University of Wisconsin in conjunction with the Robert Wood Johnson Foundation created a county health rankings model based on three primary, sequential categories—1) policies and programs, 2) health factors, and 3) health outcomes. The category of health factors in further divided into four sub-groupings with percentage contributions—1) health behaviors (30%), 2) clinical care (20%), 3) social and economic factors (40%), and 4) the physical environment (10%). These sub-grouping are further broken down into specific indicators and measurable variables. For this particular model, health outcomes are measured by both the length and quality of life, with each contributing 50%.

The sub-grouping of social and economic factors, contributes the most (40%) to the health factors category. Such factors act in response to the basic principles outlined by economic

theory. Economic theory states that choices are determined by the rational allocation of resources, which are purposed to maximize an individual's or firm's perceived utility, well-being, or profit (Drummond et al., 2005; Rice & Unruh, 2016; Ceddia et al., 2013). Economic theory also discusses the exchange of goods between buyers and sellers. In order to maximize utilities and increase profits, many individuals and businesses engage in international trade and commerce. This has resulted in previously unprecedented macroeconomic growth brought about by an increase in globalization, fossil fuel transport, trade liberalization, information technology, and telecommunications (Ceddia et al., 2013). Because "human beings are amongst the most common vectors of epidemic disease…as humans travel, so, too do the infections [that they] harbor" (Markel, 2004, p. 5). International travel and globalization has directly influenced the emergence (and even the re-emergence) of infectious diseases, specifically via the movement of microbes. Increased trade and globalization have simply opened new pathways for the migration of pests and pathogens to areas without prior exposure or immunity by connecting undeveloped or under-developed areas to developed ones (Perrings, 2016; Ceddia et al., 2013; Kimball, 2012).

Conceptual Model

This study aims to investigate the direct and indirect impact of four latent constructs (political stability, economic stability, health system indicators, and detection policies) on the outcome of tuberculosis incidence. The initial conceptual model is presented in Figure 1 below.

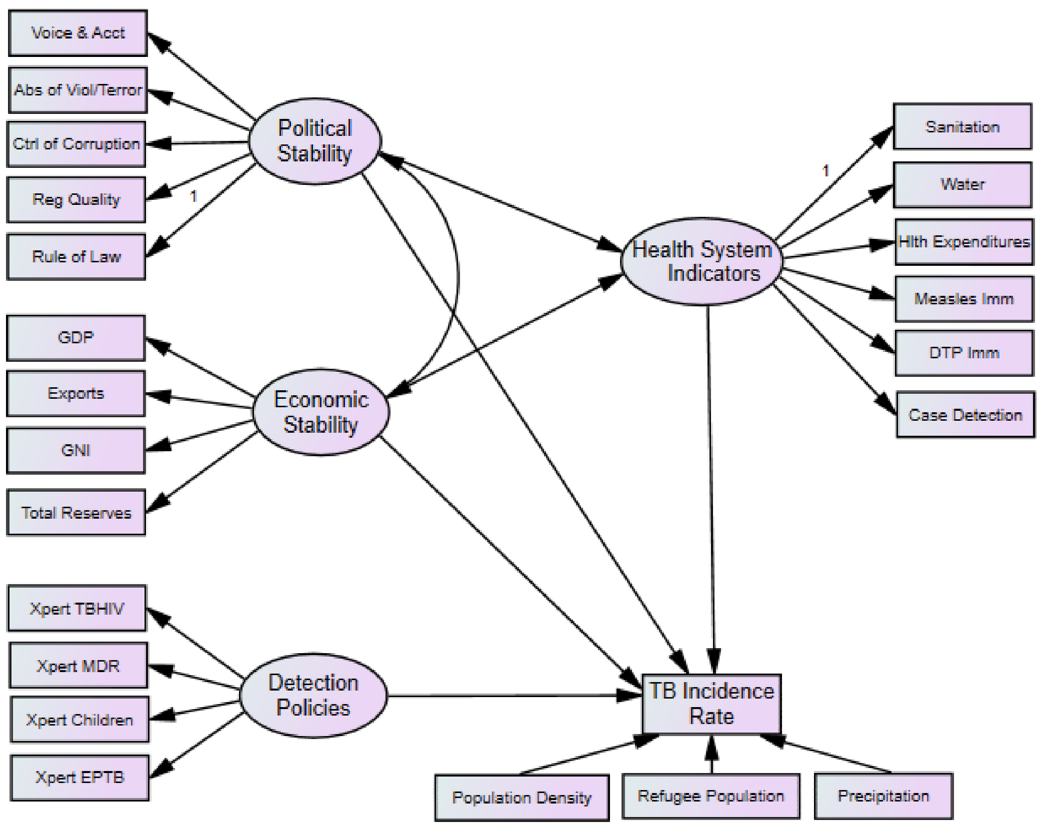

Figure 1: Initial Conceptual Model

The *political stability* latent construct is comprised of variables measuring voice and accountability, violence and terrorism, control of corruption, regulatory quality, and rule of law. The literature discussed below indicates that political stability is associated with economic stability (Bausch & Schwarz, 2014; Aisen & Veiga, 2013; Polachek & Sevastianova, 2012; Svensson, 1998; Alesina et al., 1996; Alesina & Perotti, 1996) and variables comprising the health system indicators construct, such as water and sanitation (Ostrach & Singer, 2012; McNeill, 1999). Other sources indicate that political stability influences infectious disease (WHO, 2014; Canetti et al., 2014; Ostrach & Singer, 2012; Ali et al., 2012; McNeill, 1999), but not necessarily tuberculosis; this model aims to test both the indirect effect of political stability

on tuberculosis incidence through either economic stability or health indices as well as the possible direct effect of political stability on tuberculosis incidence.

The observed variable of tuberculosis *detection policies* was measured by the presence or absence of national guidance for use of Xpert MTB/RIF (Mycobacterium tuberculosis/ resistance to rifampicin) as the initial test for diagnosis of drug-resistant TB, HIV-associated TB, TB in children, and extra-pulmonary TB among suspected individuals or people at risk (World Health Organization, 2016c). Over 85 research articles are available on data pertaining to the accuracy of the Xpert MTB/RIF assay, the utility of Xpert MTB/RIF diagnostics, and the cost-effectiveness of the Xpert MTB/RIF (WHO Policy Update, 2014), but data is not available on country-level implementations or outcomes. Although other forms of TB diagnostics exist and have been in place longer than Xpert, country-wide data is not readily available for these detection methods; therefore, national guidance for use of Xpert MTB/RIF serves as a representation of other detection policies for this purpose of this research.

The literature also indicates that when standardized diagnostic and testing techniques are made into specific TB-testing policies, more cases of tuberculosis are identified and treated, thereby reducing incidence rates and further contraction (Lönnroth et al., 2015; Chai, Mattingly, & Varma, 2013; Lienhardt et al., 2012). Due to this relationship between policies and increased detection, tuberculosis policies are directly related to health system indicators, specifically the observed variable measuring tuberculosis detection. Furthermore, policies should directly influence tuberculosis incidence.

The latent construct of *economic stability* is comprised of variables measuring gross domestic product (GDP), exports, gross national income, and total reserves. The literature indicates that economic stability is associated with political stability and variables comprising the

health system indicators construct, such as government health expenditures and immunization rates (Semenza, Tsolova, & Lim, 2012). Other sources indicate that economic stability influences infectious disease (Przybylski et al., 2014; Semenza, Tsolova, & Lim, 2012), but tuberculosis is not specified as one of those diseases. This model aims to test both the indirect effect of economic stability on tuberculosis incidence through either political stability or health indices as well as the possible direct effect of economic stability on tuberculosis incidence.

The latent construct of *health system indicators* is comprised of variables measuring tuberculosis case detection, measles immunizations, DTP immunizations, health expenditures, improved water sources, and improved sanitation facilities. The literature indicates that health system indicators directly influence tuberculosis incidence (WHO, 2015b; Zorzella-Pezavento et al., 2013). Three observed variables—population density, precipitation, and refugee populations—will be controlled for under the endogenous or dependent variable of tuberculosis incidence. These variables have been found to directly or indirectly influence disease incidence and spread (Leblebicioglu & Ozaras, 2015; Norredam et al., 2015; De Vries et al., 2014; Bausch & Schwarz, 2014; Bloom & Fink, 2013; Diaz et al., 2010).

Literature Review

This study hypothesizes that several latent constructs impact tuberculosis directly and indirectly through health system indicators. The latent constructs are political stability, economic stability, and health system indicators. Also, an observed variable—tuberculosis policy—is hypothesized to affect TB incidence. This literature review will discuss important findings and relationships between the observed variables and each of the three latent constructs. It will also review the literature pertinent to the relationship between these constructs and

between each and TB incidence. Finally, it will examine literature on the relationship between the control variables and TB incidence. Such findings and relationships also serve as the basis for this study's significance, research questions, and hypotheses.

Political Stability

The *political stability* latent construct is comprised of variables measuring voice and accountability, violence and terrorism, and control of corruption. Voice and accountability measures citizen participation in terms of electing their government; it also entails freedom of speech aspects and media censorship (World Bank, 2016r). Violence and terrorism measures instability within a political system, violence fueled by political aspirations, and terrorism (World Bank, 2016m). Control of corruption measures the involvement of public influence in private gain; detailed measures include both trivial and salient types of corruption and coup d'états of the public government or entity by private or select groups (World Bank, 2016c).

Numerous studies have analyzed various indicators of political stability. In 1995, Mauro utilized the *Business International* indices variables such as institutional political change, social political stability, the probability of opposition group takeover, stability of labor, relationships with neighboring countries, terrorism, legal system judiciary, bureaucracy and red tape, and corruption to examine government stability. Other variables used to measure political stability include the propensity for government collapse, political unrest, government turnovers, and the transfer of government power (Alesina, 1996b). Since the late 1990s, Kaufmann and colleagues (1999a, 1999b, 2002, 2009) utilized the World Bank's Worldwide Governance Indicator variables of voice and accountability, violence and terrorism, government effectiveness, regulatory quality, rule of law, and control of corruption to present their data sets. Other studies by Andres (2006), Das and Andriamananjara, (2006), Jung (2006), Liu and San (2006), Hart,

Atkins and Youniss (2005), Llamazares (2005), Neumayer (2002), and Apodaca (2004) have used the indicators as explanatory variables.

While several studies have indicated that political corruption and its indices influence population health and infectious disease, to the researcher's knowledge, no studies have directly examined tuberculosis incidence.

Voice & Accountability as an Indicator of Political Stability & Its Impacts

Few studies have identified voice and accountability as an indicator of political stability. One study, however, attributed numerous violent conflicts in Africa to an absence of voice and accountability, resulting in political instability (Asongu & Nwachukwu, 2016).

Voice and accountability influence infectious disease. Letendre, Fincher, and Thornhill (2010) found that as citizen expression of policy and leader preferences increased, executive power decreased, and civil liberties increased, the incidence of disease also decreased. In Delhi, citizens in need of specialized care for HIV, AIDS, and tuberculosis were able to make their requests known to federal planners and program managers instead of having to go through health post channels, which are unequipped to handle these conditions (Houtzager et al., 2014). Man and colleagues (2014) found that countries with greater levels of political accountability had higher levels of antiretroviral therapy for HIV prevention and treatment. No research has examined the role of voice & accountability on economic stability and tuberculosis.

Violence & Terrorism as an Indicator of Political Stability and Its Impacts

Violence and/or terrorism have been considered to be indicators of political stability by the World Bank (World Bank, 2016m) and a number of studies (Alesina, 1996b; Kaufmann, et

al.,1999a, 1999b, 2002, 2009). Violence directly affects population health via physical injuries, psychological consequences (depression and anxiety), detrimental behavior changes (smoking, alcohol use, illicit drug use, and unsafe sexual practices), undesired pregnancies, and the spread of disease (WHO, 2014). Violence may result in death, disability, suicide, HIV or AIDS, cancer, or cardiovascular disease (WHO, 2014; Dunkle et al., 2004; Conner et al., 2001). Around 14,000 individuals die daily from injuries; about one-quarter of which are acts of violence against others or oneself (WHO, 2014). These violent acts predominantly include child abuse, domestic and sexual assault, suicide (16% of all injuries), homicide (10% of all injuries), and war or conflict (2% of all injuries). Violence also impacts economic stability because a heavy cost is imposed on both individuals and societies in the form of treatment, rehabilitation, and lost worker productivity (WHO, 2014).

The form of violence most visible at the global level is war, usually in the form of terrorism or conflict. A direct relationship exists between both civil and international violence and negative population health outcomes, often in the form of psychological illness (Canetti et al., 2014) and infectious disease (Ostrach & Singer, 2012; Ali et al., 2012). This has been demonstrated since times of early exploration such as the Conquest of Jamaica, Battle of Guadeloupe, War of Spanish Succession, Seven Years' War, American Revolution, and the Napoleonic Wars (McNeill, 1999). War and violence traumatizes populations both directly and indirectly by physically

> destroying health care systems and social infrastructures, despoiling the environment, intentionally or unintentionally causing or exacerbating food insecurity and malnutrition, creating refugee populations, and spreading infections (e.g. through the movement of troops, dislocation of civilian populations, changes in the environment).

(Ostrach & Singer, 2012, p. 257)

These repercussions of violence almost never exist in isolation of each other. Instead, detrimental outcomes are compounded, usually indirectly through infrastructure destruction, sanctions, and policies, promoting disease clustering and comorbidities. For instance, the Persian Gulf War in 1991 severely damaged Iraq's sanitation and water systems which almost instantly increased the incidence of malaria, measles, polio, cholera, typhoid, and hepatitis. Furthermore, sanctions regarding food imports coupled with a lack of sanitation and clean water contributed to malnutrition, more diarrheal episodes, and respiratory infections (Ostrach & Singer, 2012). Canetti and researchers (2014) discovered clustering between post-traumatic stress disorder, depression, and inflammation among citizens experiencing prolonged exposure to conflict and violence via terrorism. Similarly, Ali and colleagues (2012) noted the comorbidities of Hepatitis B and severe liver disease in soldiers fighting against terror groups.

The types of weapons and chemical warfare utilized can also directly affect specific conditions. Jansen and researchers (2014) discussed how biological weapons enable the deliberate release of specific viruses and bacteria to cause illness or death. For instance, both civilians and militants living in Iran during a mustard gas siege later suffered from severe respiratory and lung conditions, eye damage, and skin lesions (Khateri et al., 2003).

In sum, while there is ample evidence demonstrating both the direct and indirect effects of violence and terrorism on infectious disease and economic systems, to my knowledge studies have not specifically examined its impact on tuberculosis.

Control of Corruption as an Indicator of Political Stability and Its Impacts

Government corruption is another indicator of political stability. For instance, civil wars in Liberia, Sierra Leone, and Guinea have resulted in decades of corrupt rulers, power grabs, periods of violence, coup d'états, and inefficient governments (Bausch & Schwarz, 2014). Ecological and man-made crises such as earthquakes, over-fishing, floods, and droughts may put added pressure on already tense political and social situations, resulting in even more violence or (Galaz et al., 2011). Depending on the nation and its history, political structure may play a role in violence and corruption. Corruption, unemployment, and the presence or absence of state leadership and government, are each correlated to violence (Brück, Naudé, & Verwimp, 2013; Agostini et al., 2008, Rodgers, 2004).

Forms of government that rule by many, such as a democracy, are commonly believed to reduce corruption (Kolstad & Wiig, 2015; Bohara, Mitchell, & Mittendorff, 2004). Koubi and researchers (2012) found that non-democratic countries were more likely to engage in conflict than democratic nations. Ultimately, government types may indirectly influence population health and disease. For instance, numerous researchers have indicated that infectious disease decreases as countries transition into democracies (Letendre, Fincher, & Thornhill, 2010; Thornhill et al., 2009). Similarly, Man and colleagues (2014) found that countries with better controls in place to monitor and punish corruption also had higher levels of antiretroviral therapy for HIV prevention and treatment.

As far as impacts on health system indicators, political corruption results in decreased life expectancies and shortened disability adjusted life years (Siverson & Johnson, 2014). These results primarily stem from disease mortality and morbidity. The cycle is further continued as investments in public health and welfare decrease (Letendre, Fincher, & Thornhill, 2010). This

could be detrimental for many nations because research suggests that a direct relationship exists between health security and state stability. As health security increases, via funding, food access, and sustainable agriculture, state stability is bolstered, even if only in the short-term; this creates a positive feedback loop which strengthens a nation's capacity (Quinn et al., 2014).

Relationship between Political & Economic Stability

A link between political stability and economic stability has been found in a few studies. Politically unstable nations are among the poorest in the world; its citizens oftentimes are isolated and neglected, while diverse ethnic and minority groups possess little or no voice and extremely limited power (Man et al., 2014; Bausch & Schwarz, 2014; Letendre, Fincher, & Thornhill, 2010). As previously discussed, decades of violence, such as in African nations, have resulted in power grabs, corruption, and changes in leadership. These unstable governments have completely stalled or even reversed national development and growth in many areas (Bausch & Schwarz, 2014; Aisen & Veiga, 2013; Svensson, 1998; Alesina et al., 1996; Alesina & Perotti, 1996). Alesina and Perotti (1996) found that socio-political instability, in the form of political unrest and violent phenomena, created uncertainty among a nation's citizen and investors. This then resulted in reduced domestic investments, which harmed national economic growth. Similarly, Alesina and colleagues (1996) discovered that in nations with a high tendency of government instability, in the form of potential government collapse, per capital GDP growth was significantly lower than other, more stable time periods. Violence and conflict, in terms of war, have also been demonstrated to slow economic growth (Polachek & Sevastianova, 2012).

Tuberculosis Detection Policies and Their Impact

The observed variable of tuberculosis policies is measured by the presence or absence of national guidelines for use of Xpert MTB/RIF (Mycobacterium tuberculosis/ resistance to rifampicin) as the initial test for diagnosis of drug-resistant TB, HIV-associated TB, and TB among suspected individuals or people at risk (World Health Organization, 2016d). This study hypothesizes that countries with tuberculosis policies in place will experience a lower incidence of tuberculosis, both directly and indirectly.

Tuberculosis polices were developed by several global organizations, such as the WHO and the International Union against TB and Lung Disease. These groups initiated the *Global Project on Drug Resistance Surveillance* in 1994 with hopes of standardizing the techniques of TB sampling and laboratory technologies needed for the measurement of drug-resistant tuberculosis (Lönnroth et al., 2015; Lienhardt et al., 2012; WHO, 2015a). These standardized techniques are made into specific TB-testing policies and implemented by nations world-wide. The Global Project on Drug Resistance Surveillance paved the way for the WHO's formal publication of *Guidelines for the Programmatic Management of Drug-Resistant Tuberculosis*. The *Guidelines* provide valuable practice implications for public health workers as well as policy applications for law makers (WHO, 2011). Another policy titled the *Stop TB Initiative* created a world-wide plan focused on high-burden countries, drug-resistant mutations, and HIV-associated TB (Lienhardt et al., 2012).

Original infection control policies were based on expert opinion, but more recent evidenced- based approaches, such as the *Guidelines* and *Stop TB Initiative*, have been shown to substantially reduce tuberculosis rates and contraction among healthcare workers, specifically occupational policies implemented in hospitals, laboratories, and clinics (Lönnroth et al., 2015;

Chai, Mattingly, & Varma, 2013; Lienhardt et al., 2012). Such initiatives and guidelines recommend that patients experiencing resistance to rifampicin be tested via rapid dug-susceptibility molecular techniques. The use of microbial cultures remains important for the early detection of failure during treatment (Chai, Mattingly, & Varma, 2013; WHO, 2011). Such detection methods include Xpert MTB/RIF, the newest and most prescribed detection assay (Weyer et al, 2013). Xpert MTB/RIF serves as the current and future policy recommendation for diagnostics, as established by the WHO.

Many countries have already adopted the Xpert MTB/RIF testing policies. Such initiatives aim to reduce morbidity by 90% and reduce incidence rates by "80% between 2015 and 2030" (WHO, 2015b). On average, TB incidence has decreased by 1.5% annually since these many of these initiatives went into effect in the early 2000s. However, these statistics need to improve to reflect decreases of 4% to 5% annually in order to meet the WHO's 2020 goals (WHO, 2015b). It is estimated that if adopted in the African nations of Lesotho, Namibia, Swaziland, Botswana, and South Africa, the Xpert testing system would prevent 132,000 TB cases, eliminate 182,000 possible TB deaths, and reduce prevalence rates by over 28% within a ten-year period (Menzies et al., 2012). However, as more and more countries adopt Xpert testing and modern treatment regiments, health system costs are projected to rise substantially. This presents a challenge for developing and financially constrained nations.

Economic Stability

The latent construct of *economic stability* is comprised of variables measuring gross domestic product (GDP), central government debt, and unemployment. Gross domestic product is the "sum of gross value added by all producers" in a country's economy in addition to any "product taxes minus subsidies not included in the value of products"; it is calculated at market

price in current United States dollars (World Bank, 2016e). Central government debt is defined as "fixed-term contractual obligations" by direct governments to others that are outstanding by a particular date (World Bank, 2016b). This includes "domestic and foreign liabilities" in the form of currency, monetary deposits, securities, and loans (World Bank, 2016b). It is measured as a percent of the nation's total GDP (World Bank, 2016b). Unemployment comprised the labor force share that is without work but available to work or actively seeking employment; it is measured as a percent of a country's total labor force (World Bank, 2016r). This study hypothesizes that economically stable countries, with high GDP, low government debt, and low unemployment rates, will experience a lower incidence of tuberculosis, both directly and indirectly.

<u>Gross Domestic Product as an Indicator of Economic Stability and Its Impacts</u>

Gross domestic product is commonly used as an economic indicator throughout numerous fields of research. Its growth or decline is an indication of both a country's labor share (Karabarbounis & Neiman, 2013) and productions of outputs. Both of these further contribute to another economic indicator- unemployment. Per capita GDP and its related factors indirectly contribute to overall population health outcomes (Murthy & Okunade, 2014). For instance, economic conditions and GDP growth in China have drastically expanded over the last several decades due to an increase use of fossil fuels. However, this has also resulted in increased emissions, greenhouse gases, and carbon dioxide, which have led to a crisis of air pollution (Kan, Chen, & Tong, 2012). Such pollutants impair health by causing chronic obstructive pulmonary disease (Mehta et al., 2012), lung cancer and other lung conditions (Raaschou-Nielsen et al., 2013; Hystad et al., 2013; Pope III et al., 2002) which can negatively affect tuberculosis patients (Hwang et al., 2014; Smith et al., 2014; Sumpter & Chandramohan, 2013). These studies have

indicated that GDP influences population health, infectious disease, and tuberculosis indirectly, in both positive and negative ways, but to the researcher's knowledge, no studies have directly examined tuberculosis incidence rates as an outcome of GDP growth.

Central Government Debt as an Indicator of Economic Stability and Its Impacts

Many countries around the world have accumulated large debts, measured in the form of debt to GDP. Given the current economic recession characterized by stimulus spending, financial bailouts, and lower revenues, public debt/GDP ratios are higher than they have been in the past 40 years (Ghosh et al., 2013). Ratios near or above 1 are very common. For instance, the U.S., which historically is a low debt nation, is projected to have a debt of 90% of the GDP within the next decade. Low, world-wide interest rates have worsened debt burdens in numerous high-debt nations. As deficits increase and debt alarmingly increases in bad times, like the present, governments are forced to gain added tax revenue and face lower demands for spending transfer when economic and fiscal conditions improve (Hall, 2014).

Governments are steadily approaching an endogenous debt ceiling, pertaining to the difference between current debt ratios and estimated debt limits, beyond which liabilities cannot be rolled over (Ghosh et al., 2013). At this point, countries attempting to reduce their deficits may opt to cut public or welfare services, many of which are valuable health resources (McKeeargue, 2010; Peabody, 1996), negatively impacting population health. By disassembling safety nets such as protective welfare programs and government services, unforeseen consequences arise which have the potential to ignite infectious disease epidemics (Semenza, Tsolova, & Lim, 2012).

Since 2007, the global financial crisis has disproportionally affected vulnerable groups within societies (Kentikelenis et al., 2011); it is these vulnerable groups that also carry a disproportional burden for infectious disease as compared to the general population (Semenza, Tsolova, & Lim, 2012). It is during these times of economic crisis that increases, not decreases, in preventative services for vulnerable groups are needed (Rechel et al., 2011). Preventative services would assist in containing the numerous indirect pathways of infectious disease outbreaks that appear during periods of economic struggle (Semenza, Tsolova, & Lim, 2012). These indirect pathways are for general infectious disease; no studies were found that specifically linked the pathways to tuberculosis. The pathway begins as pools of susceptible populations, due to decreased immunization coverage, increase, resulting in person-to-person transmissions. A combination of internal and external factors contributes to breakdowns in public infrastructures and systems, such as water treatment facilities, which then increase the size of infected populations (Suhrcke et al., 2011). Government and individual financial strains, create a detrimental cycle of disease continuance as patients experience reduced access to care, decreases or alteration to coverage benefits, and increased health service costs. These studies have indicated that central government debt influences population health and infectious disease; however, no studies have directly examined the specific outcome of tuberculosis incidence rates.

Unemployment as an Indicator of Economic Stability and Its Impacts

Unemployment rates serve as an indicator of a country's economic stability, which effects population health. Economic crises or worsening employment conditions, negatively affect cause-specific mortality. After the Soviet Union fell, an economic collapse ensued, resulting in unemployment; this increased mortality rates by as much as 20% in some surrounding nations (Karanikolos et al., 2013). In Europe, a 1% or greater rise in unemployment

was associated with increases in suicides, murders, and alcohol related deaths (Stuckler et al., 2009). Mental health is adversely affected by unemployment (Strandh et al., 2014; Gili et al., 2013; Backhans & Hemmingsson, 2012; Warr, 1987). Unemployed individuals have twice the prevalence of psychological problems than employed individuals. Similarly, countries with strong employment protection systems experienced less negative unemployment effects than countries with poor employment protection systems (Paul & Moser, 2009; Karanikolos et al., 2013).

While mental health has been largely examined in relation to unemployment, not much research has analyzed the potential impact of unemployment on clinical epidemiology, specifically tuberculosis. Przybylski and colleagues (2014) did find that societal risk factors, such as unemployment, may favor the occurrence of tuberculosis. Pulmonary TB, advanced radiological lesions, and extra-pulmonary sites were more frequently diagnosed and associated with treatment interruptions and higher mortality during hospitalization in unemployed patients, but more research is needed to further investigate the role of unemployment on TB (Przybylski et al., 2014).

Health System Indicators

The latent construct of *health system indicators* is comprised of variables measuring tuberculosis case detection, HIV prevalence, immunizations, health expenditures, improved water sources, and improved sanitation facilities. Tuberculosis case detection rates are the “number of new and relapse cases for all forms of tuberculosis” reported to the WHO in a given year divided by the “WHO’s estimate of the number of incident cases for the same year”, measured as a percent (World Bank, 2016q). HIV prevalence is the number of individuals in a

country who are infected with HIV; it is measured per 1,000 people in the population (World Bank, 2016o). Immunizations are measured as the

> percentage of children ages 12-23 months who received vaccinations before 12 months or at any time before survey. A child is considered adequately immunized against diphtheria, pertussis (or whooping cough), and tetanus (DPT) after receiving three doses of the vaccine and adequately immunized against measles after receiving one dose of the vaccine. (World Bank, 2016g & 2016h)

Health expenditures are the "sum of public and private health expenditures" (World Bank, 2016f). They cover the "provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health, but do not include provision of water and sanitation" (World Bank, 2016f). Expenditures are measured as a percent of a country's total GDP (World Bank, 2016f). Improved water sources are measured as a percentage of the population using an "improved drinking water source" (World Bank, 2016j). These source include "piped water on the premises, such as piped household water connection located inside the user's dwelling, plot, or yard, and other improved drinking water sources like public taps or standpipes, tube wells or boreholes, protected dug wells, protected springs, and rainwater collection" (World Bank, 2016j). Improved sanitation facilities are measured as a percent of the population using improved sanitation facilities. They include "flush or pour" methods to piped sewer systems, septic tanks, or pit latrines. They may also include "ventilated improved pit latrines, pit latrines with slabs, and composting toilets" (World Bank, 2016i).

Tuberculosis Case Detection as a Health System Indicator and Its Impacts on TB

Although finding and treating individuals with active disease is one of the main goals of global tuberculosis control, case detection rates continue to be low in many nations (Datiko & Lindtjørn, 2009). In addition to the common Xpert MTB/RIF method, adding health extension workers into local communities has also been shown to increase detection rates (Menzies et al., 2012; Datiko & Lindtjørn, 2009).

Contributions from public private mix initiatives have increased case detection rates for all forms of TB, increased case notifications, improved treatment outcomes, aided in TB/HIV activity collaborations, and improved the management of drug-resistant TB (WHO, 2010). As a result of the Stop TB campaign and other TB initiatives, over 5.8 million new and relapse cases of TB were detected and notified in 2009; an additional 2.6 million incident cases were detected from sputum smear technology (WHO, 2010). Additionally, case detection rates have increased and now average 63% as of 2009. Vulnerable nations like those in Africa have the lowest detection rates between 48% and 53%, which severely lag behind Europe's rates of 80% detection. Despite these differences, overall TB incidence rates are beginning to slowly decrease as detection and notification rates increase in regions of the Mediterranean, Asia, and Africa. This indicates that case detection methods such as Xpert MTB/RIF testing are improving in quality and effectiveness (WHO, 2010).

HIV Prevalence as a Health System Indicator and Its Impacts on TB

A high incidence or prevalence of chronic diseases and certain immunosuppressive diseases generally lowers an individual's immunity, making them more susceptible to other diseases. Such is the case with HIV and acquired immune deficiency syndrome (AIDS) (Biello et al., 2012; Bout et al., 2014; Ceddia et al., 2013; Siawaya, 2014; Man et al., 2014; Siverson &

Johnson, 2014; Hargreaves & Glynn, 2002). HIV has the highest mortality rate of all sexually transmitted infections (Siawaya, 2014; Joint United Nations Programme, 2011). Controlling transmissions is a major public health priority, particularly in nations with low literacy rates, a lack of proper sex education, and individuals who frequently engage in high-risk behaviors (Siawaya, 2014). Co-infections among HIV and TB continue in increase. Among people with latent TB infections, "HIV is the strongest known risk factor for progression" from latent TB into active TB disease (WHO, 2015b).

Immunizations as a Health System Indicator and Its Impacts on TB

For decades, vaccines have been utilized to reduce the number of susceptible individuals in a population by creating communal immunity (Babiuk, 2014; Fukuda et al., 2014). Such an immunity is effective if natural communicable diseases or passive immunization successfully prevents future infections (Doerr & Berger, 2014). If vaccinations in an area are voluntary, as vaccination coverage approaches the critical level required for communal immunity, fewer incentives exist for remaining unvaccinated individuals to become immunized. This increases the number of free-riders who avoid becoming infected via their surrounding community while not paying the associated cost of vaccinations. Individual decisions made regarding immunizations revolve around anticipated risk and perceived probabilities of becoming infected. If too many individuals chose to remain unvaccinated, communal immunity destabilizes and disease resurges (Fukuda et al., 2014).

Not only do vaccines create communal immunity, but when administered to newborns and young children, they also have resulted in decreased infant mortality and increased childhood survival rates (Aksan, 2014). Evidence shows that increased immunization rates (Goenka & Liu, 2012; Babiuk, 2014; Doer & Berger, 2014; Aksan, 2014; Man et al., 2014)

greatly improve health outcomes and reduce mortality (Mubila, 2012; Goenka & Liu, 2012; Goodman, 2007). The use of vaccinations at the national level has even resulted in eradication of some diseases, such as small pox and polio. Other vaccinations assist in preventing vertical infections of maternal-fetal transfusion during pregnancy (Doerr & Berger, 2014).

Currently, only one WHO recommended tuberculosis vaccine exists: *M. bovis* Bacillus Calmette-Gu´erin (BCG). However, this vaccine is given to infants under 1 year of age, but induced immunity decreased with age and does not provide sufficient protection against adult TB (Zorzella-Pezavento et al., 2013). Furthermore, various studies have indicated that the vaccine's efficacy widely ranges from 0% to 80% protective (Tanghe et al., 2001). While DTP and measles vaccinations do not directly protect against tuberculosis, they represent public health infrastructure systems.

<u>Health Expenditures as a Health System Indicator and Its Impacts on TB</u>

Data on health spending, measured as a proportion of GDP (Murthy & Okunade, 2014), has indicated a positive relationship between increase health spending and better population health (Drummond et al., 2015; Sisko et al., 2014; Kondilis et al., 2013; Kringos et al., 2013; Moreno-Serra, & Smith, 2012). Health spending also indirectly affect infectious disease (Karanikolos et al., 2013). In theory, the more money families or governments have to dedicate towards healthcare, the better their health outcomes will be. However, this increased spending does not necessarily have a linear relationship with improved patient outcomes for all countries. For instance, the United States spends more money per capita on healthcare than any other country in the world, approximately 18% of their Gross Domestic Product (GDP) (Centers for Medicare and Medicaid Services [CMS], 2013a). The U.S. also spends 60% more on hospital

care and 250% more on physicians and specialists (Organization of Economic Cooperation and Development [OECD], 2011); yet, it ranks last or near last in terms of access, efficiency, equity, infant mortality, and life expectancy (The Commonwealth Fund, 2015; MacDorman et al., 2014; MacDorman, Hoyert, & Mathews, 2013).

Due to recent economic recessions, government health expenditures have been negatively impacted by reductions in public budgets and program funding, which has resulted in limited access to healthcare services (Karanikolos et al., 2013; McKeeargue, 2010; Peabody, 1996). Initially, no changes were made to health benefits packages, coverage options, and public services provided by the state. However, once fiscal austerity measures were implemented, numerous standard services were removed from benefits packages in some countries, while others were forced to expand benefits for low-income and vulnerable groups (Mladovsky et al., 2012). Still other countries experiencing decreases in expenditure budgets shifted costs by decreasing coverage and increasing user charges for certain health services. This is concerning because it increases out-of-pocket payments by patients and increases the financial burden to households and families (Wagstaff & Van Doorslaer, 1992). By increasing user charges, the use of high-value and low-value care among low income and high use individuals is reduced (Gemmill, Thomson, & Mossialos, 2008; Newhouse & Rand Corporation, 1993). Ultimately, health outcomes are worsened, specifically in terms of primary and ambulatory specialist care, and increases are seen in the use of free, but resource-intensive services, like emergency room visits. Several consequences of this included increased suicide rates and HIV outbreaks (Karanikolos et al., 2013). Depending on the country and its covered benefits and services, tuberculosis may be directly or indirectly related to health expenditures. Even if tuberculosis services are covered, patients are still likely to be faced with high indirect expenses for travel,

food, and accommodation (Chimbindi et al., 2015).

Improved Water Sources & Sanitation Facilities as Health System Indicators and Their Impact on TB

For centuries, people have noted the direct impact of tainted water and poor sanitation on disease spread. One of the most noted cases of this was the 1854 cholera outbreak in London. Cholera seeped into the water system from an infected infant's soiled diaper. Because there was no indoor plumbing and no real sanitation systems in place during this time, people simply disposed of their waste and trash outside in ditches or into the rivers. By talking to local residents and physically mapping the pattern of disease outbreak, John Snow identified the source of the outbreak. The handle to the public water pump on Broad Street was then removed to stop the outbreak (Johnson, 2006). As demonstrated by this epidemic and many others, proper water, sanitation, and hygiene processes, were completely absent. However, such practices remain "inadequate in large parts of low- and middle-income countries" even today (Grimes et al., 2014, p. 2).

Evidence abounds demonstrating that improved water, sanitation (Babiuk, 2014; Sahoo & Dash, 2012; Grimes et al., 2014; Aksan, 2014; Vittecoq et al., 2014; Lopez et al., 2015) and hygiene (Man et al., 2014; Francesconi et al., 2003) greatly improve health outcomes and reduce mortality (Mubila, 2012; Goenka & Liu, 2012; Goodman, 2007). In China, soil-transmitted helminths infections were greatly reduced after improving sanitation and water treatment facilities (Wang et al., 2009). Similarly, St. Lucia re-constructed its water supply in the 1970s, which decreased infection rates of neglected tropical disease (Jordan, Bartholomew, & Unrae, 1978). *S. mansoni* and soil-transmitted helminths prevalence rates also decreased when Ethiopia

integrated a trachoma control initiative by increase the number of latrines and water sources (King et al., 2003).

In general, many people perceive that infectious diseases fall into two main categories--airborne or waterborne—with food and water contamination being a major factor in the spread of infectious diseases (Sahoo & Dash, 2012). Individuals residing in areas without proper water access or clean water are more likely to contract diarrheal and waterborne illnesses. Such infections weaken an individual’s overall immune system and make them more susceptible to other conditions, such as tuberculosis. In addition, a lack of clean water and proper fluid intake directly influences dehydration, contributes to malnutrition, and may ultimately result in death (Gleick, 1998; Davidhizar, Dunn, & Hart, 2004). For instance, more soldiers died from conditions of poor sanitation than from fighting in battle during the United States Civil War (Ostrach & Singer, 2012).

While water and sanitation do not directly relate to tuberculosis, they directly impact it through the pathway of increased adult and child mortality, increased diarrheal diseases, compromised immune systems, and HIV/ AIDS co-morbidities (Obi et al., 2007). The role of clean water for drinking, cooking, preparation of infant milk supplements, and consumption of anti-retrovirals is profound. Unclean water and poor sanitation may weaken people’s immune systems and make them prone to other diseases, like HIV and AIDS (Manase, Nkuna, & Ngorima, 2009; Obi et al., 2007; Bartram et al., 2005). Once individuals contract HIV/ AIDS, they are more likely to contract tuberculosis (Biello et al., 2012; Bout et al., 2014; Coker & Miller, 1997; Narain, Raviglione, & Kochi, 1992).

Control Variables

Three observed variables—population density, precipitation, and refugee populations—will be controlled for under the endogenous or dependent variable of tuberculosis incidence rates. Population density is the “mid-year population divided by land area” in square kilometers; it includes “all residents regardless of legal status or citizenship”, with the exception of “refugees not permanently settled in an area of asylum” (World Bank, 2016n). Precipitation is the “long-term average in depth, measured over time and space, of annual precipitation in a country”; it includes water in the form of either a solid or a liquid (World Bank, 2016a). Refugees are “people recognized under the 1951 Convention Relating to the Status of Refugees or its 1967 Protocol, the 1969 Organization of African Unity Convention Governing the Specific Aspects of Refugee Problems in Africa, people recognized under the United Nations Human Refugee Council statute, people granted humanitarian status, and people provided with temporary protection” (World Bank, 2016p).

Population Density Impact on TB Incidence Rates

In order to prevent infectious disease outbreaks and spread, population growth should be stable over the years (Hannan & Freeman, 1977; de la Croix & Dottori, 2008) and the population density of an area should be low (Hannan & Freeman, 1977; McNeill, 1999; Yoshikura, 2014; Lopez et al., 2015). Similarly, individual areas (such as cities and towns) should have sparse densities to prevent overcrowding (Sahoo & Dash, 2012; Goenka & Liu, 2012; Letendre, Fincher, & Thornhill, 2010). If a population grows in upcoming decades, then there may be adverse effects on food security (Babiuk, 2014; Sahoo & Dash, 2012; Aksan, 2014; Ostrach & Singer, 2015; Vittecoq et al., 2014), economic development, and natural resource sustainability

(de la Croix & Dottori, 2008; Bausch & Schwarz, 2014; Konneh, 2014; Ostrach & Singer, 2015) if appropriate policies are not implemented (Mubila, 2012).

In addition to these adverse effects, population density has been directly associated with increased tuberculosis incidence rates through increased person-to-person contact with active TB cases, leading to further disease transmission. De Vries and researchers (2014) examined European countries and found that in 15 large cities, all located within low tuberculosis incidence countries, rates were twice the national incidence. These results depicted an epidemiological tuberculosis transition in which the disease concentrates in densely populated areas as overall nation tuberculosis incidence rates decrease. Diaz and colleagues (2010) discovered similar findings in Cuban municipalities. Areas that were not densely populated experienced large reductions in tuberculosis incidence, while rates in densely populated areas remained high.

Precipitation Impact on TB Incidence Rates

Like population density, climate has also been shown to influence the growth and spread of disease. Climate, temperature, and precipitation greatly impact disease outbreaks (Bausch & Schwarz, 2014), population health (Sahoo & Dash, 2012), and population responses (Lima, 2014). Countries located in tropical climates tend to be hot zones for infectious diseases; the warm, moist air provides a unique ecological niche that works as a large-scale incubator for microbial growth and development (Bloom & Fink, 2013; Lafferty, 2009; Lipp, Huq, & Colwell, 2002; Weber, Mulholland, & Greenwood, 1998; Manson-Bahr, 1950). For instance, physicians and researchers in the early 1800s identified a connection between the quality of life of tuberculosis patients and clean, dry, less humid air. Sanatoriums located in mountain towns and

deserts became popular treatment destinations for patients (Rutgers Global Tuberculosis Institute, 2016; Murray, Schraufnagel, & Hopewell, 2015b; Andreas, 2015; Roberts & Bernard, 2015; Nash et al., 2014). Vitamin D deficiencies were also found to influence tuberculosis disease progression via immune control (Talat et al., 2010).

In addition to being breeding grounds for disease, long-term climate changes can also result in food and water shortages, which inevitably destabilize civilizations and result in population collapses. Ecological competition indirectly occurs as the fixed supply of natural resources is decreased. This is usually the case when both groups rely on the same supply of resources for sustainability (Hannan and Freeman, 1977). There also exists a link between climate and human population growth in pre-industrialized societies. Put simply, small changes in climate may result in large changes in population growth rates due to the interaction between climate, agriculture, and population sustainability (Lima, 2014; Vörösmarty et al., 2000; Cheeseman, 2015; Plantinga, Lewis, & Langpap, 2015; Schewe et al., 2014). For instance, Easter Island experienced cold, dry weather and minimal rainfall due to its northern location. This resulted in water shortages, increased hunting, deforestation, aerial volcanic fallout, and Asian dust plumes. These factors contributed to both a population and environmental collapse as the land exceeded its carrying capacity (De la Croix & Dottori, 2008).

Infectious disease outbreaks usually occur during the transitional period between rainy and dry seasons. Ecological and biological factors may force the emergence of viruses out of their natural habitats into populated areas. Man-made factors, such as deforestation, urban sprawl, overfishing, and greenhouse gas emissions, negatively contribute to climate change. Most of these changes have resulted in less cold winters with reduced rain, inconsistent rain patterns, extreme heat, and cataclysmic weather episodes (Sahoo & Dash, 2014; Galaz et al.,

2011). Extreme deforestation has been shown to force a faster transition from wet into dry seasons, and it may also cause dry periods to last beyond their normal season. This combination of deforestation and dry conditions is thought to have influenced more frequent contact between humans and bats carrying the Ebola virus in Africa (Bausch & Schwarz, 2014). These climactic changes not only result in an increase of zoonic disease, but also incur a loss of biodiversity, which may have ripple-like effects on political systems and governments, population health, and economics (Galaz et al., 2011).

Climate, particularly precipitation, has recently been found to influence tuberculosis incidence rates. Beiranvand and colleagues (2016) found a relationship between climate and the geographic distribution of tuberculosis in Khuzestan. Data revealed an inverse correlation between annual rain rates and TB incidence rates; extra dry areas experienced high TB incidence rates while low incident cases occurred in areas with average annual rain greater than 1,000 millimeters. Overall, the risk of TB increases for individuals living in extra dry climates or areas with low annual rainfall (Beiranvand et al., 2016).

Refugee Populations' Impact on TB Incidence Rates

Conflicts and instability in the Middle East, Africa, and some parts of Asia have resulted in mass migrations of refugees out of these nations and into the European Union and other countries of asylum (Nicolai, Fuchs, & von Mutius, 2015; Catchpole & Coulombier, 2015). In addition to the main concerns of safety, housing, and shelter, refugee health is becoming an ever-increasing concern. Many refugees suffer from violent trauma, injuries, sexual and reproductive health issues, and psychological disorders which further disrupt and strain nations' healthcare

delivery systems resulting in limited access to care and treatment interruptions (Catchpole & Coulombier, 2015).

Because many countries of origin have experienced devastation in terms of public health programs, particularly primary care and immunizations, many refugees are at specific risk for contracting and carrying infectious diseases (Norredam et al., 2012) within their native countries and to countries traveled through during migration (Catchpole & Coulombier, 2015). For instance, when Germany recently accepted a new wave of refugees, health workers identified conditions not normally seen in developed countries today. Such conditions included louse borne relapsing fever and severe tuberculosis (Nicolai, Fuchs, & von Mutius, 2015). The treatment of chronic and infectious conditions in refugee populations is a large financial burden to asylum countries. Additionally, if infectious conditions are not adequately controlled, they may spread from refugee groups to the general population. Because refugees come in waves, the issue of population density and overcrowding in already populated cities is an issue of increasing concern (Leblebicioglu & Ozaras, 2015; Norredam et al., 2015; Darr & Conn, 2015; Dang & Tribble, 2014; Bausch & Schwarz, 2014; Ostrach & Singer, 2012) as limited resources become even more constrained.

CHAPTER THREE: METHODOLOGY

The following sections discuss the proposed research questions and hypotheses, as informed by the study's problem and purpose statements and the literature. Research design with initial conceptual and structural models will be discussed. Information pertaining to sample selection, sample size, unit of analysis, and data collection will also be covered. Additionally, statistical measures and data analysis including descriptive statistics, univariate and bivariate analyses, missing data imputation, correlations, measurement models, confirmatory factor analyses, and structural equation modeling will be discussed in detail.

Research Questions & Hypotheses

The research questions and hypotheses were developed after a thorough review of the literature and determination of the problem statement and study purpose. Each research question and hypothesis concerned one of the four latent constructs (*political stability*, *economic stability*, *detection policies*, and *health system indicators*) and the observed outcome variable of *tuberculosis incidence*.

1) How is a country's political stability associated with health system indicators?
    a. H_A: Politically stable countries, with high voice and accountability, an absence of violence and terrorism, high control of corruption, high regulatory quality, and high rule of law will experience favorable health conditions.
2) How is a country's economic stability associated with health system indicators?
    a. H_A: Economically stable countries, with high GDP, high exports, high GNI, and high total reserves will experience favorable health system indicators.
3) How is a country's political stability associated with TB incidence rates when accounting for population density, precipitation, and refugee populations?
    a. H_A: Politically stable countries, with high voice and accountability, an absence of violence and terrorism, high control of corruption, high regulatory quality, and high rule of law will experience a lower incidence rate of tuberculosis.
4) How is a country's economic stability associated with TB incidence rates when accounting for population density, precipitation, and refugee populations?

a. H_A: Economically stable countries, with high GDP, high exports, high GNI, and high total reserves will experience a lower incidence rate of tuberculosis.

5) How are a country's health system indicators associated with TB incidence rates when accounting for population density, precipitation, and refugee populations?
   a. Countries with high tuberculosis case detection rates, high health expenditures, high measles immunization rates, high DTP immunization rates, increased access to clean water, and increased access to sanitation will experience a lower incidence rate of tuberculosis.
6) How are a country's policies regarding tuberculosis detection associated with TB incidence rates when accounting for population density, precipitation, and refugee populations?
   a. H_A: Countries with tuberculosis detection policies in place will experience a lower incidence rate of tuberculosis.
7) Is there a reciprocal relationship between a country's political stability & economic stability**?**
   a. H_A: Countries that are politically stable have more economic stability than countries with political instability and vice versa.

Research Design

The study employed a retrospective, cross-sectional, non-experimental design. Due to the holistic nature of this study and the unit of analysis, it would be very challenging to gather primary data from every country in the world. Open-source, secondary data from international databases already exists, so it was beneficial to employ a retrospective rather than a prospective design. The available data is provided by year, so it further made sense to utilize a cross-sectional design for the year 2014, which was the latest year of available data. It was beyond the researcher's control to utilize an experimental design because all nations experience tuberculosis incidence to some degree, so a true control group at the national level would not exist. Because of this, it was appropriate to use a non-experimental design.

Structural equation modeling (SEM) was utilized to test associations between four exogenous latent constructs (*political stability*, *economic stability*, *detection policies*, and *health system indicators*) and the latent endogenous observed variable (*incidence rates of TB*). Structural equation modeling was selected as the primary analytic method because it is an

extension of multivariate regression that analyzes covariance models (Wan, 2002; Jöreskog & Sörbom, 1993). Structural equation modeling also aids in controlling for issues of endogeneity. Non-stepwise regression ignores multicollinearity or the close linear relationship between two independent variables as they act on the dependent variable, which introduces bias into the model (Field, 2013). SEM controls for the instability of estimated coefficients and standard errors, which often becomes quite large due to sampling variability in the coefficients (Pagano & Gauvreau, 2000). Latent constructs are conceptualized as theoretical variables comprised of multiple indicators or observed variables and their corresponding errors (Wan, 2002).

The initial conceptual model was presented in Chapter 2. Based on the theoretical framework, literature review and research hypotheses, the *political stability* latent construct comprised variables measuring voice and accountability, violence and terrorism, control of corruption, regulatory quality, and rule of law. The latent construct of *economic stability* comprised variables measuring gross domestic product (GDP), exports, gross national income, and total reserves. The latent construct of *health system indicators* comprised variables measuring tuberculosis case detection, measles immunizations, DTP immunizations, health expenditures, improved water sources, and improved sanitation facilities. The latent construct of tuberculosis *detection policies* was measured by the presence or absence of national guidance for use of Xpert MTB/RIF (Mycobacterium tuberculosis/ resistance to rifampicin) as the initial test for diagnosis of drug-resistant TB, HIV-associated TB, TB in children, and extra-pulmonary TB among suspected individuals or people at risk (WHO, 2016c). Three observed variables—population density, precipitation, and refugee populations—were independent control variables for the endogenous or dependent variable of *tuberculosis incidence rates*.

Sample Selection

This study gathered secondary data from open-source, international databases such as the World Bank's World Development Indicators, World Governance Indicators, as well as the World Health Organization for the year 2014. This data comprised the observed variables used to measure four latent constructs (*political stability*, *economic stability*, *detection policies*, and *health system indicators*) and the latent endogenous observed variable of *tuberculosis incidence rates*. The unit of analysis was country-level. Currently, there are only 196 officially recognized countries in the world; however, the World Bank also monitors non-officially recognized nations. The term *country* refers both to independent nations and economies of "any territory for which authorities report separate social or economic statistics" (World Bank, 2016d). This increased the number of countries to 248 nations. When combined with the WHO data, the total number of countries used for analysis was 264 (listed in Appendix A).

An A priori sample size calculator for structural equation models, http://www.danielsoper.com/statcalc3/calc.aspx?id=89, was used to determine the minimum sample size necessary given an anticipated effect size of 0.29, a statistical power level of 0.95, and a probability level of 0.05. The minimum sample size to detect effect was 224 and the minimum sample size for model structure was 166.

Data Collection

Data on the observed variables from each of the 264 countries came from the World Bank's World Development Indicators and World Governance Indicators, as well as the World Health Organization. Each of these sources provided free, available data in Excel format for multiple years. The year 2014 was chosen due to its overlap between a majority of the variables

and because this was the most recent year for which data is available. Each latent construct comprised observed variables from these databases.

The World Bank's World Development Indicators compiled time-series data and statistics for over 200 economies divided into six sections-- Environment, Economy, World View, Global Links, People, and States and Markets. Data was from officially-recognized international sources of current and accurate development data with global, national, and region estimates. The World Bank's Worldwide Governance Indicators included six dimensions--voice and accountability, absence of violence/terrorism, government effectiveness, regulatory quality, rule of law, and control of corruption. However, for the purpose of this research, only five dimensions (voice and accountability, absence of violence/terrorism, control of corruption, regulatory quality, and rule of law) will be examined in the model due to sample size constraints. The Indicators came from public sector data, private sector data, non-governmental organization data, and citizen and firm surveys totaling to 35 data sources from 33 different organizations. Data were obtained from sources such as the French Ministry of Finance Institutional Profiles Database, Global Insight, Political Risk Services, Economist Intelligence Unit, Global Integrity, Reporters Without Boarders, Freedom House, Global Competitive Report survey, and the Gallup World Poll to name a few.

The World Health Organization data was compiled from four sources. The Service Availability and Readiness Assessment measured health facility access and services. The Civil Registration and Vital Statistics measured country-level birth and death data. The World Health Survey monitored population health measurements and outcomes. Lastly, the WHO Study on Global Ageing and Adult Health longitudinally collected individual and household data.

Together these sources compiled the WHO Indicator and Measurement Registry, a collection of health-related metadata.

Measures

Table 1 displays observed variables that comprised the latent constructs, the control variables, and the endogenous observed variable of *TB incidence rates*. The table presents their operational definitions, data sources, and data year. [Note: These are the formal definitions from the World Bank and WHO databases.] The WHO provides more detailed definitions and data sources for the variables voice and accountability, absence of violence and terrorism, control of corruption, regulatory quality, and rule of law, which are listed in Appendix B.

Table 1: Study Measures, Definitions, & Sources

Constructs & Observed Variables	Definition & Measurement	Source & Year
Political Stability		
Voice & Accountability	"Extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media."* [Data is compiled from numerous representative and non-representative indexes and surveys.] Measured in "percentile rank terms from 0 to 100, with higher values corresponding to better governance performance."*	World Bank's Worldwide Governance Indicators, 2014
Absence of Violence/ Terrorism	"Likelihood of political instability and/or politically-motivated violence, including terrorism."* [Data is compiled from numerous representative and non-representative indexes and surveys.] Measured in "percentile rank terms from 0 to 100, with higher values corresponding to better governance performance."*	
Control of Corruption	"Extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests."* [Data is compiled from numerous representative and non-representative indexes and surveys] Measured in "percentile rank terms from 0 to 100, with higher values corresponding to better governance performance."*	
Regulatory Quality	"Extent to which a country's government is able to formulate and implement sound policies and regulations that permit and promote private sector development."* [Data is compiled from numerous representative and non-representative indexes and surveys.] Measured in "percentile rank terms from 0 to 100, with higher values corresponding to better governance performance."*	
Rule of Law	"Extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence."* [Data is compiled from numerous representative and non-representative indexes and surveys.] Measured in "percentile rank terms from 0 to 100, with higher values corresponding to better governance performance."*	
Economic Stability		
Gross Domestic Product (GDP)	Per capita "sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products."** Measured in current US dollars $/ country's population.	World Bank's World Development Indicators, 2014

Constructs & Observed Variables	Definition & Measurement	Source & Year
Exports	“The value of all goods and other market services provided to the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude compensation of employees and investment income (formerly called factor services) and transfer payments.”** Measured as % of a country’s total GDP.	
Gross National Income (GNI)	“Per capita gross national income, converted to U.S. dollars using the World Bank Atlas method, divided by the midyear population. GNI is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad.”** Measured in current US dollars $/ country’s population.	World Bank’s World Development Indicators, 2014
Total Reserves	“Holdings of monetary gold, special drawing rights, reserves of IMF members held by the IMF, and holdings of foreign exchange under the control of monetary authorities. The gold component of these reserves is valued at year-end (December 31) London prices.”** Measured in “current U.S. dollars $.”**	
Health System Indicators		
Sanitation	“Percentage of the population using improved sanitation facilities. Improved sanitation facilities are likely to ensure hygienic separation of human excreta from human contact. They include flush/pour flush (to piped sewer system, septic tank, pit latrine), ventilated improved pit (VIP) latrine, pit latrine with slab, and composting toilet.”** Measured as % of population with access.	World Bank’s World Development Indicators, 2014
Water	“Percentage of the population using an improved drinking water source. The improved drinking water source includes piped water on premises (piped household water connection located inside the user’s dwelling, plot or yard), and other improved drinking water sources (public taps or standpipes, tube wells or boreholes, protected dug wells, protected springs, and rainwater collection).”** Measured as % of population with access.	
Health Expenditures	“Sum of public and private health expenditure; covers provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health but does not include provision of water and sanitation.”** Measured as % of a country’s total GDP.	World Bank’s World Development Indicators, 2013
Measles Immunizations	“Percentage of children ages 12-23 months vaccinated for measles.”** Adequate immunization is 1 dose. Measured as % of children ages 12-23 months who are adequately immunized.	World Bank’s World Development Indicators, 2014
DTP Immunizations	“Percentage of children ages 12-23 months vaccinated for diphtheria, pertussis (or whooping cough).”** Adequate immunization is 3 doses. Measured as % of children ages 12-23 months who are adequately immunized.	

Constructs & Observed Variables	Definition & Measurement	Source & Year
TB Case Detection	Number of new and relapse tuberculosis cases (all forms) notified to WHO in a given year, "divided by WHO's estimate of the number of incident tuberculosis cases for the same year." Measured as % detected.	World Bank's World Development Indicators, 2014
Detection Policies		
Xpert TBHIV	"Absence or presence of national guidance that indicates the use of Xpert MTB/RIF as the initial diagnostic test for the diagnosis of TB in all people suspected of having TB."*** Dummy coded: 0 = absence (no national guidance in place), 1 = presence (national guidance in place).	World Health Organization, 2014
Xpert MDR	"Absence or presence of national guidance that indicates the use of Xpert MTB/RIF as the initial diagnostic test for the diagnosis of drug-resistant TB among people at risk."*** Dummy coded: 0 = absence (no national guidance in place), 1 = presence (national guidance in place).	
Xpert Children	"Absence or presence of national guidance that indicates the use of Xpert MTB/RIF as the initial diagnostic test for the diagnosis of TB in children suspected of having TB."*** Dummy coded: 0 = absence (no national guidance in place), 1 = presence (national guidance in place).	
Xpert EPTB	"Absence or presence of national guidance that indicates the use of Xpert MTB/RIF as the initial diagnostic test for the diagnosis of extra-pulmonary TB using selected specimens."*** Dummy coded: 0 = absence (no national guidance in place), 1 = presence (national guidance in place).	
TB Incidence Rate	"Estimated number of new and relapse tuberculosis cases arising in a given year, expressed as the rate per 100,000 population. All forms of TB are included, including cases in people living with HIV."** Measured per 1,000 population.	World Bank's World Development Indicators, 2014
Controls		
Population Density	"Midyear population divided by land area in square kilometers; counts all residents regardless of legal status or citizenship--except for refugees not permanently settled in the country of asylum."** Measured as #/sq. km.	World Bank's World Development Indicators, 2014
Refugee Population	"People who are recognized as refugees under the 1951 Convention Relating to the Status of Refugees or its 1967 Protocol, the 1969 Organization of African Unity Convention Governing the Specific Aspects of Refugee Problems in Africa, people recognized as refugees in accordance with the UNHCR statute, people granted refugee-like humanitarian status, and people provided temporary protection."** Measured as % of refugees [(#/ country's population)*100].	
Precipitation	"Long-term average in depth (over space and time) of annual precipitation in the country. Precipitation is defined as any kind of water that falls from clouds as a liquid or a solid."** Measured in millimeters per year.	

Data Definition & Measurement Sources:

* World Bank's Worldwide Governance Indicators. Dataset retrieved from http://info.worldbank.org/governance/wgi/index.aspx#home

** World Bank's World Development Indicators. Dataset retrieved from http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators.

*** World Health Organization. Dataset retrieved from http://www.who.int/tb/country/data/download/en/.

Data Analysis

To begin, the WHO and World Bank data variables were merged into a single Excel spreadsheet, then imported into IBM® SPSS®. This produced a sample of 264 countries. Missing data percentages were then calculated to identify countries with 50% or more of the variable data missing. In total, 35 countries had over 50% or more missing data and were removed, decreasing the sample size to 229 countries.

Data Imputation

The first step in the analysis was to handle missing data values in the remaining observations. In order to run a multivariate analysis, the data set must be complete without missing values. Descriptive statistics were run on the remaining 229 observations to find the number of missing values per variable (these are reported in Appendix C). Due to the macro-level nature of this data, numerous observed variables contained missing data. Variables with more than 20% missing data were eliminated while variables missing 20% or less data were imputed using linear interpolation in IBM® SPSS®. Descriptive statistics post-linear interpolation are reported in Appendix D).

Univariate Analyses

Numerous researchers recommend that variables be verified for univariate normality (normal distribution) before undergoing multivariate analysis, especially for structural equation modeling (SEM), which assumes normality for all indicator variables (Finney & DiStefano, 2013; Mertler & Vannatta, 2005; Kline, 2010; Wan, 2002). Skewness and kurtosis ratios as well as the Shapiro-Wilk test were employed to test normality in this analysis. Skewness and kurtosis statistics were divided by the respective standard error within acceptable value between +/- 1.96

(Kline, 2010). However, normality is generally accepted with skewness values in the range of +/- 1.00 and kurtosis values in the range of +/- 3.00 (Finney & DiStefano, 2013). Studies with sample sizes less than 2,000 that state a high p-value (greater than .05) for the statistic rejects the null hypothesis of non-normal distribution should examine the Shapiro-Wilk test of normality (Kline, 2010).

For the purpose of this study, variables with skewness values outside the +/- 1 range and/or kurtosis values outside the +/- 3 range were transformed in order to optimize normality levels. First, logarithmic transformations were performed on the variables of *population density, refugee population, GDP per capita, TB incidence rates, case detection rates, DTP immunizations,* and *measles immunizations*. Descriptive statistics were again re-run on these 9 variables. Kurtosis figures were still high for *case detection rates, DTP immunizations,* and *measles immunizations*, so the original data for these variables were then square root transformed to improve kurtosis and yield an optimum normality (Mertler & Vannatta, 2005).

Following this transformation, normality tests and descriptive statistics were run again and were within acceptable ranges. The final descriptive statistics are presented in Table 3 of Chapter 4 of this dissertation. The normality tests are presented in Table 2 below. As indicated by Table 2, all the skewness (+/- 1) and kurtosis (+/- 3) values fell within or very close to acceptable ranges with the exception of *DTP immunizations* (skewness of -2.701 and kurtosis of 9.310) and *measles immunizations* (skewness of -2.384 and kurtosis of 7.703) which underwent square root transformations. All other variable values fell within acceptable ranges of normality.

Table 2: Normality Tests

Indicator	N	Skewness	Std. Error	Kurtosis	Std. Error	Shapiro-Wilk Test	df	P-Value
Voice & Account.	229	0.077	0.161	-1.126	0.320	0.962	229	0.000
Absence of Vio./Ter.	229	0.053	0.161	-1.144	0.320	0.960	229	0.000
Ctrl of Corruption	229	0.142	0.161	-1.101	0.320	0.959	229	0.000
Regulatory Quality	229	0.148	0.161	-1.115	0.320	0.959	229	0.000
Rule of Law	229	0.121	0.161	-1.126	0.320	0.958	229	0.000
GDP per capita	229	-0.067	0.161	-0.764	0.320	0.983	229	0.008
Exports	229	-0.002	0.161	1.014	0.320	0.988	229	0.049
GNI per Capita	229	-0.071	0.161	-0.733	0.320	0.982	229	0.004
Total Reserves	229	0.214	0.161	-0.696	0.320	0.982	229	0.005
TB Case Detection	229	-0.173	0.161	3.591	0.320	0.896	229	0.000
DTP Immuniz.	229	-2.701	0.161	9.310	0.320	0.703	229	0.000
Measles Immuniz.	229	-2.384	0.161	7.703	0.320	0.740	229	0.000
Health Expenditures	229	0.939	0.161	1.403	0.320	0.949	229	0.000
Water	229	-1.189	0.161	0.520	0.320	0.834	229	0.000
Sanitation	229	-0.841	0.161	-0.687	0.320	0.844	229	0.000
Xpert TBHIV	229	-0.414	0.161	-1.630	0.320	0.733	229	0.000
Xpert MDR	229	-0.748	0.161	-1.231	0.320	0.692	229	0.000
LG Xpert TB	229	-1.117	0.161	0.257	0.320	0.807	229	0.000
Xpert Children	229	0.061	0.161	-1.851	0.320	0.727	229	0.000
Xpert EPTB	229	0.200	0.161	-1.791	0.320	0.735	229	0.000
TB Incidence Rate	229	-0.312	0.161	-0.591	0.320	0.977	229	0.001
Pop Density	229	0.464	0.161	1.950	0.320	0.968	229	0.000
Refugee Pop	229	-0.231	0.161	-0.426	0.320	0.987	229	0.035
Precipitation	229	0.675	0.161	-0.209	0.320	0.949	229	0.000

Correlation Analysis

The purpose of the correlation analyses was to see if the observed variables for each construct were correlated to one another and to see if each observed variable for each construct was correlated to TB incidence rates. Some of the bivariate correlations revealed strong correlations, which indicated that the latent constructs, measurement model, and structural model were on the right track. After examining each latent variable construct, bivariate correlation coefficients were observed between all respective latent constructs and the outcome variable of

tuberculosis incidence rates. Correlations for each latent construct and between the observed variables and the dependent variable are located in Appendix E-I.

For the *political stability* construct, all observed variable correlations were significantly and positively correlated at the 0.01 level for a two-tailed test; however, as expected, each observed variable (voice and accountability, absence of violence and terrorism, control of corruption, regulatory quality, and rule of law) was negatively correlated to *TB incidence rates*. *TB incidence rates* and *regulatory quality* had the highest negative correlation (Pearson correlation = -0.576; significance = 0.000) while *TB incidence rates* and *voice and accountability* had the lowest negative correlation (Pearson correlation = -0.499; significance = 0.000).

For the *economic stability* construct, all observed variable correlations were statistically significant at the 0.05 level for a two-tailed test with the exception of *exports* and *total reserves* (Pearson correlation = 0.002; significance = 0.981). Each observed variable was negatively correlated to *TB incidence rates*. *TB incidence rates* and *GDP per capita* had the highest negative correlation (Pearson correlation = -0.644; significance = 0.000) while *TB incidence rates* and *total reserves* had the lowest negative correlation (Pearson correlation = -0.161; significance = 0.015).

For the *TB detection policies* construct, all observed variable correlations were significantly and positively correlated at the 0.05 level for a two-tailed test with the exception of *Xpert TB HIV* and *Xpert TB* (Pearson correlation = 0.100; significance = 0.132), *Xpert MDR* and *Xpert TB* (Pearson correlation = 0.083; significance = 0.213), *Xpert Children* and *Xpert TB* (Pearson correlation = 0.119; significance = 0.072), *Xpert EPTB* and *Xpert TB* (Pearson correlation = -0.023; significance = 0.732), *Xpert EPTB* and *TB incidence rates* (Pearson correlation = 0.075; significance = 0.216), and *Xpert TB* and *TB incidence rates* (Pearson

correlation = 0.075; significance = 0.258). Each observed variable was positively correlated to *TB incidence rates*. *TB incidence rates* and *Xpert MDR* had the highest correlation (Pearson correlation = 0.262; significance = 0.000) while *TB incidence rates* and *Xpert Children* had the lowest correlation (Pearson correlation = -0.161; significance = 0.015).

For the *health system indicators* construct, all observed variable correlations were significantly and positively correlated at the 0.01 level for a two-tailed test; however, as expected, each observed variable was negatively correlated to *TB incidence rates*. *TB incidence rates* and *sanitation* had the highest negative correlation (Pearson correlation = -0.675; significance = 0.000) while *TB incidence rates* and *health expenditures* had the lowest negative correlation (Pearson correlation = -0.255; significance = 0.000).

A final correlation was run on the dependent variable of tuberculosis incidence ratesand the control variables of population density, refuges populations, and precipitation. Two correlations, between *population density* and *refugee populations* (Pearson correlation = -0.170; significance = 0.010) and *precipitation* and *TB Incidence Rates* (Pearson correlation = -0.202; significance = 0.002), were statistically significant at the 0.05 level for a two-tailed test. *TB incidence rates* and *precipitation* were the only negative correlations (Pearson correlation = -0.202; significance = 0.002).

Measurement Model Analysis

The second step in the analysis was to ensure that the latent variables measured their intended construct by performing a measurement model analyses (Newman, Vance, & Moneyham, 2010). A confirmatory factor analysis was run on each construct (*political stability*,

economic stability, health system indicators, and *detection policies*), and a covariance analysis was run on all latent constructs together (shown in Figure 2 below).

When running the measurement models, a three-step method described by Wan was utilized (2002). The first step was to choose one indicator for each construct to serve as the scale factor in IBM® SPSS® AMOS 22®. For the *political stability* measurement model, the variable *control of corruption* was chosen. For the *economic stability* measurement model, the variable *GDP per capita* was chosen. For the *health system indicators* measurement model, the variable *health expenditures* was chosen, and for the *detection policies* measurement model, the variable *Xpert TBHIV* was chosen. No matter which indicator variable was chosen as the significant scale factor, the results of the confirmatory factor analysis would not be altered. In order to calculate estimates of the other factor loadings, a regression weight of 1.00 was then assigned to the scale indicators.

Next, factor loadings for each generic measurement model construct were analyzed. If the model did not achieve the desired goodness of fit thresholds for the dataset, revisions would need to be made, such as removing insignificant indicator variables and weak significant indicators with low factor loadings (Wan, 2002). P-value scores and critical ratios (C.R.) were examined, and variables with insignificant p-values greater than 0.05 would need to be removed. Goodness of fit indices were used to determine if the indicators comprising the generic models were appropriate. Each goodness of fit statistic was examined after removing all weak and/or insignificant indicators. If the values were not within the acceptable parameters, then significantly correlated measurement errors of indicator factor weights would need to be linked as presented by the analysis' modification indices (Wan, 2002).

All initial CFA measurement models showed good fit for each latent variable, without any need to remove an observed variable. Additionally, the covariance measurement model showed that those constructs continued to have good fit in the presence of all other constructs. Measurement model results are presented in detail in Chapter 4.

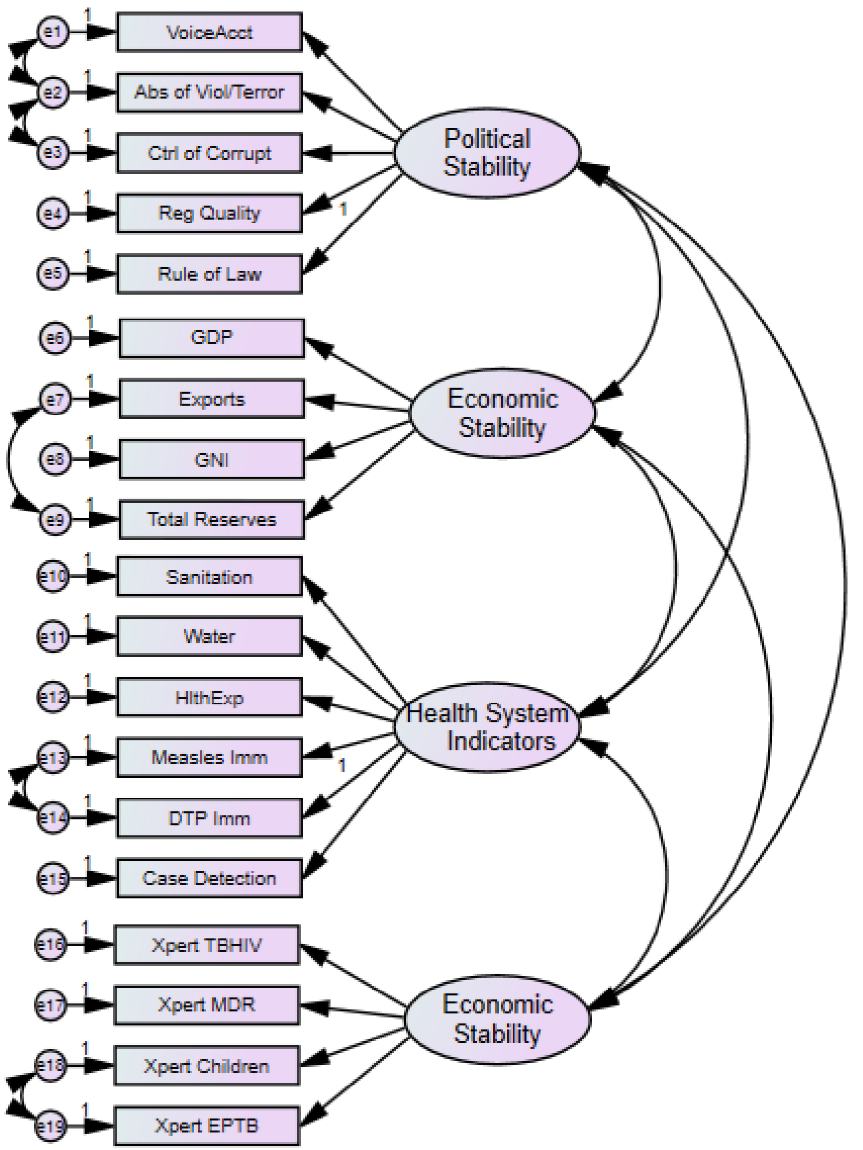

Figure 2: Measurement Model

Structural Equation Model

Good measurement model results allowed for testing the initial structural model, which is shown in Figure 3 below. A structural equation model was run via maximum likelihood estimation. A portion of the initial structural model was first run between political stability, economic stability and health system indicators. However, direct paths from *political stability* to *health system indicators* and from *economic stability* to *health system indicators* in the initial structural model were not significant; fit statistics showed that the model was not a good fit with the data. The *health system indicators* construct was then eliminated as a mediator and was covaried between *political stability* and *economic stability*. This partial structural model was significant with good fit. When adding *detection policies* to the structural model as an isolated construct directly related to *TB incidence rates*, the model failed to run. The overall structural model was then altered to test *detection policies* as a covariance path with the already covaried *political stability*, *economic stability,* and *health system indicators* constructs. This model ran, but did not have good fit. When the TB incidence control variables (population density, precipitation, and refugee population) were removed (one by one, each control variable was removed and the model was re-run) the final model fit without any control variables was good. However, economic stability was not significantly related to TB incidence rates so another model was run without this path. The goodness of fit statistics improved after this modification so the final model did not include this path. Results for the final model, including the final figure, path parameter statistics, and goodness of fit indices are reported in Chapter 4.

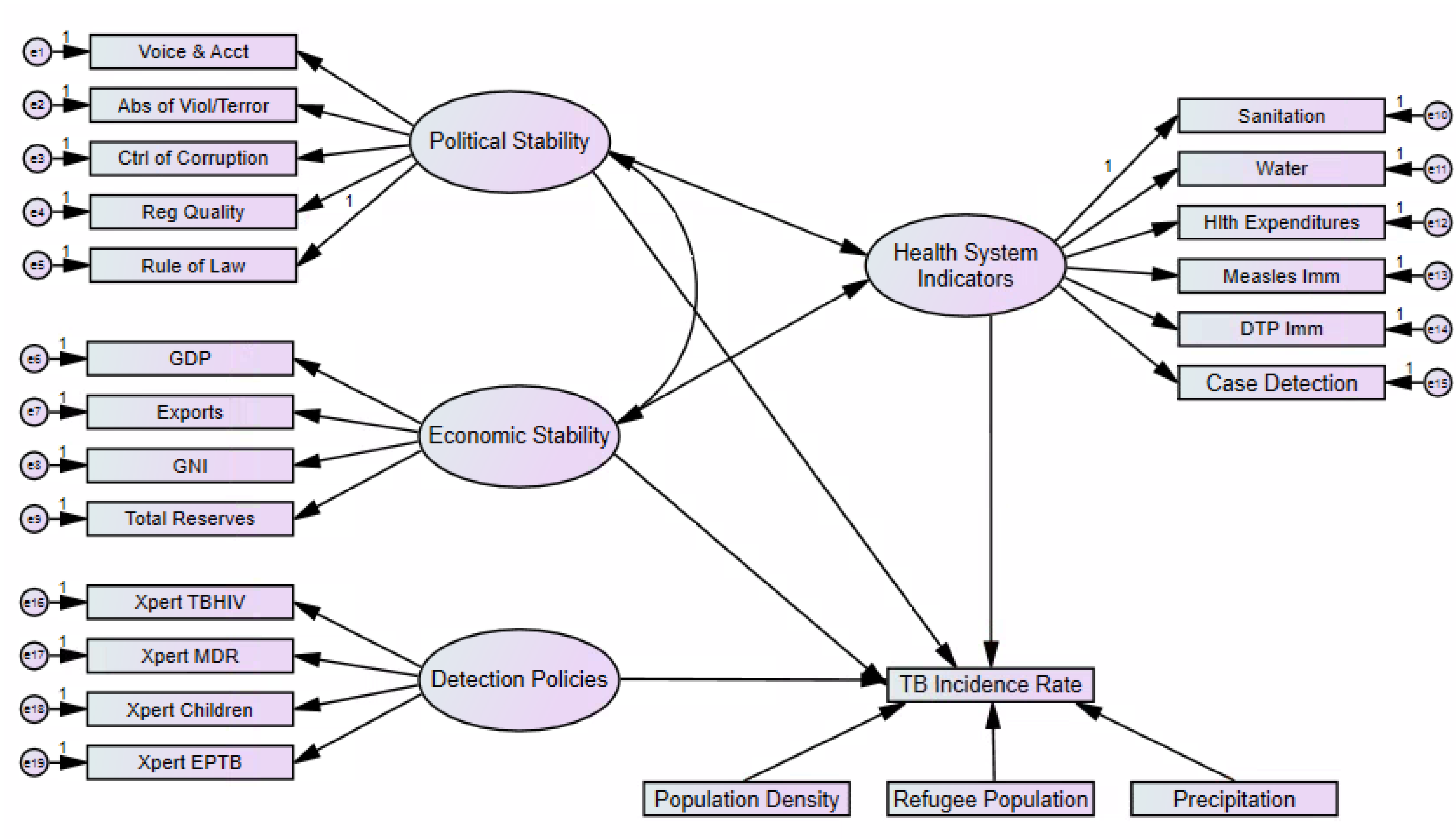

Figure 3: Initial Structural Equation Model

CHAPTER FOUR: FINDINGS

This chapter covers the main findings of the study. These include a final set of descriptive statistics after missing data imputation and logarithmic and square root transformations. Confirmatory factor analysis to test the original measurement model is also discussed in detail, along with the ways in which the model was covaried to obtain statistical significance and goodness of fit. Reliability analysis to ensure internal consistency is also reported. Lastly, this chapter will detail the results of the final structural equation model.

Descriptive Statistics

Table 3 provides the N, minimum, maximum, mean and standard deviation for each variable after missing data was imputed, after the variables *population density*, *refugee population*, *GDP per capita*, *TB incidence rates*, *case detection rates*, *DTP immunizations*, and *Measles immunizations* were log transformed, and after the variables *case detection rates*, *DTP immunizations*, and *Measles immunizations* were square root transformed.

Table 3: Descriptive Statistics Post-Linear Interpolation with Logarithmic & Square Root Transformations

Indicator Variable	N	Minimum	Maximum	Mean	Std. Deviation
Voice & Accountability	229	0.00	100.00	48.79	28.15
Absence of Violence/ Terrorism	229	0.00	99.03	48.33	27.98
Control of Corruption	229	0.00	100.00	47.79	28.39
Regulatory Quality	229	0.00	100.00	48.32	28.31
Rule of Law	229	0.00	100.00	48.16	28.49
LG GDP per Capita	229	2.66	2.41	3.79	0.61
Exports	229	0.790	2.34	1.561	0.2428
GNI per Capita	229	2.40	5.02	3.771	0.6146
Total Reserves	229	7.80	12.59	9.807	0.9645
SQ RT TB Case Detection	229	3.87	13.78	8.38	1.38
SQ RT DTP Immunizations	229	4.90	9.95	9.38	0.74
SQ RT Measles Immunizations	229	4.69	9.95	9.34	0.75
Health Expenditures	229	1.48	17.14	6.94	2.81
Water	229	28.20	100.00	83.99	17.98
Sanitation	229	6.70	100.00	72.83	28.16
Xpert TBHIV	229	0.00	1.00	0.603	0.44
Xpert MDR	229	0.00	1.00	0.677	0.42
Xpert Children	229	0.00	1.00	0.485	0.46
Xpert EPTB	229	0.00	1.00	0.450	0.45
LG TB Incidence Rate	229	-0.15	2.93	1.68	0.65
LG Population Density	229	0.27	4.28	1.87	0.62
LG Refugee Population	229	0.00	7.24	4.02	1.63
Precipitation	229	51.00	3,240.00	1,134.39	737.79

Measurement Model Analysis: Confirmatory Factor Analysis

After running descriptive statistics, performing log and square root transformations, and executing univariate analyses, measurement model analyses were performed to ensure that the data fit the hypothesized latent constructs properly before continuing (Kline, 2010; Wan, 2002). Each of the four measurement models contains the post-linear interpolation data and either the log or square root transformed variables.

Political Stability Measurement Model

Figure 4: Political Stability Confirmatory Factor Analysis displays the generic model for the endogenous latent variable construct of *political stability*. As indicated in Table 4: Political Stability Confirmatory Factor Analysis, Path Parameter Statistics, all indicator variables had significant p-values. A review of the modification indices revealed no significant correlations of the measurement errors or indicator factor weights. Because of this, there was no additional manner in which the model could have been better optimized.

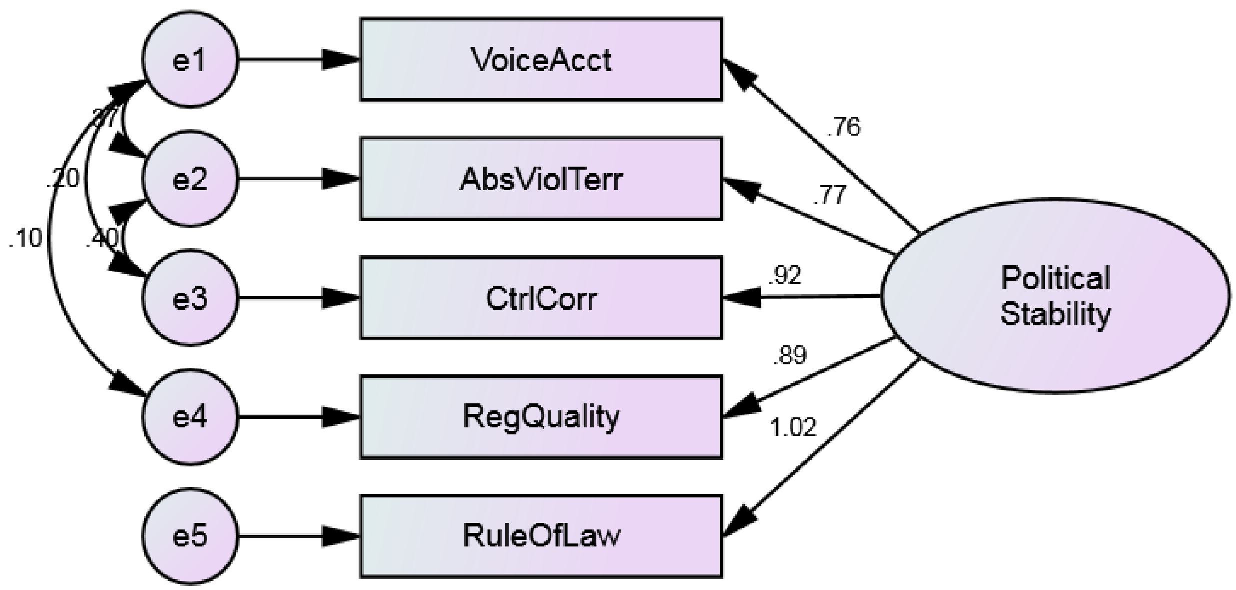

Figure 4: Political Stability Confirmatory Factor Analysis

Table 4: Political Stability Confirmatory Factor Analysis, Path Parameter Statistics

Path Parameter	Unstandardized Regression Coefficient	S.E.	C.R.	P-Value	Standardized Regression Coefficient
Rule of Law ⟵ Political Stability	1.000				1.017
Regulatory Quality ⟵ Political Stability	0.867	0.030	28.595	***	0.888
Control of Corruption ⟵ Political Stability	0.892	0.026	33.806	***	0.916
Absence of Violence/Terrorism ⟵ Political Stability	0.739	0.040	18.386	***	0.770
Voice & Accountability ⟵ Political Stability	0.738	0.041	18.053	***	0.764

Unstd.: Unstandardized; S.E. Standard Error; C.R.: Critical Ratio.
***significant below the 0.001 level

Table 5: Goodness of Fit Indices for Political Stability Confirmatory Factor Analysis revealed a very high goodness of fit index of 0.999, incremental fit index of 1.000, and comparative fit index of 1.00, which were all very close to or matched the desire value of 1.000. All goodness of fit statistics, with the exception of the root mean square residual, were optimized to create the best attainable value. This indicated that the model could no longer be improved and that the data did not statistically differ from the measurement model (Wan, 2002). Resultantly, the *political stability* measurement model remained unchanged as the structural equation model was further performed.

Table 5: Goodness of Fit Indices for Political Stability Confirmatory Factor Analysis

Test	Abbreviation	Value
Likelihood Ratio (chi-square/degrees of freedom)	χ^2/df	0.816
Goodness of Fit Index	GFI	0.999
Adjusted Goodness of Fit Index	AGFI	0.979
Incremental Fit Index	IFI	1.000
Formed Fit Index	NFI	0.999
Comparative Fit Index	CFI	1.000
Root Mean Square Residual	RMSEA	0.000

Economic Stability Measurement Model

Figure 5: Economic Stability Confirmatory Factor Analysis displays the generic model for the endogenous latent variable construct of *Economic Stability*. As indicated in Table 6: Economic Stability Confirmatory Factor Analysis, Path Parameter Statistics, all indicator variables had significant p-values. A review of the modification indices revealed no significant correlations of the measurement errors or indicator factor weights. Because of this, there was no additional manner in which the model could have been better optimized.

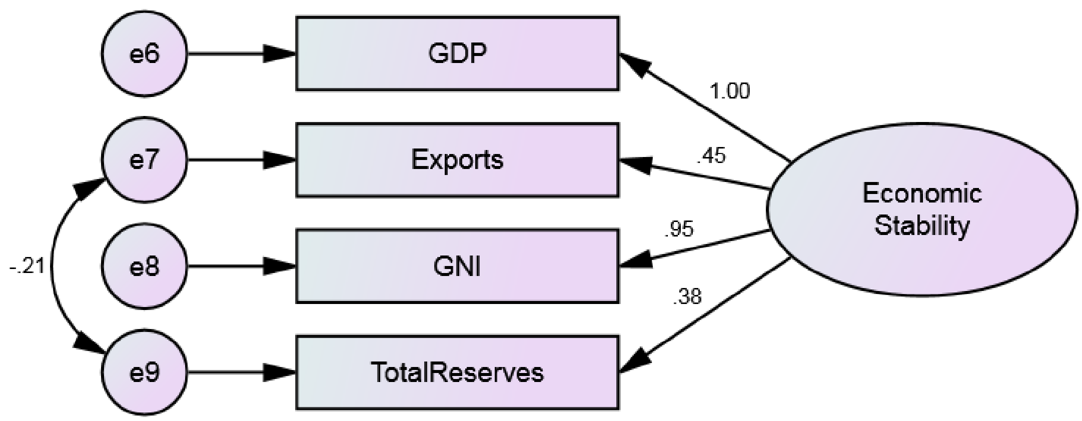

Figure 5: Economic Stability Confirmatory Factor Analysis

Table 6: Economic Stability Confirmatory Factor Analysis, Path Parameter Statistics

Path Parameter	Unstandardized Regression Coefficient	S.E.	C.R.	P-Value	Standardized Regression Coefficient
Total Reserves ⟵ Economic Stability	1.000				0.381
GNI per Capita ⟵ Economic Stability	1.584	0.258	6.140	***	0.947
Exports ⟵ Economic Stability	0.297	0.068	4.374	***	0.449
GDP per Capita ⟵ Economic Stability	1.659	0.272	6.093	***	0.996

Unstd.: Unstandardized; S.E. Standard Error; C.R.: Critical Ratio
***significant below the 0.001 level

Table 7: Goodness of Fit Indices for Economic Stability Confirmatory Factor Analysis revealed a very high goodness of fit index of 0.993, incremental fit index of 0.996, and comparative fit index of 0.996, which were all very close to the desire value of 1.000. All goodness of fit statistics, with the exception of the root mean square residual, were optimized to create the best attainable value. This indicated that the model could no longer be improved and that the data did not statistically differ from the measurement model (Wan, 2002). Resultantly, the *economic stability* measurement model remained unchanged as the structural equation model was further performed.

Table 7: Goodness of Fit Indices for Economic Stability Confirmatory Factor Analysis

Test	Abbreviation	Value
Likelihood Ratio (chi-square/degrees of freedom)	χ^2/df	3.374
Goodness of Fit Index	GFI	0.993
Adjusted Goodness of Fit Index	AGFI	0.927
Incremental Fit Index	IFI	0.996
Formed Fit Index	NFI	0.994
Comparative Fit Index	CFI	0.996
Root Mean Square Residual	RMSEA	0.102

Health System Indicators Measurement Model

Figure 6: Health System Indicators Confirmatory Factor Analysis displays the generic model for the endogenous latent variable construct of *Health System Indicators*. As indicated in Table 8: Health System Indicators Confirmatory Factor Analysis, Path Parameter Statistics, all indicator variables had significant p-values. A review of the modification indices revealed no significant correlations of the measurement errors or indicator factor weights. Because of this, there was no additional manner in which the model could have been better optimized.

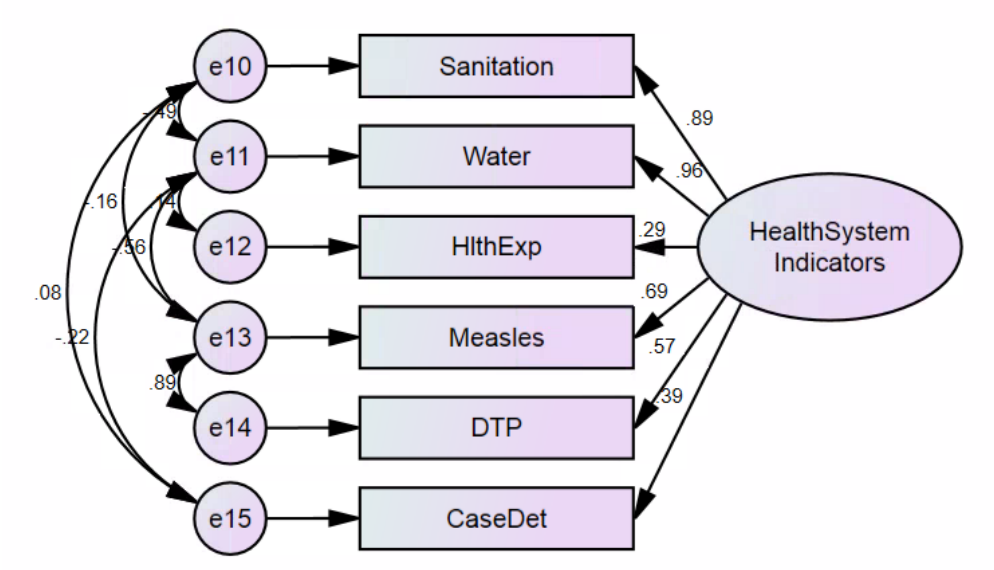

Figure 6: Health System Indicators Confirmatory Factor Analysis

Table 8: Health System Indicators Confirmatory Factor Analysis, Path Parameter Statistics

Path Parameter	Unstandardized Regression Coefficient	S.E.	C.R.	P-Value	Standardized Regression Coefficient
Case Detection ← Health System Indicators	1.000				0.386
DTP Immunizations ← Health System Indicators	0.798	0.283	2.817	0.005	0.569
Measles Immunizations ← Health System Indicators	0.983	0.352	2.792	0.005	0.694
Health Expenditures ← Health System Indicators	1.527	0.573	2.666	0.008	0.288
Water ← Health System Indicators	32.288	8.304	3.888	***	0.955
Sanitation ← Health System Indicators	46.955	11.735	4.001	***	0.886

Unstd: Unstandardized; S.E. Standard Error; C.R.: Critical Ratio.
***significant below the 0.001 level

Table 9: Goodness of Fit Indices for Health System Indicators Confirmatory Factor Analysis revealed a very high goodness of fit index of 0.999, incremental fit index of 1.002, and comparative fit index of 1.000, which are all very close to or matched the desire value of 1.000. All goodness of fit statistics, with the exception of the root mean square residual, were optimized to create the best attainable value. This indicated that the model could no longer be improved and that the data did not statistically differ from the measurement model (Wan, 2002). Resultantly,

the *health system indicators* measurement model remained unchanged as the structural equation model was further performed.

Table 9: Goodness of Fit Indices for Health System Indicators Confirmatory Factor Analysis

Test	Abbreviation	Value
Likelihood Ratio (chi-square/degrees of freedom)	χ^2/df	0.254
Goodness of Fit Index	GFI	0.999
Adjusted Goodness of Fit Index	AGFI	0.992
Incremental Fit Index	IFI	1.002
Formed Fit Index	NFI	0.999
Comparative Fit Index	CFI	1.000
Root Mean Square Residual	RMSEA	0.000

Detection Policies Measurement Model

Figure 7: Detection Policies Confirmatory Factor Analysis displays the generic model for the endogenous latent variable construct of *Detection Policies*. As indicated in Table 10: Detection Policies Confirmatory Factor Analysis, Path Parameter Statistics, all indicator variables had significant p-values. A review of the modification indices revealed no significant correlations of the measurement errors or indicator factor weights. Because of this, there was no additional manner in which the model could have been better optimized.

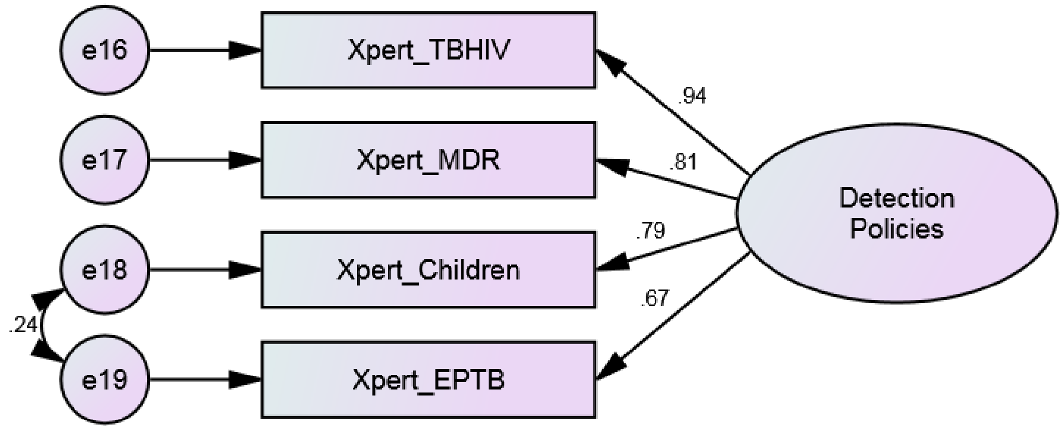

Figure 7: Detection Policies Confirmatory Factor Analysis

Table 10: Detection Policies Confirmatory Factor Analysis, Path Parameter Statistics

Path Parameter	Unstandardized Regression Coefficient	S.E.	C.R.	P-Value	Standardized Regression Coefficient
Xpert EPTB ⟵ Detection Policies	1.000				0.669
Xpert Children ⟵ Detection Policies	1.204	0.099	12.138	***	0.793
Xpert MDR ⟵ Detection Policies	1.126	0.104	10.779	***	0.807
Xpert TBHIV ⟵ Detection Policies	1.371	0.120	11.415	***	0.944

Unstd: Unstandardized; S.E. Standard Error; C.R.: Critical Ratio
***significant below the 0.001 level

Table 11: Goodness of Fit Indices for Detection Policies Confirmatory Factor Analysis revealed a very high goodness of fit index of 0.996, incremental fit index of 0.998, and comparative fit index of 0.998, which were all very close to the desired value of 1.000. All goodness of fit statistics, with the exception of the root mean square residual, were optimized to create the best attainable value. This indicated that the model could no longer be improved and that the data did not statistically differ from the measurement model (Wan, 2002). Resultantly, the *detection policies* measurement model remained unchanged as the structural equation model was further performed.

Table 11: Goodness of Fit Indices for Detection Policies Confirmatory Factor Analysis

Test	Abbreviation	Value
Likelihood Ratio (chi-square/degrees of freedom)	χ^2/df	1.853
Goodness of Fit Index	GFI	0.996
Adjusted Goodness of Fit Index	AGFI	0.960
Incremental Fit Index	IFI	0.998
Formed Fit Index	NFI	0.997
Comparative Fit Index	CFI	0.998
Root Mean Square Residual	RMSEA	0.061

Measurement Model Analysis: Covariance Model

Once each latent construct measurement model was validated via confirmatory factor analysis, a covariance analysis was run on all of the latent constructs together, as seen below in Figure 8. Covariance not only tests whether the observed variables for a construct match, but also whether the variables match to the one construct in the presence of other constructs, and do not match to other constructs.

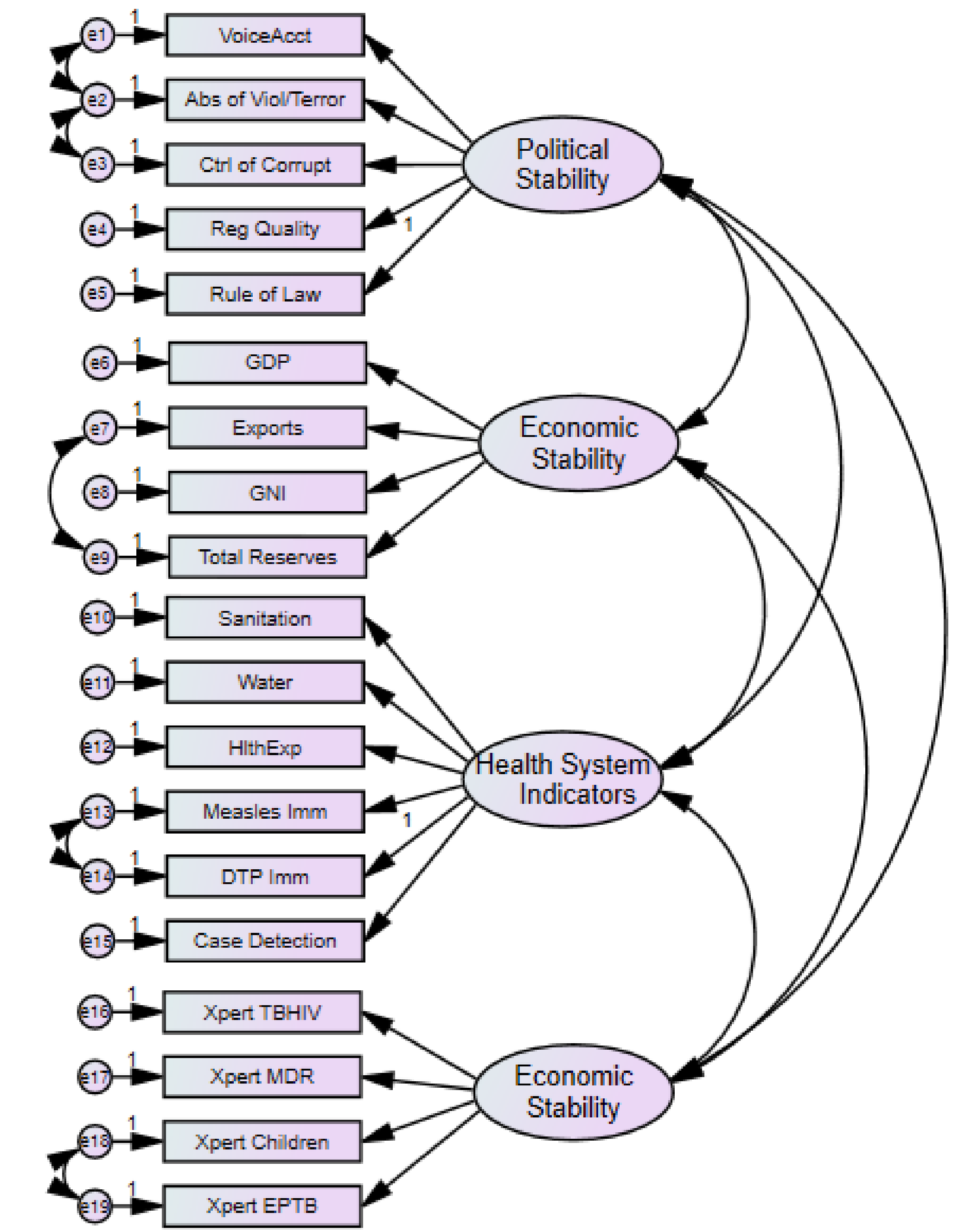

Figure 8: Final Measurement Model: Covariance Model

As depicted in Table 12, all indicator and latent variable path parameters in the covariance model were significant below the 0.01 level. After reviewing the modification indices, there were no significant correlations of the measurement errors of indicator factor

weights. Because of this, there was no manner in which to better optimize the model.

Table 12: Final Measurement Model (Covariance Model) Path Parameter Statistics

Path Parameter	Unstandardized Regression Coefficient	S.E.	C.R.	P-Value	Standardized Regression Coefficient
Rule of Law ⟵ Political Stability	1.000				1.000
Regulatory Quality ⟵ Political Stability	0.897	0.029	30.568	***	0.903
Control of Corruption ⟵ Political Stability	0.922	0.025	36.664	***	0.932
Absence of Violence/ Terrorism ⟵ Political Stability	0.762	0.040	18.847	***	0.785
Voice & Accountability ⟵ Political Stability	0.762	0.041	18.371	***	0.777
Total Reserves ⟵ Economic Stability	1.000				0.384
GNI per Capita ⟵ Economic Stability	1.577	0.255	6.183	***	0.950
Exports ⟵ Economic Stability	0.294	0.067	4.380	***	0.448
GDP per Capita ⟵ Economic Stability	1.642	0.264	6.212	***	0.993
Case Detection ⟵ Health System Indicators	1.000				0.401
DTP Immunizations ⟵ Health System Indicators	0.762	0.143	5.324	***	0.565
Measles Immunizations ⟵ Health System Indicators	0.829	0.151	5.485	***	0.607
Health Expenditures ⟵ Health System Indicators	1.655	0.424	3.904	***	0.324
Water ⟵ Health System Indicators	27.367	4.507	6.072	***	0.840
Sanitation ⟵ Health System Indicators	47.367	7.660	6.184	***	0.928
Xpert EPTB ⟵ Detection Policies	1.000				0.664
Xpert MDR ⟵ Detection Policies	1.211	0.100	12.086	***	0.790
Xpert TBHIV ⟵ Detection Policies	1.134	0.106	10.686	***	0.806
Xpert Children ⟵ Detection Policies	1.389	0.122	11.345	***	0.948

S.E.: Standard Error; C.R.: Critical Ratio
***significant below the 0.001 level

Table 13 lists the goodness of fit indices of the covariance model and revealed a moderate and adequate fit with an acceptable likelihood ratio of 2.539, an acceptable goodness of fit index (GFI) of 0.862, and an adequate root mean square error of approximation (RMSEA) statistics of 0.082. Relative goodness of fit statistics all fell within acceptable parameters (IFI = .943, NFI = .909, and CFI = .942). Parsimonious goodness of fit was acceptable with an adjusted goodness of fit index (AGFI) statistic of .814. These demonstrated an adequate data fit to the model, which indicated a sound measurement model, so the constructs were able to be utilized in the structural model.

Table 13: Goodness of Fit Indices for Final Measurement Model (Covariance Model)

Test	Abbreviation	Value
Likelihood Ratio (chi-square/degrees of freedom)	χ^2/df	2.539
Goodness of Fit Index	GFI	0.862
Adjusted Goodness of Fit Index	AGFI	0.814
Incremental Fit Index	IFI	0.943
Formed Fit Index	NFI	0.909
Comparative Fit Index	CFI	0.942
Root Mean Square Residual	RMSEA	0.082

Reliability Analysis

Each measurement model needed to ensure internal consistency because an instrument must first be reliable before it can be validated (Tavakol & Dennick, 2011). A test of Cronbach's alpha, denoted as a value between 0.00 and 1.00, was utilized to measure the internal consistency of each latent construct measurement model (Cronbach, 1951). Internal consistency was measured as the threshold or value by which the indicators measure the same latent construct. The alpha value increases as measurement model indicators correlate to each other (Tavakol & Dennick, 2011). While there are numerous tests and re-tests of reliability estimates, Cronbach's alpha is more readily utilized because it requires the administration of a single test instead of multiple tests. Alpha values are affected by the number of indicators, dimensionality, and interrelatedness (Cortina, 1993). Acceptable Cronbach's alpha ranges are from 0.70 to 0.95 (Tavakol & Dennick, 2011). Table 14: Cronbach's Alpha Scores for Measurement Models displays the results of the Cronbach's alpha test for the *political stability*, *economic stability*, *health system indicators,* and *detection policies* measurement models.

Table 14: Cronbach's Alpha Scores for Measurement Models

Measurement Model	Cronbach's Alpha Based on Standardized Items	N of Items	Acceptable Threshold
Political Stability	0.949	5	.70 - .95
Economic Stability	0.749	4	.70 - .95
Health System Indicators	0.804	6	.70 - .95
Detection Policies	0.887	4	.70 - .95

The *political stability* measurement model had the highest reliability score of 0.949. Because of this, indicators representing voice and accountability, absence of violence and terrorism, control of corruption, regulatory quality, and rule of law achieved a highly acceptable level of internal consistency. This is not surprising since the literature indicates that these variables are consistent and related to one another. The *economic stability* measurement model had the lowest reliability score of 0.749, but was still within the acceptable Cronbach's alpha threshold; this revealed a slightly less internally consistent model. The more disparate indicators of GDP, exports, GNI, and total reserves produced the slightly lower score. Because all four measurement models were within acceptable thresholds for Cronbach's alpha and goodness of fit indices, the latent constructs were then covaried to test for possible associations.

Final Structural Equation Model

Once all the latent constructs and their observed variables were tested via confirmatory factor and covariance analyses and found to be within acceptable ranges of path parameter statistics, goodness of fit indices, and reliability estimates, the structural equation model was run with causal paths to the dependent variable *TB incidence rates*. As detailed in Chapter 4, numerous models were first attempted before arriving at the final model, shown in Figure 9. For instance, a portion of the initial structural model was run between political stability, economic stability and health system indicators, but because it was not significant and did not exhibit good

model fit, the *health system indicators* construct was then eliminated as a mediator and was covaried between *political stability* and *economic stability*. When adding *detection policies* to the structural model as an isolated construct directly related to *TB incidence rates*, the model failed to run. The model also failed to run with the control variables (population density, precipitation, and refugee population), which were later removed. Models were modified until the model shown in Figure 11 ran and provided good fit statistics.

The figure shows the direct effect of political stability, health system indicators, and detection policies on tuberculosis incidence rates. However, economic stability did not have a direct effect on tuberculosis incidence rates. Both political stability and health system indicator pathways, were negatively associated with tuberculosis incidence rates. As the political stability of a country increased, tuberculosis incidence rates decreased, and as positive health system indicators increased, tuberculosis incidence rates decreased. The detection policies pathway was positively associated with tuberculosis incidence rates. Countries with more Xpert detection policies in place experienced an increase in tuberculosis incidence rates.

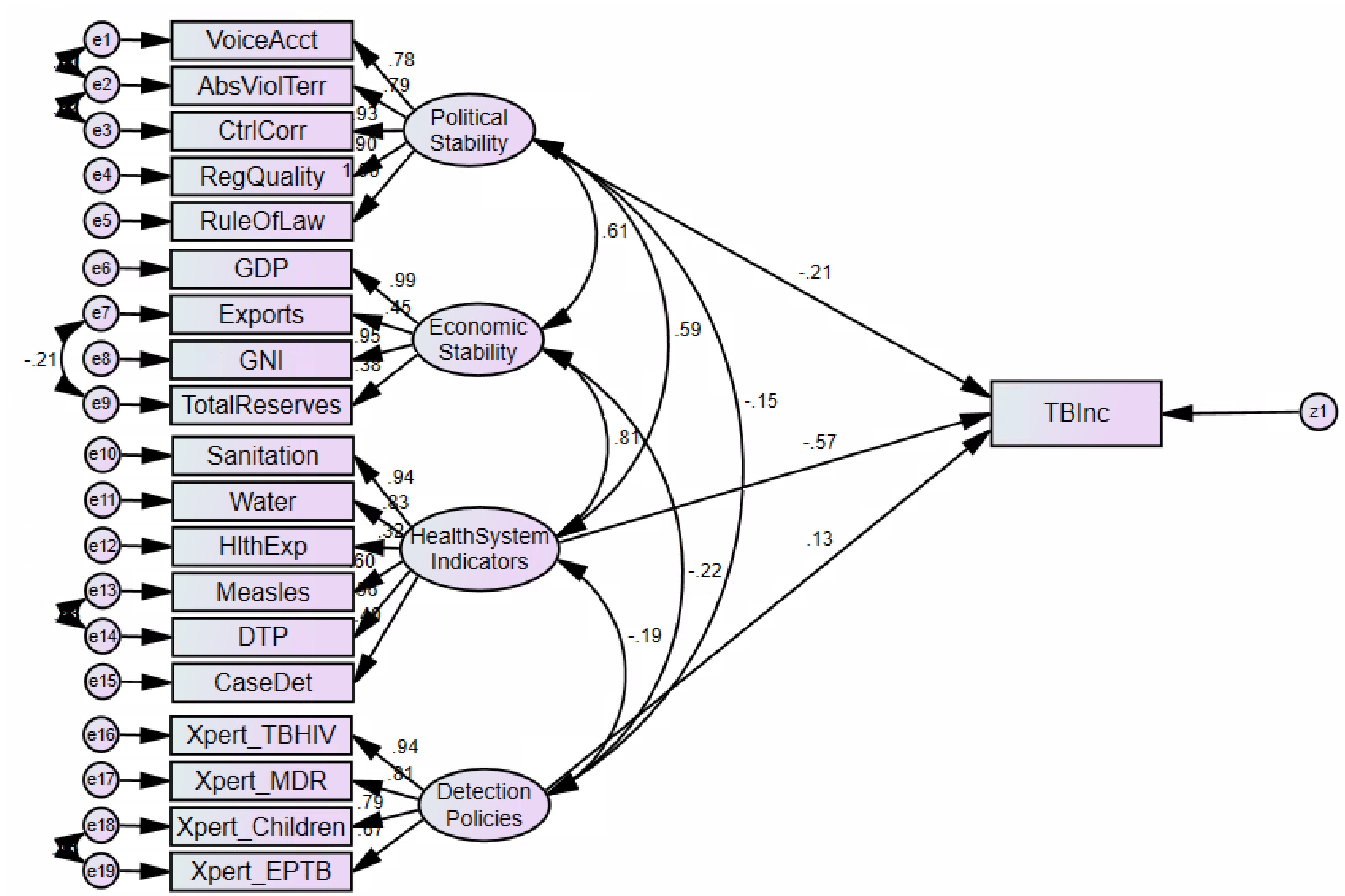

Figure 9: Final Structural Equation Model

As depicted in Table 15, all indicator and latent variable path parameters were significant with p-values below the 0.01 level. The path between the latent exogenous construct *political stability* and *TB incidence rates* had a significant p-value less than 0.001 and a standardized regression coefficient of -0.215, implying a significant negative association between political stability and TB incidence rates. The path between the latent exogenous construct *detection policies* and *TB incidence rates* had a significant p-value of 0.007 and a standardized regression coefficient of 0.132, implying a significant positive association between detection policies and TB incidence rates. The path between the latent exogenous construct *health system indicators* and *TB incidence rates* had a significant p-value of less than 0.001 and a standardized regression coefficient of -0.569, implying a significant negative association between health systems indicators and TB incidence rates.

Table 15: Final Structural Equation Model, Path Parameter Statistics

Path Parameter	Unstandardized Regression Coefficient	S.E.	C.R.	P-Value	Standardized Regression Coefficient
Rule of Law ⟵ Political Stability	1.000				0.999
Regulatory Quality ⟵ Political Stability	0.899	0.029	30.563	***	0.904
Control of Corruption ⟵ Political Stability	0.925	0.025	36.712	***	0.933
Absence of Violence/ Terrorism ⟵ Political Stability	0.764	0.041	18.836	***	0.785
Voice & Accountability ⟵ Political Stability	0.765	0.042	18.421	***	0.778
Total Reserves ⟵ Economic Stability	1.000				0.383
GNI per Capita ⟵ Economic Stability	1.580	0.256	6.164	***	0.949
Exports ⟵ Economic Stability	0.295	0.067	4.376	***	0.448
GDP per Capita ⟵ Economic Stability	1.649	0.266	6.196	***	0.994
Case Detection ⟵ Health System Indicators	1.000				0.402
DTP Immunizations ⟵ Health System Indicators	0.749	0.140	5.335	***	0.556
Measles Immunizations ⟵ Health System Indicators	0.815	0.148	5.502	***	0.599
Health Expenditures ⟵ Health System Indicators	1.610	0.417	3.863	***	0.317
Water ⟵ Health System Indicators	26.948	4.409	6.112	***	0.830
Sanitation⟵ Health System Indicators	47.688	7.615	6.262	***	0.937
Xpert EPTB ⟵ Detection Policies	1.000				0.667
Xpert EPTB ⟵ Detection Policies	1.209	0.100	12.101	***	0.793
Xpert EPTB ⟵ Detection Policies	1.134	0.105	10.750	***	0.810
Xpert EPTB ⟵ Detection Policies	1.375	0.120	11.414	***	0.943
TB Incidence Rates ⟵ Political Stabilty	-0.005	0.001	-3.721	***	-0.215
TB Incidence Rates ⟵ Detection Policies	0.284	0.106	2.688	0.007	0.132
TB Incidence Rates ⟵ Health System Indicators	-0.669	0.126	-5.323	***	-0.569

Unstd.: Unstandardized; S.E.: Standard Error; C.R.: Critical Ratio
***significant below the 0.001 level

Table 16 lists the goodness of fit indices and revealed a moderate and adequate fit with an acceptable likelihood ratio of 2.526, an acceptable goodness of fit index (GFI) of 0.857, and an adequate root mean square error of approximation (RMSEA) statistics of 0.082. Relative goodness of fit statistics all fell within acceptable parameters (IFI = .940, NFI = .905, and CFI = .940). Parsimonious goodness of fit was acceptable with an adjusted goodness of fit index (AGFI) statistic of .808. These demonstrated an adequate data fit to the structural equation model.

Table 16: Goodness of Fit Indices for Final Structural Equation Model

Test	Abbreviation	Value
Likelihood Ratio (chi-square/degrees of freedom)	χ^2/df	2.526
Goodness of Fit Index	GFI	0.857
Adjusted Goodness of Fit Index	AGFI	0.808
Incremental Fit Index	IFI	0. 940
Formed Fit Index	NFI	0.905
Comparative Fit Index	CFI	0.940
Root Mean Square Residual	RMSEA	0.082

Lastly, a power analysis of the final model was performed via an A priori sample size calculator (http://www.danielsoper.com/statcalc/calculator.aspx?id=89). With 4 latent constructs, 20 observed variables, a probability level of 0.05, and a sample size of 229 countries, the model exhibited a small to moderate effect size of 0.27 and a moderate to high power level of 0.91.

Support for Research Questions & Hypotheses

Research Question 1

Research Question 1 examined the relationship between a country's political stability and health outcomes. The alternative hypothesis proposed that politically stable countries, with high voice and accountability, an absence of violence and terrorism, high control of corruption, high regulatory quality, and high rule of law would experience favorable health system indicators. Although political stability was not directly related to health system indicators, the two constructs co-varied. The covariance path between the latent exogenous construct political stability and latent exogenous construct of health system indicators had a significant p-value below the 0.001 level and positive standardized regression coefficient, indicating a significant positive association between political stability and health system indicators.

Research Question 2

Research Question 2 examined the relationship between a country's economic stability and health outcomes. The alternative hypothesis proposed that economically stable countries, with high GDP, high exports, high GNI, and high total reserves would experience favorable health system indicators. Although economic stability was not directly related to health system indicators, the two constructs covaried. The covariance path between the latent exogenous construct economic stability and latent exogenous construct of health system indicators had a significant p-value below the 0.001 level and a positive standardized regression coefficient, implying a significant positive association between economic stability and health system indicators.

Research Question 3

Research Question 3 examined the relationship between a country's political stability and TB incidence rates when accounting for population density, precipitation, and refugee populations. The alternative hypothesis proposed that politically stable countries, with high voice and accountability, an absence of violence and terrorism, high control of corruption, high regulatory quality, and high rule of law would experience a lower incidence rates of tuberculosis. Political stability directly related to TB incidence rates; however, the control variables were not significant in the model. The path between the latent exogenous construct political stability and TB incidence rates had a significant p-value below the 0.001 level and a negative standardized regression coefficient implying a significant negative association between political stability and TB incidence rates.

Research Question 4

Research Question 4 examined the relationship between a country's economic stability and TB incidence rates when accounting for population density, precipitation, and refugee populations. The alternative hypothesis proposed that economically stable countries, with high GDP, high exports, high GNI, and high total reserves would experience a lower incidence of tuberculosis. The path between the latent exogenous construct economic stability and TB incidence rates was not statistically significant, so the direct path was removed from the model. This indicated that economic stability was not directly related to TB incidence rates.

Research Question 5

Research Question 5 examined the relationship between a country's health system indicators and TB incidence rates when accounting for population density, precipitation, and refugee populations. The alternative hypothesis proposed that countries with high tuberculosis case detection rates, high health expenditures, high measles immunization rates, high DTP immunization rates, increased access to clean water, and increased access to sanitation would experience a lower incidence of tuberculosis. The path between the latent exogenous construct health system indicators and TB incidence rates had a significant p-value below the 0.001 level and a negative standardized regression coefficient indicating a significant negative association between detection policies and TB incidence rates. Additionally, health system indicators also indirectly related to TB incidence through the other latent constructs.

Research Question 6

Research Question 6 examined the relationship between a country's policies regarding tuberculosis detection and TB incidence rates when accounting for population density,

precipitation, and refugee populations. The alternative hypothesis proposed that countries with tuberculosis detection and treatment policies in place will experience a lower incidence of tuberculosis. The path between the latent exogenous construct detection policies and TB incidence rates had a significant p-value below the 0.001 level and a positive standardized regression coefficient, indicating a significant positive association between detection policies and TB incidence rates. Additionally, detection policies also indirectly related to TB incidence rates through the other latent constructs.

Research Question 7

Research Question 7 examined whether a covariate relationship between a country's political stability & economic stability existed. The alternative hypothesis proposed that politically stable countries have more economic stability than countries with political instability and vice versa. The path between the latent exogenous construct political stability and latent exogenous construct of economic stability had a significant p-value below the 0.001 level and a standardized regression coefficient of 0.61, implicating a significant positive association between political and economic stability. Additionally, positive reciprocal relationships also existed between political stability and health system indicators (significant p-value below the 0.001 level and a standardized regression coefficient of 0.61) and economic stability and health system indicators (significant p-value below the 0.001 level and a standardized regression coefficient of 0.82). Negative reciprocal relationships existed between political stability and detection policies (significant p-value below the 0.001 level and a standardized regression coefficient of -0.13), economic stability and detection policies (significant p-value below the 0.001 level and a standardized regression coefficient of -0.21), and health system indicators and detection policies (standardized regression coefficient of. -0.18).

CHAPTER FIVE: DISCUSSION

The purpose of this research was to identify potential areas of infectious disease influence that were not obviously health-related in order to help governments and policymakers establish new policies, correct current policies, or further address these issues in order to effectively combat infectious disease. This research expanded upon previous determinants of health and population health models (Evans & Stoddart, 1990; Kindig & Stoddart, 2003; University of Wisconsin Population Health Institute, 2016) by examining associations between political stability, tuberculosis detection policies, economic stability, and health system indicator constructs in relation to infectious disease using a multivariate structural equation model approach. This study presented a previously uninvestigated perspective from which to gauge disease incidence at the country-level, using tuberculosis as a focal point.

This concluding chapter will discuss the major findings of the structural equation model in relation to the proposed research questions and hypotheses. Limitations and recommendations pertaining to the research will also be discussed followed by policy implications and future research suggestions.

Major Findings

As hypothesized, political stability, health system indicators, and detection policies had a direct effect on tuberculosis incidence rates. Economic stability, however, did not have a direct effect on tuberculosis incidence rates. Two of the direct pathways, political stability and health system indicators, were negatively associated with tuberculosis incidence rates, as was hypothesized. In other words, as the political stability of a country increased, tuberculosis incidence rates decreased. As positive health system indicators increased, tuberculosis incidence

rates decreased. One of the direct pathways, detection policies, was positively associated with tuberculosis incidence rates. Countries with more Xpert detection policies in place experienced an increase in tuberculosis incidence rates. This ran counter to the hypothesis that greater detection policies would be associated with lower TB incidence rates. The direction of the relationship maybe due to the fact that countries with better detection policies actually detect more TB, thus increasing their apparent TB incidence rates. This is a highly significant finding in that it may indicate that there are much higher incidences of TB in countries that have worse detection policies than are shown in the measure of TB incidence rates.

Policy Implications

The role of political stability, a non-health determinant, and factors like citizen voice and accountability, violence and terrorism, and government corruption, have not frequently been studied in tandem with economic constructs, tuberculosis policies, and health system indicators. Furthermore, many studies have linked health and non-health determinants in terms of infectious disease, but few to none have studied the direct and indirect pathways leading to tuberculosis specifically. This study revealed a direct relationship between political stability and tuberculosis incidence rates. These findings highlight the importance of government and political control as a contributor to infectious disease.

Numerous studies (Kan, Chen, & Tong, 2012; Mehta et al., 2012; Hwang et al., 2014; Smith et al., 2014; Sumpter & Chandramohan, 2013) have examined the indirect relationship of economic indicators on population health, infectious disease, and tuberculosis, but no studies have examined the direct relationship to tuberculosis incidence rates. Although this study

examined the direct pathway of economic stability to tuberculosis, the relationship was not statistically significant, so the direct pathway was removed from the model.

In terms of the relationship between health system indicators and TB incidence rates, the literature indicated that health system indicators oftentimes have a direct impact on infectious disease via population and individual health. For instance, data on health spending (Murthy & Okunade, 2014) has indicated a direct positive relationship between increased health spending and better population health (Drummond et al., 2015; Sisko et al., 2014; Kondilis et al., 2013; Kringos et al., 2013; Moreno-Serra, & Smith, 2012), and an indirect relationship between increased health spending and infectious disease (Karanikolos et al., 2013). Other health system indicators, such as water and sanitation, have not been found to directly relate to tuberculosis, but indirectly impact it through the pathway of increased adult and child mortality, increased diarrheal diseases, compromised immune systems, and HIV/ AIDS co-morbidities (Obi et al., 2007). This study revealed a direct pathway between the health system indicators construct and tuberculosis incidence rates.

Regarding TB policies impact on TB incidence rates, global organizations, such as the WHO and the International Union against TB and Lung Disease, have standardized specific TB testing, sampling, and laboratory techniques (Lönnroth et al., 2015; Lienhardt et al., 2012; WHO, 2015a) into policies implemented nationally world-wide. These evidenced-based approaches and policies have substantially reduced tuberculosis rates and contraction among healthcare workers (Lönnroth et al., 2015; Chai, Mattingly, & Varma, 2013; Lienhardt et al., 2012), but no research has examined the policies at the country-level. Results in this study indicated a direct pathway between detection policies and tuberculosis incidence rates. Surprisingly, there was a positive association, meaning that countries with more Xpert detection policies in place experienced an

increase in tuberculosis incidence rates. While this seems counter-intuitive, a possible explanation is that countries with better detection policies actually detect more TB, thus increasing their TB incidence rates.

An influential issue regarding disease detection policies and reduction as a whole is limited resources, both in terms of funding and medical personnel. Diagnostic technologies, while state-of-the-art and effective, are usually very expensive. Similarly, lab technicians, nurses, and physicians are usually in high demand, but in short supply. Combined, these issues further strain already struggling national budgets and increase healthcare costs. The issue of affordability can be very challenging for low income countries, developing nations, and areas with high TB burdens.

Both now and in future years, it will be imperative for countries to adopt and implement TB policies and initiatives either internally, by re-prioritizing public health budgets, or externally, through grants or international public assistance. Because no country is in the fight against tuberculosis alone, raising the general public's awareness about TB, sharing timely and accurate TB data, forming partnerships via international cooperation and resource sharing, and removing activity barriers may be a few ways to approach this disease at a macro level. By examining and replicating the practices of low burden countries, high burden countries may be able to increase detection and decrease incidence rates. Technical assistance and prevention efforts is vital to the health of all neighboring countries.

Currently, international cooperation is very limited. Many across-boarder collaborations that once existed have been forced to retire due to various social and political factors. For instance, the United States and Mexico were forced to stop their partnership due to decreased budgets and increased Mexican drug violence (McKay, 2013). The movement of individeuals

across borders, whether legally or illegally, can create gaps in data collection and TB surveillance if countries do not have proper protocols in place to screen for TB or if countries do not require proof of immunization or medical history records upon entrance. This then hinders the accurate and timely sharing of diagnostic and clinical information needed for treatment and therapy completions. For instance, the US Immigration and Naturalization Services has no database system for monitoring TB cases. Lapses in treatment occur and further promote TB transmission and the development of drug-resistant TB strains (Lobato & Cegielski, 2001).

In summary, this study's findings contributed to the literature by indicating direct path relationships to TB incidence rates that previously were unexplored. These findings noted the role of government and political control, health system indicators, and detection policies as a contributor to infectious disease, in particular, TB. Infectious diseases, like tuberculosis, are "wicked problems" entangled in a web of other interrelated issues (Rittel & Webber, 1973). As demonstrated by this dissertation research, the problem of disease does not exist in isolation; it is interconnected to other challenging problems like politics, policy-making, and economics which do not have simple or quick-fix solutions. Instead of focusing primarily on health system indicators of disease, it is important, if not more important, for future global health research to examine the "up-stream" effects of these intractable problems in relation to tuberculosis incidence rates. If these "up-stream" conditions can be improved or corrected, then the "down-stream" consequences of disease could perhaps be prevented. Additionally, there may large cost savings for countries in monetary terms, increased workforce productivity, and an increase life years saved or mortality averted by addressing these "up-stream" effects.

Limitations & Recommendations

The primary constraint of this study was the limited sample size due to the number of countries in the world. Unlike primary data collection, there was no way to increase this size by surveying more countries. Another concern was that the secondary data sets were not entirely complete. Therefore, the researcher used what was provided and imputed missing values using post-linear interpolation. Some of the constructs and variables were modified or eliminated in order to ensure a large enough model power. Because of these limitations, the number of observed and latent variables in the analysis was restricted, and it may have resulted in omitted variable bias. Furthermore, this low number of observations made it challenging to have enough observed variables to arrive at a good measurement model, but the confirmatory factor analysis assisted in assuring that the observed variables hung well together with the latent construct they comprised. Further model revisions and the goodness of fit criteria also aided in finding an acceptable measurement model.

Another limitation is the issue of bounded rationality (Simon, 1957). Decisions can only be made with available information, which may or may not be limited in terms of information, time, mental capacity, and problem difficulty. Several of the variables utilized in this study were bounded in terms of information, time, and accuracy. For instance, tuberculosis incidence rate data from the WHO database is continually updated as countries notify the WHO of corrections to previously-submitted data; therefore, the data used at the time of analysis may differ from today's revised dataset.

In order to guard against over-reaching conclusions about the study results, it is important to avoid faulty reasoning, such an ecological fallacy or reductionism. What has been learned about the ecological system, in this case, the relationship between indicators and tuberculosis

incidence rates at the country-level, does not directly indicate any other relationships about the individuals within the unit or country at the micro-level. Furthermore, while this study did indicate direct path relationships between the latent constructs and the dependent variable, the results should not be reduced to a simple explanation. In reality, this is a very complex problem (Rittel & Webber, 1973; Ritchey, 2005) comprised of many interdependencies, and with no simple statistical solution.

There is also the potential for internal, construct, and external validity issues. Regarding internal validity, while there may be casual links between some the independent variables (latent constructs and observed variables) and the dependent variable, this study did not examine temporal ordering for the purpose of establishing causation, so inferences cannot be made regarding cause and effect or causal relationships. Future research should perhaps examine if any of the variables do indeed occur in temporal sequence by conducting a longitudinal analysis.

Another possible issue pertains to construct validity- whether what was observed was what the researcher intended to measure. Take, for example, the results for the relationship between detection policies and TB incidence rates, in which countries with better detection policies had a higher incidence rate of TB. The researcher intended TB incidence rates to be a measure of actual TB incidence rates, but instead, these results indicate that it may be merely a measure of TB detection, not the actual incidence rate. Furthermore, TB data may prove difficult to compare between countries due to national differences in diagnosis, testing, and TB reporting. For instance, cases in Mexico are mostly diagnosed clinically, but in the United States, cases are diagnosed only after confirmatory TB tests (United States-Mexico Border Health Commission, 2003).

A final limitation is the generalizability of the results which are impacted by the cross-sectional nature of the study. Longitudinal data going back several decades was available for the observed variables, but not every variable contained complete data for each year. Because only one year of data was used, there exists the possibility of externality validity—that the conclusions drawn for the results are not strongly generalizable and cannot be solely relied upon for future policy recommendations; however, this study was a start toward the validation of this structural equation model.

Future Research

Future research could utilize numerous, cross-sectional years of data, perhaps two years at a time going back a decade or further, to compile into a longitudinal study. Additional research could also perform an in-depth policy analysis of the WHO's Xpert detection and treatment recommendations to better understand the positive association found in the study of detection policies with TB incidence rates. Future research should also incorporate numerous other variables by creating additional latent constructs pertaining to climate and the environment (with observed variables including precipitation, temperature, humidity, natural disasters), population and demographics (with observed variables including education, poverty rates, urbanization, and overcrowding), individual behaviors (with observed variables including intravenous drug use, corticosteroid therapy, smoking, and alcoholism), barriers to care (with observed variables including language and cultural barriers, values systems, religious beliefs, and stigmas), and policies and laws (with observed variables including immigration and emigration medical documentation, laws requiring masks, quarantine and isolation laws, and pharmaceutical compliance laws). Additional research should also examine why the latent construct of

economic stability was not directly related to TB incidence rates. The construct may have required additional observed variables in order to be significant in the model.

Further research should also include other detection methods such as skin tests, blood analysis, sputum smears, and chest X-rays; it could be that Xpert testing was too limited and may not have been the best indicator to utilize. Policies regarding TB treatment and pharmaceutical compliance could also contribute to the model. For instance, Directly Observed Treatment, Short Course (DOTS) is a cost-effective and efficient strategy for TB control that monitors patients' drugs, dosages, and timing to ensure compliance for the full treatment duration (WHO Regional Office for South-East Asia, 2016). Data on intra-country drug susceptibility testing could also be examined. Furthermore, the Xpert testing policies should be examined longitudinally from the implementation year of 2010 onward. Post-implementation, there may be an increase in apparent TB incidence rates, but if those increases result in increased detection and treatment, then this should later result in decreased incidence rates.

This study was unique in that it utilized global measures of disease incidence rates from a country-wide perspective as oppose to other studies that only analyzed specific areas or several countries. However, it is important to note that there may exist large difference and disparities of the data within the country. For instance, just because a country has a relatively low incidence rate of disease on the average does not mean that specific regions or provinces within a country reflect these same attributes. Future research may specifically examine provinces, areas, or states that comprise countries on a specific continent or in the high-burden TB nations.

Additionally, because the literature indicates that specific countries comprise a larger share of the overall tuberculosis burden, TB incidence rates could be further stratified into high, moderate, and low burden country categories. While this may decrease the sample size, the

results may reveal differences in terms of which indicators directly or indirectly influence the stratified incidence levels and to what extent. This would help to better inform country-specific policies. Lastly, additional research should examine multiple infectious diseases, because most diseases are co-morbidities of one another. For instance, an infectious disease construct comprising tuberculosis, HIV, AIDS, and pneumonia. Finally, it would also be interesting to see if the same constructs that relate to infectious disease would also relate to chronic disease.

APPENDIX A: LIST OF COUNTRIES USED IN SAMPLE

Afghanistan	Comoros
Albania	Congo, Dem. Rep.
Algeria	Congo, Rep.
American Samoa	Costa Rica
Andorra	Cote d'Ivoire
Angola	Croatia
Antigua and Barbuda	Cuba
Arab World	Curacao
Argentina	Cyprus
Armenia	Czech Republic
Aruba	Denmark
Australia	Djibouti
Austria	Dominica
Azerbaijan	Dominican Republic
Bahamas, The	East Asia & Pacific (all income levels)
Bahrain	East Asia & Pacific (developing only)
Bangladesh	Ecuador
Barbados	Egypt, Arab Rep.
Belarus	El Salvador
Belgium	Equatorial Guinea
Belize	Eritrea
Benin	Estonia
Bermuda	Ethiopia
Bhutan	Euro area
Bolivia	Europe & Central Asia (all income levels)
Bosnia and Herzegovina	Europe & Central Asia (developing only)
Botswana	European Union
Brazil	Faeroe Islands
Brunei Darussalam	Fiji
Bulgaria	Finland
Burkina Faso	Fragile and conflict affected situations
Burundi	France
Cabo Verde	French Polynesia
Cambodia	Gabon
Cameroon	Gambia, The
Canada	Georgia
Caribbean small states	Germany
Cayman Islands	Ghana
Central African Republic	Greece
Central Europe and the Baltics	Greenland
Chad	Grenada
Channel Islands	Guam
Chile	Guatemala
China	Guinea
Colombia	Guinea-Bissau
Guyana	Macedonia, FYR
Haiti	Madagascar
Heavily indebted poor countries (HIPC)	Malawi
High income	Malaysia
High income: non-OECD	Middle East & North Africa (all income levels)
High income: OECD	Middle East & North Africa (developing only)

Honduras	Middle income
Hong Kong SAR, China	Moldova
Hungary	Monaco
Iceland	Mongolia
India	Montenegro
Indonesia	Morocco
Iran, Islamic Rep.	Mozambique
Iraq	Myanmar
Ireland	Namibia
Isle of Man	Nepal
Israel	Netherlands
Italy	New Caledonia
Jamaica	New Zealand
Japan	Nicaragua
Jordan	Niger
Kazakhstan	Nigeria
Kenya	North America
Kiribati	Northern Mariana Islands
Korea, Dem. Rep.	Norway
Korea, Rep.	Not classified
Kosovo	OECD members
Kuwait	Oman
Kyrgyz Republic	Other small states
Lao PDR	Pacific island small states
Latin America & Caribbean (all income levels)	Pakistan
Latin America & Caribbean (developing only)	Palau
Latvia	Panama
Lebanon	Papua New Guinea
Least developed countries: UN classification	Paraguay
Lesotho	Peru
Liberia	Philippines
Libya	Poland
Liechtenstein	Portugal
Lithuania	Puerto Rico
Low & middle income	Qatar
Lower middle income	Romania
Low income	Russian Federation
Luxembourg	Rwanda
Macao SAR, China	Samoa
Maldives	San Marino
Mali	Sao Tome and Principe
Malta	Saudi Arabia
Marshall Islands	Senegal
Mauritania	Serbia
Mauritius	Seychelles
Mexico	Sierra Leone
Micronesia, Fed. Sts.	Singapore
Sint Maarten (Dutch part)	Timor-Leste
Slovak Republic	Togo
Slovenia	Tonga
Small states	Trinidad and Tobago

Solomon Islands	Tunisia
Somalia	Turkey
South Africa	Turkmenistan
South Asia	Turks and Caicos Islands
South Sudan	Tuvalu
Spain	Uganda
Sri Lanka	Ukraine
St. Kitts and Nevis	United Arab Emirates
St. Lucia	United Kingdom
St. Martin (French part)	United States
St. Vincent and the Grenadines	Upper middle income
Sub-Saharan Africa (all income levels)	Uruguay
Sub-Saharan Africa (developing only)	Uzbekistan
Sudan	Vanuatu
Suriname	Venezuela, RB
Swaziland	Vietnam
Sweden	Virgin Islands (U.S.)
Switzerland	West Bank and Gaza
Syrian Arab Republic	World
Tajikistan	Yemen, Rep.
Tanzania	Zambia
Thailand	Zimbabwe

APPENDIX B: WORLD BANK’S WORLDWIDE GOVERNANCE POLITCAL STABILITY INDICATORS DESCRIPTION & SOURCES

"***Voice and accountability*** captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media. This table lists the individual variables from each data sources used to construct this measure in the Worldwide Governance Indicators" (World Bank, 2016s).

Representative Sources

EIU	Democracy Index
	Vested interests
	Accountability of Public Officials
	Human Rights
	Freedom of association
FRH	Political Rights (FRW)
	Civil Liberties (FRW)
	Press Freedom Index (FRP)
	Media (FNT)
	Civil Society (FNT)
	Electoral Process (FNT)
GCS	Transparency of government policymaking
	Freedom of the Press
	Favoritism in Decisions of Government Officials
	Effectiveness of Law-Making Body
GWP	Confidence in honesty of elections
IPD	Freedom of elections at national level
	Are electoral processes flawed?
	Do the representative Institutions (e.g. parliament) operate in accordance with the formal rules in force (e.g. Constitution)?
	Freedom of the Press (freedom of access to information, protection of journalists, etc.)
	Freedom of Association
	Freedom of assembly, demonstration
	Respect for the rights and freedoms of minorities (ethnic, religious, linguistic, immigrants...)
	Is the report produced by the IMF under Article IV published?
	Reliability of State budget (completeness, credibility, performance...)
	Reliability of State accounts (completeness, audit, review law...)
	Reliability of State-owned firms' accounts
	Reliability of basic economic and financial statistics (e.g. national accounts, price indices, foreign trade, currency and credit, etc.).
	Reliability of State-owned banks' accounts
	Is the State economic policy (e.g. budgetary, fiscal, etc.)… communicated?
	Is the State economic policy (e.g. budgetary, fiscal, etc.)… publicly debated?
	Degree of transparency in public procurement
	Freedom to leave the country (i.e. passports, exit visas, etc.)
	Freedom of entry for foreigners (excluding citizens of countries under agreements on free movement, e.g. Schengen Area, etc.)
	Freedom of movement for nationals around the world
	Genuine Media Pluralism
	Freedom of access, navigation and publishing on Internet
PRS	Military in politics
	Democratic accountability
RSF	Press Freedom Index

Non-representative Sources

AFR	How much do you trust the parliament?
	Overall, how satisfied are you with the way democracy works in your country?
	Free and fair elections
BTI	Political Participation (SI)
	Stability of Democratic Institutions (SI)
	Political and Social Integration (SI)
CCR	Civil Liberties
	Accountability and public voice
GII	Elections
	Public Management
	Access to Information and Openness
	Rights
IFD	Policy and legal framework for rural organizations
	Dialogue between government and rural organizations
IRP	Africa Electoral index
LBO	Satisfaction with democracy
	Trust in Parliament
MSI	Media Sustainability Index
OBI	Open Budget Index
VAB	Trust in parliament
	Satisfaction with democracy
WCY	Transparency of government policy
WJP	Factor 1: Limited Government Powers
	Factor 4: Fundamental Rights
	Factor 5: Open Government

Code	**Data Source Name**
ADB	African Development Bank Country Policy and Institutional Assessments
AFR	Afrobarometer
ASD	Asian Development Bank Country Policy and Institutional Assessments
BPS	Business Enterprise Environment Survey
BTI	Bertelsmann Transformation Index
CCR	Freedom House Countries at the Crossroads
EBR	European Bank for Reconstruction and Development Transition Report
EIU	Economist Intelligence Unit Riskwire & Democracy Index
FRH	Freedom House
GCB	Transparency International Global Corruption Barometer Survey
GCS	World Economic Forum Global Competitiveness Report
GII	Global Integrity Index
GWP	Gallup World Poll
HER	Heritage Foundation Index of Economic Freedom
HUM	Cingranelli Richards Human Rights Database and Political Terror Scale
IFD	IFAD Rural Sector Performance Assessments
IJT	iJET Country Security Risk Ratings
IPD	Institutional Profiles Database
IRP	IREEP African Electoral Index
LBO	Latinobarometro
MSI	International Research and Exchanges Board Media Sustainability Index
OBI	International Budget Project Open Budget Index
PIA	World Bank Country Policy and Institutional Assessments
PRC	Political Economic Risk Consultancy Corruption in Asia Survey
PRS	Political Risk Services International Country Risk Guide

RSF	Reporters Without Borders Press Freedom Index
TPR	US State Department Trafficking in People report
VAB	Vanderbilt University Americas Barometer
WCY	Institute for Management and Development World Competitiveness Yearbook
WJP	World Justice Project Rule of Law Index
WMO	Global Insight Business Conditions and Risk Indicators

Source: World Banks' Worldwide Governance Indicators
http://info.worldbank.org/governance/wgi/va.pdf

"***Political Stability and Absence of Violence/Terrorism*** measures perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism. This table lists the individual variables from each data sources used to construct this measure in the Worldwide Governance Indicators" (World Bank, 2016s).

Representative Sources

EIU	Orderly transfers
	Armed conflict
	Violent demonstrations
	Social Unrest
	International tensions / terrorist threat
GCS	Cost of Terrorism
HUM	Political terror scale
IJT	Security Risk Rating
IPD	Intensity of internal conflicts: ethnic, religious or regional
	Intensity of violent activities…of underground political organizations
	Intensity of social conflicts (excluding conflicts relating to land)
PRS	Government stability
	Internal conflict
	External conflict
	Ethnic tensions
WMO	*Protests and riots*. The risk that the nature and impact of protests and riots (excluding those related to labour) cause damage to assets or injure or detain people, particularly if these disrupt normal movement, business operations, and activity.
	Terrorism. The risk that the activities of any non-state armed group or individual cause (or are likely to cause) property damage and/or death/injury through violence. This risk definition includes terrorism, which uses violence (or the threat of) to advance a political cause, and similar tactics used by "for profit" organised crime.
	Interstate war. This risk measures resultant impacts (death/property damage) and means, covering the spectrum from targeted military strikes against limited targets to full-scale war with the aim of changing the government and/or occupation.
	Civil war. The risk of intra-state military conflict, in the form of an organised insurgency, separatist conflict, or full- blown civil war, in which rebels/insurgents attempt to overthrow the government, achieve independence, or at least heavily influence major government policies.

Non-representative Sources

WCY	The risk of political instability is very high
WJP	Factor 3.2: Civil conflict is effectively limited (Order and Security)

Code	**Data Source Name**
ADB	African Development Bank Country Policy and Institutional Assessments
AFR	Afrobarometer
ASD	Asian Development Bank Country Policy and Institutional Assessments
BPS	Business Enterprise Environment Survey
BTI	Bertelsmann Transformation Index
CCR	Freedom House Countries at the Crossroads
EBR	European Bank for Reconstruction and Development Transition Report
EIU	Economist Intelligence Unit Riskwire & Democracy Index
FRH	Freedom House

GCB	Transparency International Global Corruption Barometer Survey
GCS	World Economic Forum Global Competitiveness Report
GII	Global Integrity Index
GWP	Gallup World Poll
HER	Heritage Foundation Index of Economic Freedom
HUM	Cingranelli Richards Human Rights Database and Political Terror Scale
IFD	IFAD Rural Sector Performance Assessments
IJT	iJET Country Security Risk Ratings
IPD	Institutional Profiles Database
IRP	IREEP African Electoral Index
LBO	Latinobarometro
MSI	International Research and Exchanges Board Media Sustainability Index
OBI	International Budget Project Open Budget Index
PIA	World Bank Country Policy and Institutional Assessments
PRC	Political Economic Risk Consultancy Corruption in Asia Survey
PRS	Political Risk Services International Country Risk Guide
RSF	Reporters Without Borders Press Freedom Index
TPR	US State Department Trafficking in People report
VAB	Vanderbilt University Americas Barometer
WCY	Institute for Management and Development World Competitiveness Yearbook
WJP	World Justice Project Rule of Law Index
WMO	Global Insight Business Conditions and Risk Indicators

Source: World Banks' Worldwide Governance Indicators
http://info.worldbank.org/governance/wgi/pv.pdf

"***Control of corruption*** captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. This table lists the individual variables from each data sources used to construct this measure in the Worldwide Governance Indicator" (World Bank, 2016s).

Representative Sources

EIU	Corruption among public officials
GCS	Public Trust in Politicians
	Diversion of Public Funds
	Irregular Payments in Export and Import
	Irregular Payments in Public Utilities
	Irregular payments in tax collection
	Irregular Payments in Public Contracts
	Irregular Payments in Judicial Decisions
	State Capture
GWP	Is corruption in government widespread?
IPD	Level of "petty" corruption between administration and citizens
	Level of corruption between administrations and local businesses
	Level of corruption between administrations and foreign companies
PRS	Corruption
WMO	*Corruption*. The risk that individuals/companies will face bribery or other corrupt practices to carry out business, from securing major contracts to being allowed to import/export a small product or obtain everyday paperwork. This threatens a company's ability to operate in a country, or opens it up to legal or regulatory penalties and reputational damage.

Non-representative Sources

ADB	Transparency, accountability and corruption in public sector
AFR	How many elected leaders (parliamentarians) do you think are involved in corruption?
	How many judges and magistrates do you think are involved in corruption?
	How many government officials do you think are involved in corruption?
	How many border/tax officials do you think are involved in corruption?
ASD	Transparency, accountability and corruption in public sector
BPS	How common is it for firms to have to pay irregular additional payments to get things done?
	Percentage of total annual sales do firms pay in unofficial payments to public officials?
	How often do firms make extra payments in connection with taxes, customs, and judiciary?
	How problematic is corruption for the growth of your business?
BTI	Anti-Corruption policy
	Prosecution of office abuse
CCR	Anti-Corruption and Transparency
FRH	Corruption (FNT)
GCB	Frequency of household bribery – paid a bribe to one of the 8/9 services
	Frequency of corruption among public institutions: Political parties
	Frequency of corruption among public institutions: Parliament/Legislature
	Frequency of corruption among public institutions: Media
	Frequency of corruption among public institutions: Legal system/Judiciary
	Frequency of corruption among public institutions: Public officials
GII	Accountability
IFD	Accountability, transparency and corruption in rural areas

LBO	Frequency of corruption
PIA	Transparency, accountability and corruption in public sector
PRC	To what extent does corruption exist in a way that detracts from the business environment for foreign companies?
VAB	Frequency of corruption among government officials
WCY	Bribing and corruption exist in the economy
WJP	Factor 2: Absence of Corruption

Code	**Data Source Name**
ADB	African Development Bank Country Policy and Institutional Assessments
AFR	Afrobarometer
ASD	Asian Development Bank Country Policy and Institutional Assessments
BPS	Business Enterprise Environment Survey
BTI	Bertelsmann Transformation Index
CCR	Freedom House Countries at the Crossroads
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IPD	Institutional Profiles Database
IRP	IREEP African Electoral Index
LBO	Latinobarometro
MSI	International Research and Exchanges Board Media Sustainability Index
OBI	International Budget Project Open Budget Index
PIA	World Bank Country Policy and Institutional Assessments
PRC	Political Economic Risk Consultancy Corruption in Asia Survey
PRS	Political Risk Services International Country Risk Guide
RSF	Reporters Without Borders Press Freedom Index
TPR	US State Department Trafficking in People report
VAB	Vanderbilt University Americas Barometer
WCY	Institute for Management and Development World Competitiveness Yearbook
WJP	World Justice Project Rule of Law Index
WMO	Global Insight Business Conditions and Risk Indicators

Source: World Banks' Worldwide Governance Indicators
http://info.worldbank.org/governance/wgi/cc.pdf

"***Regulator quality*** captures perceptions of the ability of the government to formulate and implement sound policies and regulation that permit and promote private sector development. This table lists the individual variables from each data sources used to construct this measure in the Worldwide Governance Indicators" (World Bank, 2016s).

Representative Sources

EIU	Unfair Competitive Practices
	Price Controls
	Discriminatory Tariffs
	Excessive Protections
	Discriminatory Taxes
GCS	Burden of Government Regulations
	Extent and Effect of Taxation
	Prevalence of Trade Barriers
	Intensity of Local Competition
	Ease of Starting an New Business
	Effectiveness of Anti-Trust Policy
	Stringency of Environmental Regulations
HER	Investment Freedom
	Financial Freedom
IPD	Ease of Starting a Business Governed by Local Law?
	Ease of Setting up a Subsidiary for a Foreign Firm?
	Share of Administered Prices
	Does the State Subsidize Commodity Prices (i.e. food and other essential goods, excluding oil)?
	Does the State Subsidize the Price of Petrol at the Pumps?
	Importance, de facto, of Barriers to Entry for New Competitors in Markets for Goods and Services (excluding finance and beyond the narrow constraints of the market)…related to the practices of already established competitors
	Efficiency of Competition Regulation in the Market Sector (excluding financial sector)
PRS	Investment Profile
WMO	Regulatory Burden. The risk that normal business operations become more costly due to the regulatory environment. This includes regulatory compliance and bureaucratic inefficiency and/or opacity. Regulatory burdens vary across sectors so scoring should give greater weight to sectors contributing the most to the economy.

Non-representative Sources

ABD	Trade Policy
	Regional Integration
	Business Regulatory Environment
ASD	Trade Policy
	Business Regulatory Environment
BPS	How problematic are labor regulations for the growth of your business?
	How problematic are tax regulations for the growth of your business?
	How problematic are customs and trade regulations for the growth of your business?
BTI	Organization of the Market and Competition
EBR	Price Liberalization
	Trade & Foreign Exchange System
	Competition Policy

IFD	Enabling Conditions for Rural Financial Services Development
	Investment Climate for Rural Businesses
	Access to Agricultural Input and Product Markets
PIA	Business Regulatory Environment
	Trade Policy
WCY	Protectionism in the county negatively affects the conduct of business
	Competition legislation in your country does not prevent unfair competition
	Price controls affect pricing of products in most industries
	Access to capital markets (foreign and domestic) is easily available
	Ease of doing business is not a competitive advantage for your country
	Financial institutions' transparency is not widely developed in your country
	Customs' authorities do not facilitate the efficient transit of goods
	The legal framework is detrimental to your country's competitiveness
	Foreign investors are free to acquire control in domestic companies
	Public sector contracts are sufficiently open to foreign bidders
	Real personal taxes are non-distortionary
	Banking regulation does not hinder competitiveness
	Labor regulations hinder business activities
	Subsidies impair economic development
	Easy to start a business

Source: World Banks' Worldwide Governance Indicators
http://info.worldbank.org/governance/wgi/rq.pdf

"***Rule of law*** captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. This table lists the individual variables from each data sources used to construct this measure in the Worldwide Governance Indicators" (World Bank, 2016s).

Representative Sources

EIU	Violent Crime
	Organized Crime
	Fairness of Judicial Process
	Enforceability of contracts
	Speediness of Judicial Process
	Confiscation/ Expropriation
	Intellectual Property Rights Protection
GCS	Business Cost of Crime and Violence
	Cost of Organized Crime
	Reliability of Police Services
	Judicial Independence
	Efficiency of Legal Framework for Challenging Regulations
	IPR Protection
	Property Rights
	Informal Sector
GWP	Confidence in the Police Force
	Confidence in Judicial System
	Have you had money property stole from you or another household member?
	Have you been assaulted or mugged?
HER	Property Rights
IPD	Degree of security of goods and persons by criminal organizations (drug trafficking, weapons, prostitution)
	Degree of judicial independence vis-a-vice the State
	Degree of enforcement of court orders
	Timeliness of judicial decisions
	Equal treatment of foreigners before the law (compared to nationals)
	Practical ability of the administration to limit tax evasion
	Efficiency of the legal means to protect property rights in the event of conflict between private stakeholders?
	Generally speaking, does the State exercise arbitrary pressure on private property (e.g. red tape…)?
	Does the State pay compensation equal to the loss in cases of expropriation (by law or fact) when the expropriation concerns production means?
	Degree of observance of contractual terms between national private stakeholders
	Degree of observance of contractual terms between national and foreign private stakeholders.
	In the past 3 years, has the State withdrawn from contracts without paying the corresponding compensation… vis-a vis national stakeholders?
	In the past 3 years, has the State withdrawn from contracts without paying the corresponding compensation… vis-a vis foreign stakeholders?
	Respect for intellectual property rights relating to…trade secrets and industrial patents
	Respect for intellectual property rights relating to…industrial counterfeiting
	Does the State recognize formally the diversity of land tenure system?
PRS	Law and Order
TPR	Trafficking in People

WMO Expropriation. The risk that the state or other sovereign political authority will deprive, expropriate, nationalize, or confiscate assets of private businesses, whether domestic or foreign.
State contract alteration. The risk that a government or state body alters the terms of, cancels outright, or frustrates (usually through delay) contracts it has with private parties without due process.
Contract enforcement. The risk that the judicial system will not enforce contractual agreements between private-sector entities whether domestic or foreign, due to inefficiency, corruption boas, or an inability to enforce rulings promptly and firmly.

Non-representative Sources

ADB	Property rights and rule based governance
AFR	Over the past year, how often have you or anyone in your family feared crime in your own home?
	Over the past year, how often have you or anyone in your family had something stolen from your house?
	Over the past year, how often have you or anyone in your family ben physically attacked?
	How much do you trust the courts of law?
	Trust in police
ASD	Property rights and rule based governance
BPS	How often is following characteristic associated with the court system: Fair and honest?
	How often is following characteristic associated with the court system: Enforceable?
	How often is following characteristic associated with the court system: Quick?
	How problematic is crime for the growth of your business?
BTI	Separation of Powers
	Independent Judiciary
	Civil Rights
CCR	Rule of Law
FRH	Judicial Framework and independence (FNT)
GII	Public Management
	Rights
	Gender
IFD	Access to land
	Access to water for agriculture
LBO	Trust in Judiciary
	Trust in Police
	Have you been a victim of crime?
PIA	Property rights and rule based governance
VAB	Trust in supreme court
	Trust in justice system
	Trust in police
	Have you been a victim of crime?
WCY	Tax evasion is a common practice in your country
	Justice is not fairly administered in society
	Personal security and private property are not adequately protected
	Parallel economy impairs economic development in your country
	Patent and copyright protection is not adequately enforced in your country

Source: World Banks' Worldwide Governance Indicators
http://info.worldbank.org/governance/wgi/rl.pdf

APPENDIX C: DESCRIPTIVE STATISTICS

Indicator Variable	N	Minimum	Maximum	Mean	Std. Deviation
Voice & Accountability	195	0.00	100.00	48.65	28.84
Absence of Violence/ Terrorism	193	0.00	99.03	47.93	28.59
Control of Corruption	194	0.00	100.00	47.90	28.84
Regulatory Quality	194	0.00	100.00	48.37	28.92
Rule of Law	194	0.00	100.00	48.42	28.90
GDP per Capita	212	$255.00	$116,358.00	$14,058.99	$20,023.75
Exports	194	6.13	219.62	42.34	29.18
GNI per Capita	200	250.00	103,620.00	13,796.79	19,301.31
Total Reserves	170	$63,425,762.44	$3.90 * 10^{12}	$7.36 * 10^{10}	$3.26 * 10^{11}
TB Case Detection	189	0.00	190.00	72.04	25.81
DTP Immunizations	221	24.00	99.00	88.45	12.65
Measles Immunizations	221	22.00	99.00	87.64	12.89
Health Expenditures	219	1.48	17.14	6.90	2.84
Water	211	28.20	100.00	83.70	18.38
Sanitation	215	6.70	100.00	72.76	28.72
Xpert TBHIV	153	0.00	1.00	0.6013	0.49124
Xpert MDR	153	0.00	1.00	0.6863	0.46553
Xpert Children	153	0.00	1.00	0.4967	0.50163
Xpert EPTB	152	0.00	1.00	0.4145	0.49426
TB Incidence Rates	217	0.71	852.00	117.38	151.81
Population Density	226	1.87	19,073.07	370.50	1,896.16
Refugee Population	197	1.00	17,531,780.00	720,258.13	2,415,807.63
Precipitation	179	51.00	3,240.00	1,146.71	783.43

APPENDIX D: DESCRIPTIVE STATISTICS POST –LINEAR INTERPOLATION

Indicator Variable	N	Minimum	Maximum	Mean	Std. Deviation
Voice & Accountability	229	0.00	100.00	48.79	28.15
Absence of Violence/ Terrorism	229	0.00	99.03	48.33	27.98
Control of Corruption	229	0.00	100.00	47.79	28.39
Regulatory Quality	229	0.00	100.00	48.32	28.31
Rule of Law	229	0.00	100.00	48.16	28.49
GDP per Capita	229	$255	$116,613	$14,564.02	$20,070.35
Exports	229	0.790	2.34	1.561	0.2428
GNI per Capita	229	2.40	5.02	3.771	0.6146
Total Reserves	229	7.80	12.59	9.807	0.9645
TB Case Detection	229	0.00	190.00	71.10	24.58
DTP Immunizations	229	24.00	99.00	88.54	12.53
Measles Immunizations	229	22.00	99.00	87.78	12.77
Health Expenditures	229	1.48	17.14	6.94	2.81
Water	229	28.20	100.00	83.99	17.98
Sanitation	229	6.70	100.00	72.83	28.16
Xpert TBHIV	229	0.00	1.00	0.603	0.442
Xpert MDR	229	0.00	1.00	0.677	0.424
Xpert Children	229	0.00	1.00	0.485	0.462
Xpert EPTB	229	0.00	1.00	0.450	0.454
TB Incidence Rates	229	0.71	852.00	114.85	149.16
Population Density	229	1.87	19,073.07	367.87	1,883.82
Refugee Population	229	1.00	17,531,780.00	683,250.07	2,278,924.51
Precipitation	229	51.00	3,240.00	1,134.39	737.79

APPENDIX E: CORRELATION ANALYSIS FOR POLITICAL STABILITY CONSTRUCT

		Voice & Accountability	Absence of Violence/ Terrorism	Control of Corruption	Regulatory Quality	Rule of Law	TB Incidence Rates
Voice & Acct	Pearson Correlation	1	0.740**	0.752**	0.704**	0.777**	-0.499**
	Sig. (2-tailed)		0.000	0.000	0.000	0.000	0.000
	N	229	229	229	229	229	229
Abs of V/T	Pearson Correlation	0.740**	1	0.809**	0.668**	0.781**	-0.507**
	Sig. (2-tailed)	0.000		0.000	0.000	0.000	0.000
	N	229	229	229	229	229	229
Ctrl Corrupt	Pearson Correlation	0.752**	0.809**	1	0.815**	0.932**	-0.560**
	Sig. (2-tailed)	0.000	0.000		0.000	0.000	0.000
	N	229	229	229	229	229	229
Reg. Quality	Pearson Correlation	0.704**	0.668**	0.815**	1	0.903**	-0.576**
	Sig. (2-tailed)	0.000	0.000	0.000		0.000	0.000
	N	229	229	229	229	229	229
Rule of Law	Pearson Correlation	0.777**	0.781**	0.932**	0.903**	1	-0.566**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.000
	N	229	229	229	229	229	229
TB Incidence Rates	Pearson Correlation	-0.499**	-0.507**	-0.560**	-0.576**	-0.566*	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	
	N	229	229	229	229	229	229

** Correlation is significant at the 0.01 level (2-tailed).

APPENDIX F: CORRELATION ANALYSIS FOR ECONOMIC STABILITY CONSTRUCT

		GDP per Capita	Exports	GNI per Capita	Total Reserves	TB Incidence Rates
GDP per Capita	Pearson Correlation	1	0.449**	0.943**	0.377**	-0.644**
	Sig. (2-tailed)		0.000	0.000	0.000	0.000
	N	229	229	229	229	229
Exports	Pearson Correlation	0.449**	1	0.401**	0.002	-0.190**
	Sig. (2-tailed)	0.000		0.000	0.981	0.004
	N	229	229	229	229	229
GNI per Capita	Pearson Correlation	0.943**	0.401**	1	0.390**	-0.596**
	Sig. (2-tailed)	0.000	0.000		0.000	0.000
	N	229	229	229	229	229
Total Reserves	Pearson Correlation	0.377**	0.002	0.390**	1	-0.161*
	Sig. (2-tailed)	0.000	0.981	0.000		0.015
	N	229	229	229	229	229
TB Incidence Rates	Pearson Correlation	-0.644**	-0.190**	-0.596**	-0.161*	1
	Sig. (2-tailed)	0.000	0.004	0.000	0.015	
	N	229	229	229	229	229

** Correlation is significant at the 0.01 level (2-tailed).

APPENDIX G: CORRELATION ANALYSIS FOR TB DETECTION POLICIES CONSTRUCT

		TB HIV	MDR	Children	EP TB	TB	TB Incidence Rates
Xpert TB HIV	Pearson Correlation	1	0.763**	0.752**	0.625**	0.100	0.255**
	Sig. (2-tailed)		0.000	0.000	0.000	0.132	0.000
	N	229	229	229	229	229	229
Xpert MDR	Pearson Correlation	0.763**	1	0.628**	0.568**	0.083	0.262**
	Sig. (2-tailed)	0.000		0.000	0.000	0.213	0.000
	N	229	229	229	229	229	229
Xpert Children	Pearson Correlation	0.752**	0.628**	1	0.640*	0.119	0.219**
	Sig. (2-tailed)	0.000	0.000		0.000	0.072	0.001
	N	229	229	229	229	229	229
Xpert TB	Pearson Correlation	0.100	0.083	0.119	-0.023	1	0.075
	Sig. (2-tailed)	0.132	0.213	0.072	0.732		0.258
	N	229	229	229	229	229	229
TB Incidence Rates	Pearson Correlation	0.255**	0.262**	0.219**	0.075	0.075	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.261	0.258	
	N	229	229	229	229	229	229

** Correlation is significant at the 0.01 level (2-tailed).

APPENDIX H: CORRELATION ANALYSIS FOR HEALTH SYSTEM INDICATORS CONSTRUCT

		TB CDet	DTP Imm	Measles Imm	Hlth Exp	Water	Sanitation	TB Inc
TB CDet	Pearson Correlation	1	0.200**	0.257**	0.135*	0.306**	0.375**	-0.322**
	Sig. (2-tailed)		0.002	0.000	0.042	0.000	0.000	0.000
	N	229	229	229	229	229	229	229
DTP	Pearson Correlation	0.200**	1	0.920**	0.180**	0.545**	0.505**	-0.387**
	Sig. (2-tailed)	0.002		0.000	0.006	0.000	0.000	0.000
	N	229	229	229	229	229	229	229
Measles	Pearson Correlation	0.257**	0.950**	1	0.207**	0.544**	0.561**	-0.386**
	Sig. (2-tailed)	0.000	0.000		0.002	0.000	0.000	0.000
	N	229	229	229	229	229	229	229
H Exp	Pearson Correlation	0.135*	0.180**	0.207**	1	0.322**	0.257**	-0.255**
	Sig. (2-tailed)	0.042	0.006	0.002		0.000	0.000	0.000
	N	229	229	229	229	229	229	229
Water	Pearson Correlation	0.306**	0.545**	0.544**	0.322**	1	0.779**	-0.585**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.000	0.000
	N	229	229	229	229	229	229	229
Sanit	Pearson Correlation	0.375**	0.505**	0.561**	0.257**	0.779**	1	-0.675**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000		0.000
	N	229	229	229	229	229	229	229
TB Inc	Pearson Correlation	-0.322**	-0.387**	-0.386**	-0.255**	-0.525**	-0.675**	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	
	N	229	229	229	229	229	229	229

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

APPENDIX I: CORRELATION ANALYSIS FOR DEPENDENT VARIABLE & CONTROL VARIABLES

		Population Density	Refugee Population	Precipitation	TB Incidence Rates
Population Density	Pearson Correlation	1	-0.170*	0.120	0.073
	Sig. (2-tailed)		0.010	0.070	0.273
	N	229	229	229	229
Refugee Population	Pearson Correlation	-0.170*	1	-0.051	0.086
	Sig. (2-tailed)	0.010		0.447	0.193
	N	229	229	229	229
Precipitation	Pearson Correlation	0.120	-0.051	1	-0.202**
	Sig. (2-tailed)	0.070	0.447		0.002
	N	229	229	229	229
TB Incidence Rates	Pearson Correlation	0.073	0.086	-0.202**	1
	Sig. (2-tailed)	0.273	0.193	0.002	
	N	229	229	229	229

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

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