CHILD MORTALITY: THE IMPACTS OF FOOD SAFETY AND TERTIARY EDUCATION

by

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ABSTRACT

Child mortality is defined as the death of children under five years old. Worldwide, child mortality was about 8.1 million in 2009, of which over fifty percent is related to diarrhea, pneumonia and malaria. Food and water borne pathogens are an important cause of deaths related to diarrhea and pneumonia.

Illiterate or semi-literate populations are often slow to adopt food and water safety standards. Practices such as washing of food in sewage water, which would repulse most westerners might be considered normal in some parts of the world. Understanding some of the basic science underlying food safety standards is important for the farm worker in California, the villager in Africa and the child in Afghanistan. Ultimately, food safety practices in production can affect the consumer of agricultural products no matter where they are in the world, and inadequate food safety standards can affect the producer as a result of diminished consumer confidence in their product, or lack of access to export markets.

In the instance of food contamination, young children and the elderly are typically most at risk. Perhaps the most sobering consequence of inadequate food safety standards is child mortality. This thesis uses a regression model to investigate determinants of the level of child mortality. We find that income distribution and levels of tertiary education, particularly for females, are significantly correlated with child mortality rates. Estimates suggest that a one percent increase in tertiary education in the female workforce is associated with a reduction of almost seven percent in the child mortality rate in countries where the rate of female tertiary education is below fifteen percent.

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ACRONYMS

ADB	Asian Development Bank
BCG	Bacillus Calmette-Guérin (vaccine against tuberculosis)
CAC	Codex Alimentarius Commission
CDC	US Center for Disease Control and Prevention
CFU	Number of colony forming units per gram or per milliliter of food sample
CM	Child Mortality of under-five years of age
Codex	Codex Alimentarius
FAO	United Nations – Food and Agricultural Organization
GDP	Gross National Product
HACCP	Hazard Analysis and Critical Control Points
IDP	Internally Displaced Persons
IGME	Interagency Group for Child Mortality Estimation
IMF	International Monetary Fund
ISAF	International Security Assistance Force
JEMRA	Joint FAO/WHO Expert Meetings on Microbiological Risk Assessment
KEMRI	Kenya Medical Research Institute
MAB	Master of Agribusiness
MDG	UN - Millennium Development Goals
MRA	FAO/WHO/CAC Microbial Risk Assessment
NATO	North Atlantic Treaty Organization
SSA	Sub Sahara Africa
UN	United Nations
UNHCR	United Nations High Commissioner for Refugee
UNIHDI	United Nations International Human Development Indicators
UNICEF	United Nations Children's Fund
USAID	US Agency for International Development
USD	United States Dollars
VIF	Variance Inflation Factors
WB	World Bank
WFP	United Nations World Food Program
WHO	United Nations World Health Organization
WTO	World Trade Organization

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CHAPTER I INTRODUCTION

"We are textbook physicians only," said Dr. Nazir Abul, a pediatrician and medical professor at Kabul University. "We don't have the most basic tools of our profession….And I, a Physician, have never in my life looked through a microscope" (Mortenson 2006)

1.1 Objective

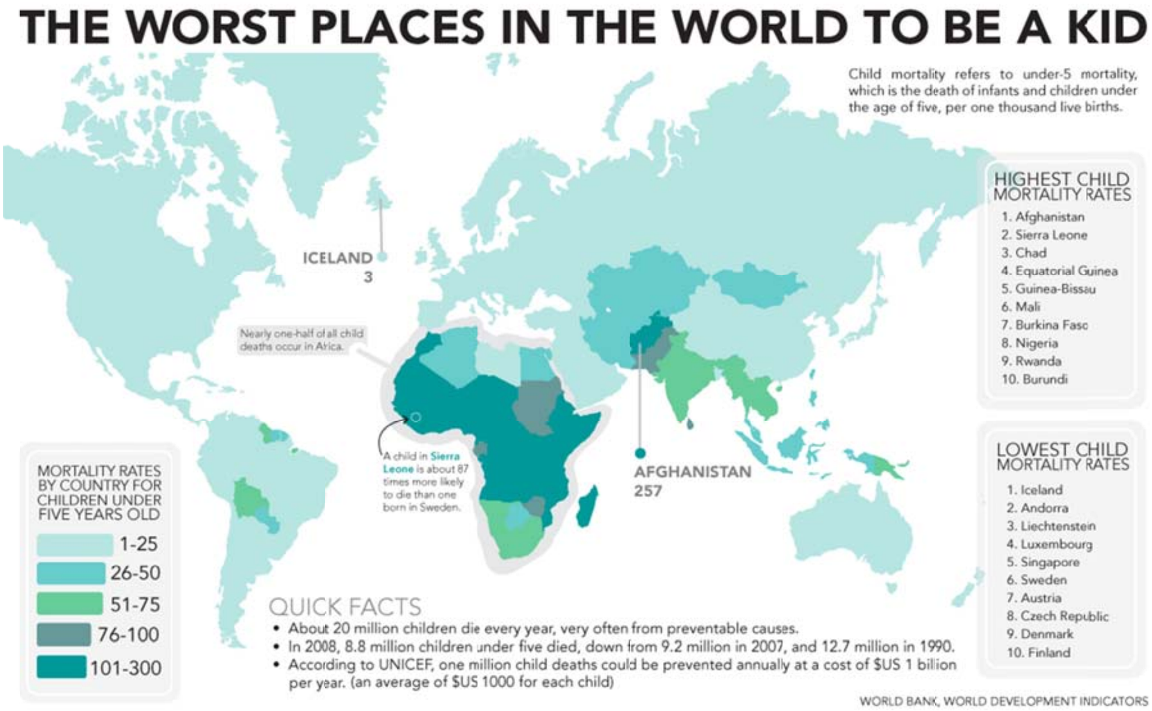
At the United Nations Millennium Summit in 2000, world leaders agreed to a set of eight goals – the UN Millennium Development Goals (MDGs) – aimed at ending extreme poverty by the year 2015 (End Poverty 2000). Goal 4 of the MDGs is to reduce by two thirds the mortality rate among children under five years old (United Nations 2000). The United Nations recognizes the critical role of food safety in achieving that goal (Schlundt 2010).

Child mortality is defined as the number of deaths of infants and children under the age of five per 1,000 live births. In 2009, approximately 8.1 million children under the age of five died worldwide, down from 8.8 million the previous year and from 12.7 million in 1990 (Figure 1.1). Child mortality rates exhibit tremendous variation across countries. In 2008, the world mean was 44 per 1,000 births with a range from of 2 per 1000 in Liechtenstein up to 209 per 1,000 in Chad (IGME 2009).

Afghanistan, with a child mortality rate of 199 per 1,000 births in 2009 is one of the world's most impoverished countries. Related to goal 4 of the MDGs, a major goal of US investment in Afghanistan is to reduce its rate of child mortality (US State Department 2010). For example, in 2009, the US spent $57 million on policies aimed at child survivability and human health, and $52 million on education (US Congress 2009). The total amount spent toward these goals is illusive since the funds come from many sources (US Congress 2009). Another major goal of US investment is to develop an effective export system in Afghanistan. This investment is connected to goal 8 of the MDGs which is to develop a global partnership for development through trade and agricultural support. In the 1970s, Afghanistan provided 43% of the world's exports of fruits and nuts (MAIL 2004). A major barrier to re-establishing Afghanistan's position as an agricultural exporter is its inability to meet world phytosanitary standards (USAID 2005). US investment in education in Afghanistan is connected to the objective of boosting agricultural output and export capability.

The objective of this thesis is to examine the factors that influence child mortality rates and in particular, what factors account for a country having over 25% of their children dying of food and water borne disease before the age of five years. The literature suggests that factors such as income distribution, access to food and clean water and the level of the education of the parents all affect the survivability of a child.

Figure 1.1: World Bank: Worst Places to be a Kid



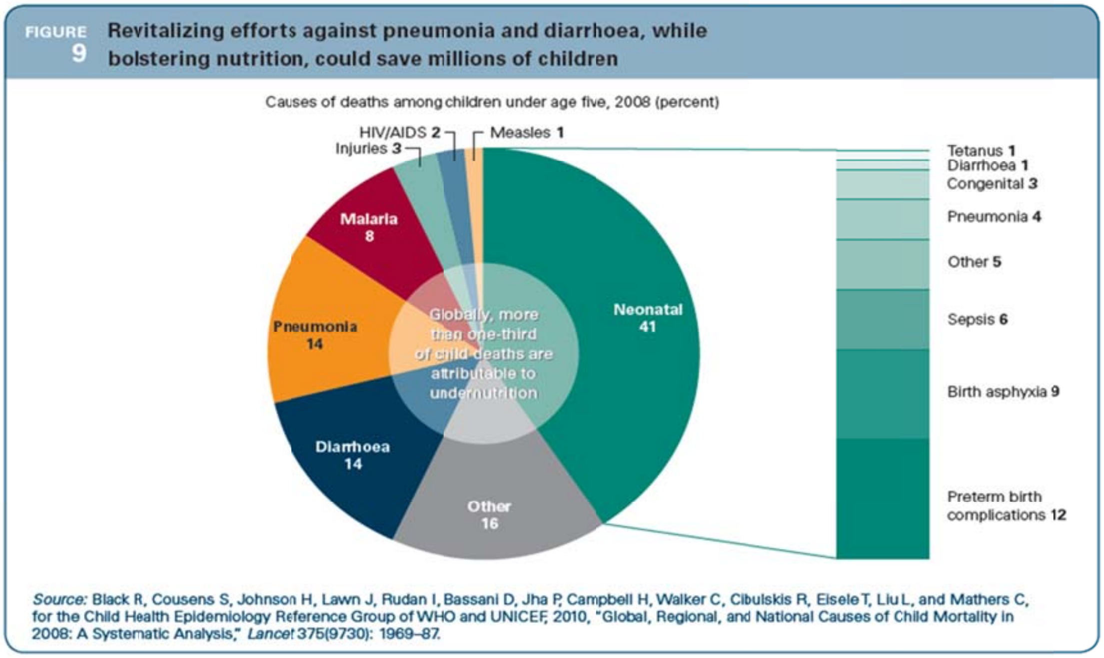
(World Bank 2008)

1.2 Causes of Child Mortality

You et al., in estimates cited by the UN Inter-agency Group for Child Mortality Estimation (IGME) in the 2010 “Levels & Trends in Child Mortality,” attribute more than one third of child mortality cases to diarrhea, malaria, and pneumonia, which in turn can be connected to food and water contamination. For example, *Pseudomonas* spp. bacteria which can cause pneumonia, is often present in sewage water. Malaria, which has been eliminated in most of the developed world, is transmitted by mosquitoes that breed in stagnant and contaminated water.

Over forty percent of child deaths are attributed to neonatal issues some of which are also related to pneumonia and diarrhea (Figure 1.2). While not identified as the proximate cause of death, inadequate nutrition is identified as a factor in more than a third of all child mortality cases.

Figure 1.2: Causes of Child Mortality

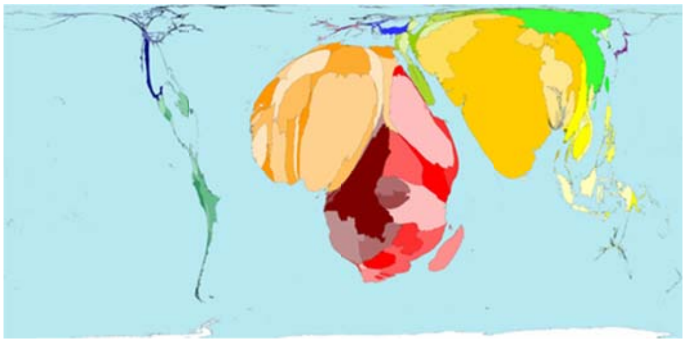


(You, Jones and Wardlaw 2010)

1.3 Regional Distribution of Child Mortality

Rates of child mortality vary greatly around the world. In 2009, the world average rate was approximately 6% with a range from 0.6% in Europe up to 12.9% in sub-Saharan Africa (You, Jones and Wardlaw 2010). The World Mapper (figure 1.3) provides a visual illustration of the distribution of child mortality indicating that Africa and Asia account for the great majority of cases (Univeristy of Sheffield 2002).

Figure 1.3: World Distribution of Child Mortality



Mortality rates in individual countries cover a wider range. The 2010 IGME report (You, Jones and Wardlow) identifies Chad as having the highest rate of any country at 209 child deaths per 1,000 births followed by Afghanistan and the Democratic Republic of the Congo at 199.

In Afghanistan, the mortality rate for children and mothers is particularly high. According to USAID, "*Estimates of maternal morbidity in Afghanistan indicate that 1,600 mothers die per 100,000 live births, while 25% of children are expected to die before their fifth birthday*" (USAID 2005). Depending on the data source, estimates of child mortality for Afghanistan vary from just under 200 to over 250 per thousand births, although a number of around 250 per thousand (i.e. more than 4 times the world average) was often used in the literature.

In 2008 Afghanistan had the second highest child mortality in the world. Observations made by the author while in Afghanistan from 2006 to 2007 were that child mortality was impacted by a combination of factors that included lack of access to tertiary education and an associated lack of basic food safety knowledge. Even parents that had means to provide adequate nutritional needs for their children did not understand how foodborne pathogens could endanger the life of their child.

Dean Ata Nazar, PhD. former head of the Department of Engineering at Kabul University who received his degree in the U.S. stated, "I*n the early 1970s Kabul University was the leader in university education in South West Asia. Kabul University was built by USAID. The Russians invaded in the late 1970s and killed many of the western educated leaders and professors. In the 1980s the civil war further destroyed the education system in Afghanistan. In the early 90s the Pakistani Taliban destroyed all books and laboratories at all the Universities in Afghanistan. The Pakistani Taliban closed all universities and forbad women to be educated*" (Ata Nazar 2006 - 2007). "*But, we hid the books that USAID gave us in secret places*," as he stroked the blue, worn irrigation-engineering book. "*We also hid the university records and all of this was done to prevent the Taliban from destroying these. Many dead bodies had to be removed when we reopened Kabul University in 2002. This is why our education is so low and the world has passed us by*" (Ata Nazar 2006 - 2007).

Figure 1.4: Chemistry Laboratory at Kabul University Afghanistan

Figure 1.4 is a picture of a chemistry laboratory at Kabul University. In the biology and medical colleges, there were no microscopes or any diagnostic equipment. When they reopened, mines and unexploded ordnance had to be cleared from the universities.

Figure 1.5: Classroom at Kabul University Afghanistan

Dr. Nazar said, "*The surviving professors continued to teach in secret throughout this time until after 2001 and then we could teach in the open*" (Ata Nazar 2006 - 2007).

Considering the circumstances of education in Afghanistan, the lack of understanding of the impact of human pathogens on child survivability is understandable.

The World Health Organization (WHO), The World Bank, UNICEF and the United Nations Population Division collaborate via the Interagency Group for Child Mortality Estimation (IGME) to collate data on child mortality and monitor progress toward meeting Millennium Development Goal 4 (reducing child mortality by two-thirds between 1990 and 2015). Table 1.1 from the 2009 IGME report lists the ten counties with highest child mortality rate between 1997 and 2009 (IGME 2009).

Table 1.1: Ten Countries with the Highest Child Mortality Rate

Country	**Years**						
	1997	**1999**	**2001**	**2003**	**2005**	**2007**	**2009**
Chad	203.10	204.60	206.00	207.50	209.00	209.00	209.00
Afghanistan	229.70	224.20	218.80	213.60	208.40	203.50	198.60
Congo DR	198.60	198.60	198.60	198.60	198.60	198.60	198.60
Guinea-Bissau	227.40	221.10	215.10	209.20	203.50	198.00	192.60
Sierra Leone	272.40	257.70	243.00	229.20	216.20	203.90	192.30
Mali	226.80	220.40	214.20	208.20	202.30	196.60	191.10
Somalia	180.00	180.00	180.00	180.00	180.00	180.00	180.00
Central African Republic	184.50	184.10	182.50	180.10	177.30	173.80	170.80
Burkina Faso	195.00	190.00	185.00	180.20	175.50	170.90	166.40
Burundi	181.50	178.90	176.30	173.70	171.20	168.70	166.30

(IGME 2009).

The literature on child mortality points to several factors that influence these rates. These include the level of GDP and the share of GDP from agriculture, the level of tertiary education in a country, and the level of food insecurity. These factors are discussed in more detail in the literature review in the following section. Section 3 and 4 of this thesis describes the data and the regression model used to explain variation in child mortality rates. The final section offers discussion of the findings and conclusions.

CHAPTER II LITATURE REVEIW

You et al. (2010) found that more than one-third of child deaths are attributable to under-nutrition, while pneumonia and diarrhea were the proximate cause in twenty-eight percent of cases (You, Jones and Wardlaw 2010). This chapter reviews the literature on some of the underlying factors associated with child mortality rates. These include measures of economic well-being such as GDP per capita, percent of GDP from agriculture, and equality of income distribution, food safety standards as reflected by adoption of Codex Alimentarius standards,[1] and other factors such as education levels and the presence of armed conflict. Table 2.1 provides a snapshot of data on some of these variables for the ten countries with the highest rates of child mortality in 2008 and 2009.

Table 2.1: Countries with the Highest Child Mortality Rates (2008)

Country	Child Mortality 2008*	GDP - per capita	Sector % from Agriculture	Codex Alimentarius	Labor Force with Tertiary Education (%)	Income Gini Coefficient	% Internally Displaced Persons
Chad	209.00	$766	57.20%	1	1.92%	39.8	17.31%
Afghanistan	201.00	$408	31.00%	1	1.28%	60	8.20%
Congo DR	198.60	$180	55.00%	1	5.05%	44.4	23.22%
Guinea-Bissau	195.20	$538	62.00%	1	2.85%	35.5	0.00%
Sierra Leone	198.00	$352	49.00%	1	2.05%	42.5	0.00%
Mali	193.80	$686	45.00%	1	5.44%	39	0.00%
Somalia	180.00	$600	65.00%	0	3.00%	30	26.23%
Central African Republic	172.30	$458	55.00%	1	2.33%	43.6	45.24%
Burkina Faso	168.70	$528	29.40%	1	3.06%	39.6	0.00%
Burundi	167.50	$145	33.30%	1	2.52%	33.3	12.58%

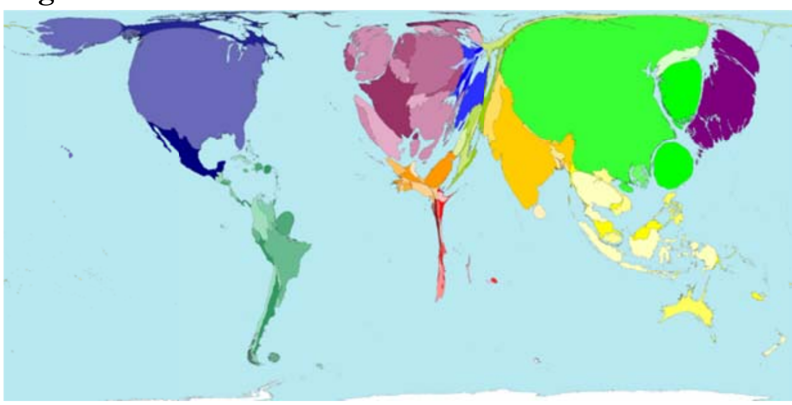
* Under-five mortality rate (deaths per 1,000 live births).

[1] Codex Alimentarius standards were created jointly by WTO, FAO and WHO to develop international food safety standards to protect human health and improve international fair trade practices (CAC 2002).

2.1 Child Mortality and GDP

Countries with high levels of child mortality tend to be poor and, as shown in Table 2.1, some countries with per capita GDP below $1,000 have child mortality rates close to 20 percent.

Figure 2.1 World Distribution of GDP



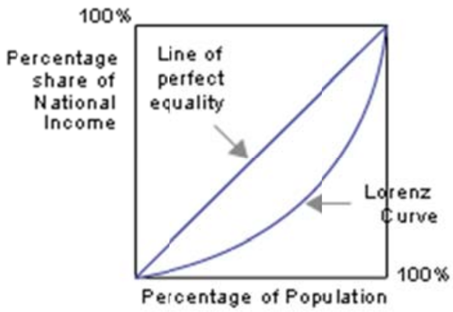
The World Mapper (University of Sheffield, 2002) above shows the distribution of GDP, illustrating the relative wealth of the U.S., Europe, Japan and China and the relative poverty of most of the southern hemisphere.

Pritchett and Summers (1996) examined the relationship between child mortality and per capita GDP in developing countries. Their goals were to explain the relationship between health and wealth by examining three hypotheses: "*i) increased wealth causes better health; ii) healthier workers are more productive and hence wealthier (reverse causation); or iii) some other factor may cause both better health and higher wealth (incidental association).*" Using World Bank data on 184 countries over a 30 year period the authors were able to control for several covariates including years of schooling, food and water safety, food acquisition, health spending and caloric intake. Pritchett and Summers (1996) found a low correlation between child mortality and per capita GDP. Reductions in communicable diseases and improvements in sanitation and nutrition were found to have a greater impact on child mortality reduction. The authors concluded, as have some other studies, that education, availability of health care and safe water have the greatest impact on reducing child mortality.

Given the results from the literature, we might not expect to find a significant association between child mortality and GDP. Nevertheless, given the evidence that the poorest countries tend to have the highest rates of child mortality we consider it important to control for income in the model. The simplest means of doing so would be to use per capita GDP. An alternative approach that explicitly recognizes the fact that poor countries tend to be less industrialized would be to use the proportion of GDP derived from the agricultural sector. While we might expect a positive correlation between mortality and percent GDP from agriculture, it is also worth bearing in mind that higher levels of production of staples such as cereals should lead to higher levels of nutrition and in turn to reduced child mortality. This suggests that it may be worthwhile to investigate a number of different model specifications.

Countries with relatively high per capita income may have very unequal income distribution and a large proportion of very poor individuals. The Gini coefficient is often used as a measure of income inequality. The coefficient is a calculation based on the Lorenz curve, which plots the percentage of income earned in a country against the percentage of the population earning that income. A Lorenz curve at a 45 degree angle would indicate perfect income equality with ten percent of income earned by ten percent of the population, thirty percent of income by thirty percent of the population, and so on. But, as illustrated in figure 2.1 below, the Lorenz curve is typically below the 45 degree line and the degree to which it deviates from the line of perfect equality indicates the extent to which income distribution is unequal. The Gini coefficient itself is calculated as the ratio of the area between the 45 degree line and the Lorenz curve, divided by total area below the 45 degree line. Values for the Gini coefficient range from zero, which would indicate a perfectly equal distribution of income, up to near one – a situation where, essentially, all income would belong to one individual (Litchfield 1999). The index may be multiplied by 100 to give a range of 0 to 100.

Figure 2.2 The Lorenz Curve



Gini coefficients have been estimated for many countries and will be used in this study as a potential explanatory factor for the rate of child mortality. It is expected that higher levels of the Gini coefficient will, ceteris paribus, be associated with higher levels of child mortality.

2.2 Child Mortality and Education

The relationship between education and human productivity is well established. For example, Lin (2004) found that for every one percent increase in education stock, there was a 0.35 percent increase in industrial output. However, education levels are also related to human survivability. The WHO concluded that lack of maternal education and decision-making power was a significant contributory factor to child and maternal death rates. The report found, for example, that a child in Nigeria is 2.5 times more likely to die if the mother is illiterate.

Kiros and Hogan (2001) investigated the effects of parental education on child mortality in a war and famine region using data from 144,090 households in Ethiopia during the civil war from 1973 to 1991. Mortality rates among children can be extremely high in the midst of armed conflict, particularly when a military or political tactic is to withhold food and medicine. Kiros and Hogan confined the study to an 80,000 km^2 plateau where eighty-five percent of the population was engaged in subsistence farming. The majority of the water in the region was contaminated and the literacy rate was estimated to be about twenty percent (28% for males, 14% for females) compared to fifty-seven percent for urban area in Ethiopia. The average child mortality rate in the region was twenty-one percent.

The main objective was to examine the impact of parental education on the rate of child mortality. Other studies had found that an illiterate mother will often succumb to a '*fatalistic*' recognition of the mortality of the child, while a literate mother will practice 'health-promotion' and seek medical assistance. Literate mothers practice cleanliness and take advantage of available resources. Educated parents are inferred to have better survival strategies and additional resources available to them, which results in higher survivability of a child (Kiros & Hogan 2001).

The authors found that there was an increase in child mortality rate in relationship to the age of the mother - as the mother became older, mortality increased. Among the youngest mothers, those aged 15 to 19, the child mortality rate was around twelve percent, but doubled to over twenty-four percent in the 40 to 44 year old group (Kiros & Hogan 2001) (Refer to Appendix A: Table A:1).

Parental education level was also found to have a significant impact on child mortality rate. When the health care system, infrastructure, and food production are destroyed then knowledge of survival techniques and resource management will impact family survivability. Among illiterate mothers in the sample, the average child mortality rate was twenty-one percent, but this dropped to fifteen percent for literate mothers. The difference was found in periods of both high and low war intensity and periods of minimal or maximal food crisis. When war intensity was high, mortality rates were higher among both literate and illiterate mothers at approximately twenty and twenty-one percent respectively. During low war intensity, the mortality rate among the literate mother group dropped to fourteen percent while among illiterate mothers it dropped to only twenty-one percent. Literacy thus appeared to have a greater impact on survivability during periods of low war intensity. A similar result was found when the effect of literacy on mortality was compared across periods of minimal and maximal food crisis. The authors concluded that even during a crisis time of war and food insecurity, parental education had an important impact on child survivability (Kiros & Hogan 2001) (See Appendix A: Table A.2, Table A.3).

Gupta (1990) noted that "*Far less is known about the behavioral and social determinants of child mortality than about the biological ones.*" Using census and survey data, Gupta evaluated how biological and the social-economic factors affected child survivability in the Punjab region of India. The sample area was characterized as having relatively high agriculture production, industrialization that provided employment opportunities, and the availability of health care and adequate nutrition. Approximately twelve percent of the families in the region accounted for over sixty percent of child mortality cases. Using a logit model to estimate the probability of a child dying at different ages, Gupta found that income and caste level had a significant effect on child survivability. Maternal education was found to have a significant influence on the provision of proper hygiene and attention to health care (e.g. rehydration, BCG immunization) which were found to increase the child survival rate. When those health care factors were eliminated from the child survival model, the significance of the mother's education increased (Gupta 1990) (Refer to Appendix B).

In Indonesia, the slums and other areas inhabited by the poor have no access to municipal water and sewage treatment. Semba et al (2008) investigated factors that influenced the type of water acquired by the household and the factors contributing to these decisions. Of the 143,126 families evaluated, 46.8% procured inexpensive water from the local vendors; 47.4% had access to spring or well water; and 5.8% purchased higher quality water. The weekly cost of purchasing water ranged from $12.29 to $15.29. In families that did not purchase water or purchased inexpensive water, 19.3% of the children had experienced diarrhea within the previous seven days compared to only 7.7% in households that purchased high quality water. The under five-mortality rate was 10.4% in households using inexpensive water, 7.1% for those using spring or well water; and 6.4% for those who purchased higher quality water. Furthermore, 96.0% of households in which the mother had at least ten years of education had no incidents of child mortality. Incidents of diarrhea were significantly fewer in households with higher levels of parental education (Semba, et al. 2008).

Bangladesh has dramatically reduced its rate of child mortality - from 13.9% in 1993 to 6.6% in 2005. The World Bank has evaluated this dramatic reduction and compared it to trends in India which has twice the level of per capita GDP but had a 7.7% rate of child mortality in 2005. The analysis pointed to five important factors. First, per capita GDP grew during the 1980's by 1.5% per annum, but at over 3% per annum in the 1990's and at a slightly higher rate during the past decade. The second identified factor was an increase in the proportion of females in secondary education - from one-third of all secondary education students in 1990 to half in 2003. Furthermore, a greater number of schoolteachers were female which provided an occupational option for females in Bangladesh. The other factors cited by the study included: a) an increase in measles immunization, b) a delay for females in beginning reproduction, and c) reduced fertility rates (Khan 2007).

This study will examine the effect of tertiary education levels on child mortality. Tertiary education is defined as any type of education beyond secondary education, this include college and trade schools. Countries with low levels of tertiary education often have a very high child mortality rate. Exceptions to this are small island states, which may have low GDP but have a developed country in close proximity. One example is Monaco, which is a port country in France with an official tertiary education rate of only 1% but only 0.4% child mortality. Another example is The Bahamas with a 1.29% tertiary education rate but a child mortality rate of 1.3%.

2.3 Child Mortality and Food Safety Standards

Foodborne microbiological hazards cause illness and deaths in both developed and undeveloped countries. Contamination can occur during production, handing, storage, and may also be due to improper cooking and poor personal hygiene. Historically, it is known that low levels of food safety are associated with high rates of illness and death. In the 1940's and 1950's, summer diarrhea was responsible for 50% of deaths in the US, UK and Canada death rates and over 50% of child mortality rates (Humphries 2008, Bray 1978). Dr. John Bray, an English physician, first discovered the link between the pathogen *E. coli* and death rates from summer diarrhea. Bray and Dr. Erwin Netar, an infectious disease specialist from New York, created the term "*enteropathogenic E. coli*." This term was later shortened to *E. coli* (Humphries 2008, Crane 2010). Deaths from *E.coli.* and other foodborne pathogens have declined dramatically in higher income countries. In 2010, of a total of 2.4 million deaths in the U.S., approximately 5,000 (0.2%) were linked to foodborne illness (CDC-DFWED 2010, CDC 2010).

Diarrhea and other food and waterborne diseases are identified as the direct cause of at least fourteen percent of child deaths, and so it seems clear that the overall standard of food safety within a country will have a bearing on its rate of child motility. Schlundt (2010) argues that emphasis must be placed on food safety in addition to food availability as society attempts to address problems of hunger and malnutrition. The concept of "nutritional security" embraces the idea that access to enough food is not sufficient to combat malnutrition if food quality is ignored. Malnutrition is an important contributory factor to child mortality. According to Schlundt "*Poor nutrition weakens immune systems and contributes to half the deaths associated with infectious disease among children aged under five in developing countries"* (Schlundt 2010).

As a means of promoting and ensuring food safety, Schlundt supports adoption of international standards such as those developed by the Codex Alimentarius Commission (Codex). Adoption of Codex standards would eliminate the current practice of double standards in some developing countries - whereby foods produced for export markets are required to meet higher standards than those that can be marketed domestically. Codex was established by the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) in 1963. It serves as an umbrella organization for food safety standards that protect consumer health and as an arbiter for disputes related to phytosanitary standards in international trade. Membership has grown from about 45 countries in 1962 to 182 in 2010 (Codex Alimentarius 2010), but not all member countries have implemented some or all of the Codex Standards.

High income (or developed) countries have relatively high standards and expectations for the quality of both domestically produced and imported foods. Developed countries also have the necessary infrastructure to support those expectations. Lower income countries do not have the same expectations for high quality standards, nor do they have the infrastructure to support those standards. FAO and WHO recognized that many developing countries lack a sufficient scientific base, and thus provide these countries with assistance in implementing

Codex standards. However, the transfer of basic knowledge about phytosanitary standards and implementation has largely not happened. Low tertiary education standards or a lack of knowledge of basic science has stalled the process of meeting international standards on food safety. Even though it has been 148 years since Pasteur and Koch discovered the connection between microorganisms and human disease, this knowledge has not been successfully transferred to the developing world. This disconnect creates a conflict between phytosanitary standards for the world vs. building capacity for the developing world.

The FAO/WHO approach to Codex implementation has come in for criticism for what some view as "downward harmonization." Ellis (1998) voiced that criticism, and suggested that the standards committee should make "*efforts to assist developing countries in meeting high level "world class" health and safety standards rather than reducing international standards to a lower common denominator*" (Ellis 1998).

Many developing countries expect the agricultural sector to provide the impetus for economic growth and development. Typically, that growth is expected to occur through the development of export markets whereby a country can exploit comparative advantage in agricultural production. To date however, many developing countries have faced problems exporting their agricultural produce because of real and perceived issues with food hygiene, pesticide residues, microbial contamination, and labeling (Lupien 2000). Thus, the efforts by FAO and other development organization to assist governments with implementing Codex standards can be viewed as an effort to enhance access to international markets and thereby promote economic growth.

Al-Ghamdi et al (2009) investigated environmental risk factors for diarrhea in school age children in Jeddah City, Saudi Arabia. The authors noted that few studies had examined the relationship between diarrheal diseases, water sources, food sources and handling practices, and personal hygiene. One of the major problems noted in Jeddah City was that cesspools were often located close to water storage systems, and water contamination incidents were frequent. Households that used chlorinated water had a 48% decrease in incidents of diarrhea. (Al-Ghamdi, Bentham and Hunter 2009).

In Afghanistan, use of chlorinated water for drinking or rinsing of food dishes, and chlorinated soak for food products has the potential to dramatically decrease the rate of gastro-intestinal infections. A common sight in Kabul is the breakfast cheese (panee panar) cart. The beautiful white globes with large mint leaves atop them sit on shiny cellophane steps. The cart is covered with a striking red printed cloth with colorful tinsel hanging from the sides.

Figure 2.3 Vegetables and Open Sewage on the Street in Kabul

The fresh cheese is served on warm bread (naan). However, every so often the cart vendor would bend over the open sewer on the street, fill his pitcher and then sprinkle the cheese with the water. Within a three block area there might be three wells which could provide clean water. Why?

The reason has to do with a lack of understanding of basic food microbiology. Many Afghans, like the street vendor, believe that diarrhea is caused by the dust in the air rather than the water in the street, and that food tastes unpleasant when washed in the well water. The street vendor has no idea that what he is doing has the potential to spread disease and sicken his customers. Incidents such as these are not isolated incident but are common practice in the markets in Afghanistan. US, NATO, and ISAF military forces and foreign aid workers all fall ill from eating tainted food or drinking unclean water. The U.S. Army Center for Health Promotion & Preventive Medicine warns that "*Afghanistan is at HIGH RISK for infectious diseases… Diarrhea from protozoa sources and bacterial diarrhea from consumption of unsafe local food, water or ice is up to 100%. …Current potential rates of infection are between 1 to 10% per month for Hepatitis A. Typhoid and paratyphoid present a high risk to unvaccinated personnel (1-10% per month)… Without forced health protection measures, mission effectiveness will be seriously jeopardized*" (US Army 2006).

Low food safety standards have a two-fold effect on child mortality, through direct contamination of foods and through reduced income because of the inability of the agricultural sector to meet international food safety standards and thereby gain access to higher value markets. An illustration of the potential boost in income as a result of meeting higher standards is provided in table 2.2 below which provides prices at the wholesale and retail level for saffron that either has or does not have food safety certification. Prices with certification are around ten times those without.

Table 2.2 Market Value of Saffron (per lb)

	Food Safety Certified	Uncertified	Difference
Wholesale Saffron	**$800.00**	**$80 to $130**	**-$670.00**
Retail Saffron	**$2,821.90 to $4,585.62**	**$200 to $400**	**-$2,621.90 to -$4,185.62**

(Rubira, et al. 2005), (DACAAR 2008), (Google 2008)

In this study, the overall level of or commitment to food safety within a country will be represented by the extent to which a country has adopted Codex standards. Data on the particular extent to which individual countries meet Codex was requested of the FAO but was not made available. Therefore, the measure used is a dummy variable – taking a value of 1 if some Codex standards have been adopted and 0 otherwise.

2.4 Child Mortality and Civil Strife

War, famine and natural disasters lead people to leave their homes and become refugees. According to the UN High Commissioner for Refugee in 2008, there were 42 million displaced people worldwide. Table 2.3 shows countries with the most displaced persons in 2003.

Feikin et al (2010) analyzed mortality and health among the 350,000 internally displaced persons (IDP) in Kenya. These IDP came from the rift valley area after violence erupted following election protests in December 2007. The relocation area was maintained by the Kenya Medical Research Institute (KEMRI) and the US Center for Disease Control and Prevention (CDC). Prior to the unrest this area had the highest child mortality rate in Kenya at 137 per 1000 live births.

Table 2.3 Highest Number of Displaced Persons in 2003

Rank	Country
1	Serbia & Montenegro
2	Bosnia Herzegovina
3	Iraq
4	Afghanistan
5	Azerbaijan
6	Gaza Strip & West Bank
7	Burundi
8	Georgia
9	Bhutan
10	Croatia
11	Puerto Rico
12	Colombia
13	Sri Lanka
14	Angola
15	Western Sahara
16	Sudan
17	Liberia
18	Sierra Leone
19	Tajikistan
20	Mauritania

The study identified the main causes of death for IDP children under five years of age as: malaria (31%), HIV (20%), tuberculosis (20%) and malnutrition (17%). IDP children were treated in hospitals about three times the rate of non-displaced children. This may have been because locals knew where to find out-patient clinics and had more resources to acquire health care. Kenya's child mortality rate for 2008 was 86 per 1,000 live births and in the area that the IDP were relocated the mortality rate rose by 24.69 to 42.40. This area had a lower mortality rate because it could provide resources and aid for the refugees. Areas without those resources, or where travel distance to resources was higher, most likely had higher mortality rates (Feikin, et al. 2010).

This study will use data on the numbers of displaced persons in a country to control for the presence of war or civil unrest, which are likely to be associated with higher rates of child mortality.

CHAPTER III THEORY

3.1 Hypotheses

Based on findings in the literature and on the author's personal observations in Afghanistan, a number of hypotheses will be tested concerning the impact of various factors on child mortality.

Tertiary education: Previous studies have concluded that parental education level and especially that of the mother increase the survivability of a child (Gupta 1990, Kiros & Hogan 2001, Semba, et al. 2008, Khan 2007, WHO 2005). Using a linear regression model in which the dependent variable is the national rate of child mortality per 1,000 live births, this study will investigate: a) whether increases in tertiary education are associated with reduced levels of child mortality, and b) whether male and female rates of tertiary education have equivalent impacts on child mortality. The expectations are a) that the regression coefficient on tertiary education will be negative, and b) that in models that separately examine the impacts of male and female rates of tertiary education, that the impact of female education will be greater than that of male (i.e., that the regression coefficient will be more negative). The analysis will thus investigate which gender has the highest impact in terms of decreasing child mortality. It will also attempt to determine a target level for tertiary education beyond which there is minimal additional impact in terms of reducing child mortality.

Gross Domestic Product per Capita (GDPPC): Based on Pritchett and Summers' (1996) examination of thirty years of World Bank data on the relationship between child mortality and GDP per Capita , the expectation is that higher levels of GDPPC will be associated with lower levels of child mortality. This analysis noted that with a larger GDP per Capita the individual has higher resources to provide nutrients and health care for the child. However, the authors also noted that the effect of increasing GDPPC on child mortality typically occurs with some lag. In the regression model, the expectation is that GDPPC will have a negative coefficient.

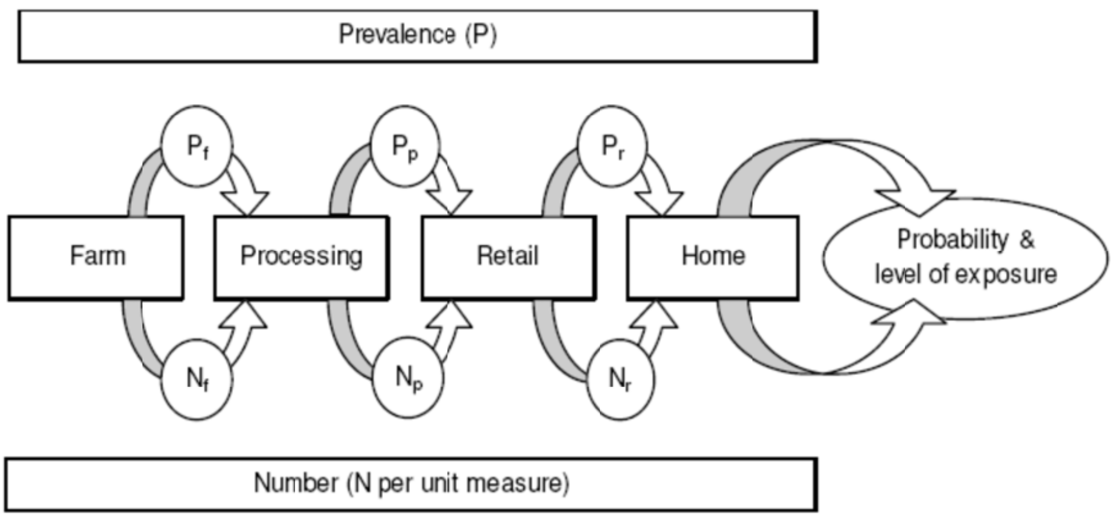
GDP Sector percentage from Agriculture (Ag): One line of thought is that if a country has sufficient agricultural production, it will have enough food production to feed the population and will have a lower child mortality rate. However, developing countries generally have a higher percentage of GDP from the agricultural sector and also have higher child mortality rates. Given this ambiguity, no hypothesis is put forward regarding the expected sign of the coefficient. It is included in the model then, primarily for an exploratory rather than for a confirmatory purpose.

Codex Alimentarius (CA): The objectives of implementing the principles of Codex Alimentarius are to protect consumer health and improve food safety systems (Traill, et al. 2002). The CA variable used in the model is a dummy variable indicating whether or not a country has adopted (or partially adopted) the Codex Alimentarius.

Based on what the author learned at a food safety meeting in Afghanistan in 2007, and on documentation from the Codex Alimentarius Commission, it was presumed that country level data on the adoption rate of Codex was publicly available. One year and three months were dedicated to fining this data. Unfortunately, neither the FAO/WHO/Codex adoption rate nor any qualitative or quantitative microbial risk assessments (MRAs) are publicly available. According to Dr. Sarah Cahill, FAO Food Safety Officer on the Codex Alimentarius Commission, "*Through our projects we do undertake work to assess the situation in a country but the output of such work belongs to the country so if it exists it is not something we can share. Some of the work of the WHO global burden of foodborne diseases is looking at extent of diarrheal disease and this information will be forthcoming*" (Cahill 2011).

The initial objective was to acquire and use in the model the *"Microbial Risk Assessment"* developed by Joint FAO/WHO Expert Meetings on Microbiological Risk Assessment (JEMRA) for implementation of Codex. The "*Microbial Risk Assessment"* models were developed to assess countries or regions of exposure assessment for capacity development of implementation of Codex. Figures 3.1 to 3.5 below illustrate the model that was first developed in 2002 and refined in 2007. (WHO / FAO 2008)

Figure 3.1 JEMRA Conceptual Model for Estimating Probability of Microbial Hazards



The JEMRA model, which was refined into the "*Qualitative Risk Analysis Matrix,"* was developed using military risk assessments. This tool was designed to eliminate the data collection and the mathematical computations required in quantitative microbial risk assessment. The "*Qualitative Risk Analysis Matrix"* can be used by a risk manager to conduct a quicker and simpler assessment.

Figure 3.2 Qualitative Risk Analysis Matrix: Level of Risk

Likelihood	Consequences				
	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
A (almost certain)	Moderate	High	Very high	Very high	Very high
B (likely)	Moderate	High	High	Very high	Very high
C (possible)	Low	Moderate	High	Very high	Very high
D (unlikely)	Low	Low	Moderate	High	Very high
E (rare)	Low	Low	Moderate	High	High

The range numbers, 1- 15 in the example below, can be a list of pathogens in a particular food, a list of pathogens that occur in the local water system, a region or country. For example, Zimbabwe has a high level of events and a high level of impact of *Vibrio cholera* = thirteen and rabies =two. The very high, upper-right cell was reserved pathogens that caused deaths. Ireland's 13 would be placed in the NIL cell, since Ireland has had one *V.cholera* illness in 20 years (WHO 2011). Utilizing this matrix a semi-qualitative risk can be calculated as in the example below:

Figure 3.3 Probability–Impact (P-I or Severity) Scores for Individual Risk Per Year

I	VHI			6			13,2
M	HI	14				15	12
P	MED		5		4	1	
A	LO						
C	VLO	11	7	3			
T	NIL			8,9		10	
		NIL	VLO	LO	MED	HI	VHI
		EVENTS PER YEAR					

Following the development of the matrix a severity scale was utilized and the severity score was calculated:

Figure 3.4 Determination of Severity Score

Rating	Probability score	Impact score
None	NA	NA
VLO	1	1
LO	2	2
MED	3	3
HI	4	4
VHI	5	6

Figure 3.5 Partial Calculations of the Severity Score

Risk index	Probability	Probability score	Impact	Impact score	Severity score
13	VHI	5	VHI	6	5+6 = 11
1	HI	4	MED	3	4+3 = 7
5	VLO	1	MED	3	1+3 = 4

$$\textbf{Overall Severity Score} = \mathbf{LOG_{10}\,(10^{11} + 10^{7} + 10^{4}) = 11} \qquad (3.1)$$

Eleven would be an overall severity score for the combination of pathogens 13, 1 and 5. Another method of using the matrix was considering the segment of the sample which occupies the upper right hand quadrant of the matrix. These calculations have been conducted for health, economics, social, and trade (CAC 2009).

If this information becomes publicly available, it would be advantageous to include it in this regression analysis. However since it was not available the regression was conducted using the dummy variable for adoption of Codex. It was recognized that this dummy variable might not be an ideal indicator of the level of food safety practices within a country. To the extent that it is a good proxy for the overall level of food safety standards, the expectation is that its estimated coefficient in the regression model will be negative.

Gini Coefficient (GC): The higher the Gini coefficient the more income inequity is present in a country. The closer the Gini coefficient is to "1" (or 100%) the higher the percentage of the countries' population is in the lowest income bracket. Filmer and Pritcher (1997) from the World Bank compared the Gini coefficients of Brazil and Sri Lanka to their rates of child mortality. Even though Brazil had twice the GDP per capita as Sri Lanka and education level were comparable, Brazil had a 38% higher child mortality rate in 1997 (Filmer and Pritchett 1997). In 2008, Brazil had a 32% higher child mortality rate than Sri Lanka. In 2008, the Gini coefficient for Sri Lanka was 41.1 and for Brazil it was 55. Evidence such as this suggests that a higher Gini coefficient is associated with higher levels of child mortality. It is expected that in this model, the coefficient on GC will be positive.

Internally Displaced Persons (IDP): When a large percentage of the population is displaced as a result of war or famine then a higher child mortality rate is a result (Kiros & Hogan 2001). In this model, IDP will be measured as the percentage of the population that is internally displaced. It is expected that the coefficient on this variable will be positive.

Why did I choose these variables? When living in Afghanistan I saw children dying of food and water borne diseases. I saw children and adults using sewage water for cooking, drinking, and cleaning. What I came away from this experience with, was a realization that neither agricultural production, nor discretionary income, but the education level of the parents was likely the factor with the greatest impact on the survivability of a child. I created this model to evaluate the effects of different factors on child mortality. My primary hypothesis is that while income and other factors matter, the lack of education or transfer of knowledge will be the main factor. Table 3.1 below summarizes the variables in the regression model, the various data sources used, and the hypothesized effects of the independent variables on the child mortality rate.

Table 3.1: Expected Signs in the Regression Analysis

Variable	Definition	Source	Predicted Relationship
CM	**Child Mortality under-five years of age**	**Interagency Child Mortality Estimator**	**n/a**
GDPPC	Gross Domestic Product per Capita	World Bank	Negative
Ag	GDP Sector % from Agriculture	CIA World Fact Book	(?)
Codex	Codex Alimentarius	Codex Alimentarius – FAO/WHO	Negative
Tert (Model 1)	Tertiary Education Gross Enrollment Rate % (Total)	World Bank	Negative
TertF (Model 2)	Tertiary Education Gross Enrollment Rate % (Female)	World Bank	Negative
TertM (Model 3)	Tertiary Education Gross Enrollment Rate % (Male)	World Bank	Negative
Gini	Gini Coefficient	UN- International Human Development Indicators	Positive
IDP	Internally Displaced Persons	United Nations High commission on Refugees	Positive

The ordinary least squares (OLS) regression model to be estimated is represented in equation 3.1.

$$\mathbf{Y_i = \beta_0 + \beta_1\, GDPPC_i + \beta_2\, Ag_i + \beta_3\, Codex_i + \beta_4\, Tert_i + \beta_5\, Gini_i + \beta_6\, IDP_i} \qquad (3.1)$$

where Y_i, the dependent variable, is the child mortality rate per 1,000 live births in country i, and the independent variables are as defined in Table 3.1. Alternative versions of (3.1) will be estimated to separately examine the roles of male and female levels of tertiary education.

CHAPTER IV DATA AND METHODOLOGY

The analysis used data for 2008, or in instances in which that data was unavailable, for a year as close as possible to 2008. Data on child mortality rates were from the Interagency Child Mortality Estimator, which uses an average from all studies conducted in a given country to determine a consistent number to evaluate MDG 4. Data on per capita GDP and sector % from agriculture were obtained from the CIA World Fact Book. Information about adoption of Codex standards was obtained from the Codex Alimentarius website. Data on tertiary education levels was obtained from the World Bank website. Data on Gini coefficients was obtained from UN- International Human Development Indicators (IHDI). Data on internally displaced persons (measured in 1,000s) originated from the United Nations High commission on Refugees. Missing data was filled in using various sources.

Data was obtained for a total of 212 countries. Table 4.1 provides a sample of the data and summary statistics for the dependent and independent variables. The complete dataset is included in Appendix D. Table 4.1 shows that the mean value for the dependent variable is 43.68 child deaths per 1,000 live births with a range from 2 to 209. Per capita GDP covers a wide range of values from $200 to over $122,000. The mean for the Codex dummy variable indicates that 77 percent of countries in the sample have adopted at least part of the Codex. The average for tertiary education is 19.8% with a range from 0.2% to 84%. For females, the rate of tertiary education is zero for some countries. Gini coefficients for income distribution range from 16.8% (Azerbaijan) to 70% (Namibia), with an average of about 40%. Twenty-six of the 212 countries in the sample have some number of displaced persons.

Table 4.1: Sample Data

Country Name	Child Mortality per 1,000 Live Births	GDP $ per capita	Sector % GDP from Agriculture	Codex Alimentarius	% of Labor Force with Tertiary Education	% of Female Labor Force with Tertiary Education	% of Male Labor Force with Tertiary Education	Income Gini Coefficient	% of Internally Displaced Persons
Afghanistan	201	$408	31.00%	1	1.28	0.50	1.95	60	0.820
Albania	16	$4,126	20.60%	1	8.00	23.40	14.94	33.03	0.00
Algeria	34	$4,974	8.30%	1	10.00	19.80	8.00	35.3	0.00
Am. Samoa	14	$8.000	34.00%	0	37.30	40.50	32.80	41	0.00
USA	8	$47,209	1.20%	1	61.10	64.30	58.40	40.8	0.00
Mean	43.68	$15,764	14.57%	0.77	19.47	20.99	18.97	32.64	0.43
SD	50.80	$25,713	0.15%	0.41	16.18	17.73	16.16	18.13	2.13
Min	2	$145	0.00%	0.00	0.20	0.00	0.40	0.00	0.00
Max	209	$211,501	90.00%	1.00	84.00	89.30	85.50	70.70	26.66

N = 212

4.1 Functional Form

While theory provides some guidance as to the appropriate functional form, each of the independent variables was also plotted against the dependent variable to get an indication as to whether a linear or non-linear functional form might be most appropriate. Scatter plots were generated and trend lines for linear, semi-log and double log functional forms were estimated. Data on the fits of those trendlines (R^2 values) are provided in Table 4.2 below. Scatterplots and trendline analysis can be a useful first step for estimating the best-fit regression models.

Table 4.2: Equation Trend Analysis

Dependent Variable →	R^2 = Child Mortality	R^2 = Ln(Child Mortality)
GDP – per Capita	0.15	0.39
Ln (GDP – per Capita)		0.76
Sector % from Agriculture	0.515	0.478
Ln (Sector % from Agriculture)		0.393
Codex Alimentarius	0.026	0.014
Tertiary Education Gross Enrollment Rate % - Total	0.253	0.266
Ln (Tertiary Education Gross Enrollment Rate % - Total)		0.356
Tertiary Education Gross Enrollment Rate % - Female	0.308	0.314
Ln (Tertiary Education Gross Enrollment Rate % - Female)		0.461
Tertiary Education Gross Enrollment Rate % - Male	0.184	0.196
Ln (Tertiary Education Gross Enrollment Rate % - Male)		0.297
Gini Coefficient	0.100	0.211
Ln (Gini Coefficient)		0.222
Displaced Persons	0.002	0.003
Ln (Displaced Persons)		0.031

As shown in table 4.2, trendlines were fit using both linear and logged versions of the dependent variable. While there are no strong theoretical reasons for using the log of the dependent variable in this case (recall that its values range from 2 to 209), the results in table 4.2 indicate in some cases a better fit with the logged value. With other variables however, the fit is slightly better with the linear form of the dependent variable. Given the lack of a compelling theoretical reason for using the log form, and to facilitate interpretation of the results, it was decided to use the linear form of the dependent variable in the analysis that follows.

For some of independent variables there may be good reasons for using a log form. For example, the data summary indicates that the range of values for per capita GDP is quite large – from $200 to over $122,000. It is likely that over this range the impact on child mortality rates will not be linear – we would expect the impact to diminish at higher levels of income. A log form of the independent variable would accommodate that declining impact, and would also reduce the possibility of heteroskedasticity in the regression model.

Figures 4.1 and 4.2 show the relationship between child mortality rates and per capita GDP and enrollment rates in tertiary education respectively. Both figures suggest a strong negative relationship between the variables, and in the case of per capita GDP it seems clear that the relationship will not be linear, even after controlling for other variables.

Another useful contribution of scatterplots is that they can help detect outliers in the data set. In figure 4.1 for example, an obvious outlier is the observation with a child mortality rate of 150 per 1,000 live births, and per capita GDP of approximately $37,000. This observation is for Equatorial Guinea, a country for which the population estimate is in some doubt. According to the CIA World Factbook entry "population figures are uncertain for

Equatorial Guinea; these per capita income figures are based on a estimated population of less than 700,000; some estimates put the figure as high as 1.2 million people; if true, the per capita GDP figures would be significantly lower." Given the uncertainty about the data, this observation, was not included in the subsequent analysis.

Figure 4.1: GDP per Capita and Child Mortality

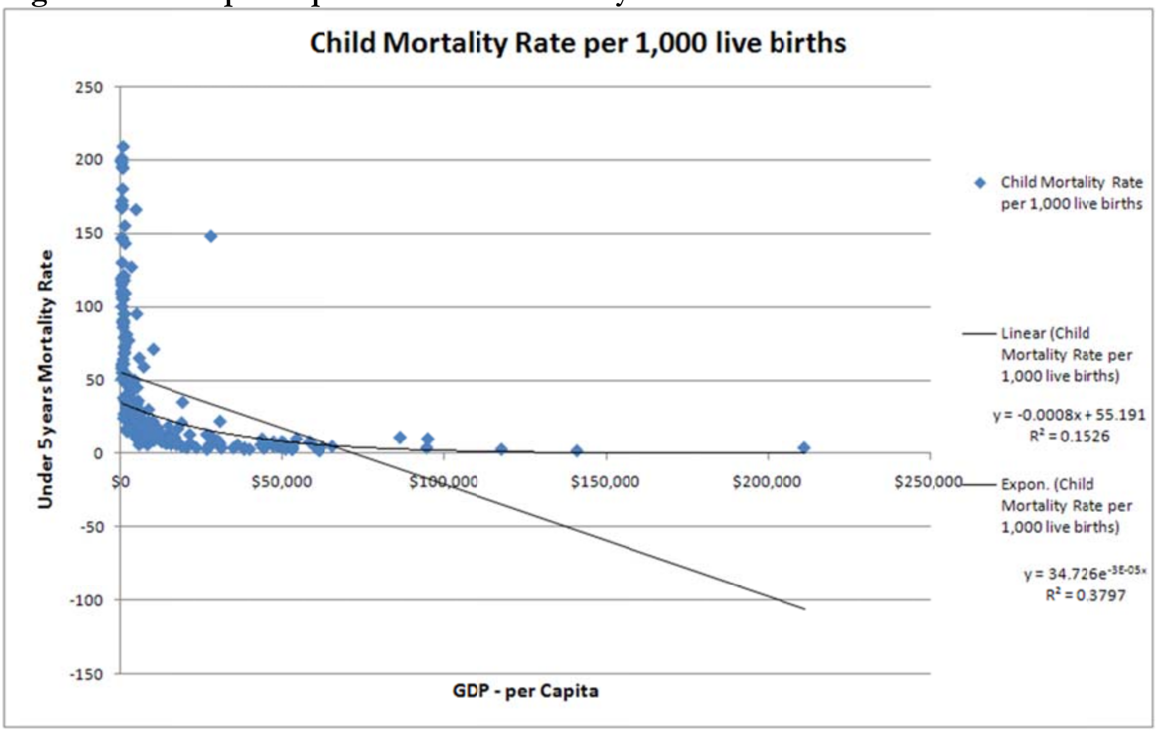
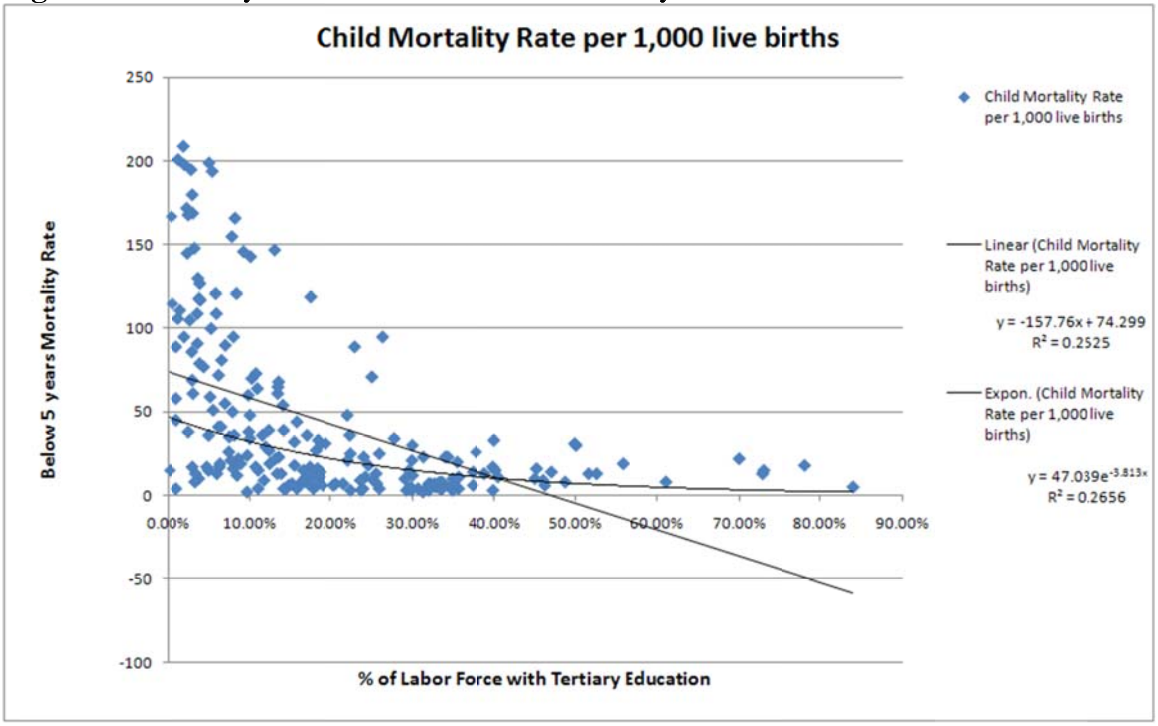


Figure 4.2: Tertiary Education and Child Mortality



Alternative models were estimated using different specifications of the tertiary education variable – i.e., total rate, rate for males, and rate for females. High correlation between the rates for males and females precluded their simultaneous inclusion in the model, so the objective will be to investigate which has the greater effect. The following regression models will be estimated:

Equation 1: Linear form of GDP per Capita

$$\mathbf{Y_i = \beta_0 + \beta_1\, GDPPC_i + \beta_2\, Ag_i + \beta_3\, Codex_i + \beta_4\, Tert_i + \beta_5\, Gini_i + \beta_6\, IDP_i} \quad (4.1)$$

Equation 2: Log GDP per Capita

$$\mathbf{Y_i = \beta_0 + \beta_1\, Ln(GDPPC_i) + \beta_2\, Ag_i + \beta_3\, Codex_i + \beta_4\, Tert_i + \beta_5\, Gini_i + \beta_6\, IDP_i} \quad (4.2)$$

Additional models (equations 3 and 4) were estimated to investigate the effects of female, male and total tertiary education. This comparison will determine the maximum potential effect of gender tertiary education on child mortality. Results will allow comparison with Kiros & Hogen's (2001) study that found if the mother in Ethiopia was literate the chance of child survivability was increased by 22%.

Separate regression models will be estimated on countries with tertiary education levels less than 35%, 15%, and 5% since the scatted plot data show an exponential increase in child mortality with less than 35% tertiary education. These equations will be referred to as equations A to I. A determination will be made on the optimum goal for level of tertiary education to reduce child mortality and increase food safety.

Observations in Afghanistan and Latin America led the author to hypothesize that these combinations of factors need to be studied to determine child mortality risks. The literature review has verified that this combination of factors have not been considered in other studies.

CHAPTER V RESULTS

Table 5.1 and table 5.2 present results from some alternative specifications of the ordinary least squares regression model using child mortality rate as the dependent variable. Equations 1 and 2 differ only in the way per capita GDP enters the model – linearly in equation 1 and in log form in equation 2. As expected, the log form of the variable provides a better fit. Equations 3 and 4 replace the overall level of tertiary education in the workforce with the levels for females and males respectively. High correlation between the overall level of tertiary education and the levels for males and females precluded inclusion of more than one variable representing tertiary education. Variance inflation factors (VIFs) were estimated for equation 2 and indicated no issues with multicollinearity. The VIF was highest for the variables Ln (GDP per capita) at 2.6 and percent GDP from agriculture at 2.3. The discussion that follows focuses on the coefficient estimates for equation 2.

The coefficient on Ln (GDP per capita) is negative as expected and statistically significant indicating that countries with higher income levels experience lower rates of child mortality. For the semi-log model using the logged form of the independent variable, the marginal effect of that variable, dY/dX_j is given by $\beta_j\ (1/X_j)$. Using the estimated coefficient of -10.357, and the 1st, 2nd, and 3rd quartile values for per capita GDP of $2,581, $8,697, and $21,812 we obtain values for the marginal effects of income of -0.0040, -0.0012, and -0.0005 respectively. Thus, at the 1st quartile value for per capita GDP of $2,581, the predicted effect of an additional $100 in per capita GDP is a reduction of 0.4 in the child mortality rate. At the 3rd quartile value of $21,812 the marginal effect of an additional $100 is smaller by a factor of almost 10 at 0.05. For a country with an extremely low income such as Afghanistan where per capita GDP is only $870, the predicted effect of an additional $100 is a reduction of 1.2 in child mortality rate.

The coefficient on the variable measuring the proportion of GDP from agriculture was positive indicating that countries that are more reliant on agriculture have, ceteris paribus, higher rates of child mortality. The coefficient indicates that for every one percent increase in share of GDP from the agricultural sector, child mortality increases by 1.23.

The coefficient on the dummy variable for adoption of Codex Alimentarius was negative but was insignificant. As noted earlier, this variable likely does a poor job of representing food safety standards within a country. Better results might be obtained if data were available to measure country level microbial risk assessments.

As expected, higher levels of participation in tertiary education are associated with lower levels of child mortality. The estimated coefficient in equation 2 indicates that a one percent increase in participation in tertiary education is associated with a 0.48 unit reduction in child mortality. The estimated coefficients in equations 3 and 4 indicate that the effect is stronger for females than for males. For every one percent of increase in female tertiary education in the labor force there was a decrease in child mortality of 0.632.

Income inequality, as measured by the Gini coefficient, is associated with an increase in child mortality. Values for the Gini coefficient, measured on a scales from 0 to 100, ranged from 16.8 to 70.7 in the sample of countries used in the analysis. The estimated regression coefficient indicates that a one unit increase on that scale is associated with a 0.393 increase in the rate of child mortality, and the effect is statistically significant. Finally, the percentage of displaced person within a country does not have a statistically significant effect in the estimated models.[2].

Table 5.1: OLS Regression Estimates: Child Mortality

Independent Variables	Equation 1	SE	Equation 2	SE	Equation 3	SE	Equation 4	SE
Constant	**+11.25** [0.500]	**16.64**	**+111.11***** [0.000]	**21.69**	**+102.73***** [0.000]	**21.30**	**+112.76***** [0.000]	**21.85**
GDP – per Capita	**-0.0001** [0.354]	**0.00**						
Ln (GDP – per Capita)			**-10.357***** [0.000]	**2.151**	**-9.113***** [0.000]	**2.129**	**-10.898***** [0.000]	**2.151**
Sector % from Agriculture	**+193.47***** [0.000]	**20.26**	**+123.02***** [0.000]	**21.13**	**+121.78***** [0.000]	**20.55**	**+127.55***** [0.000]	**21.19**
Codex Alimentarius	**+7.262** [0.378]	**8.21**	**-0.145** [0.980]	**5.81**	**+1.024** [0.856]	**5.65**	**+0.310** [0.958]	**5.85**
% of Labor Force with Tertiary Education (Total)	**-83.10***** [0.000]	**19.81**	**-48.07***** [0.002]	**15.44**				
% of Labor Force with Tertiary Education (Female)					**-63.20***** [0.000]	**13.93**		
% of Labor Force with Tertiary Education (Male)							**-36.69**** [0.014]	**14.87**
Gini Coefficient	**+0.498*** [0.110]	**0.31**	**+0.393***** [0.006]	**0.142**	**+0.414***** [0.003]	**0.14**	**+0.377**** [0.009]	**0.14**
% Displaced Persons	**-28.5** [0.779]	**111.9**	**-29.4** [0.772]	**101.0**	**-28.52** [0.772]	**98.51**	**-34.2** [0.737]	**101.8**
R-Square	61.4%		63.6%		65.3%		63%	

Note: The dependent variable is "Child Mortality per 1,000 live Births." *,**,*** denote statistically significant coefficients at the 20%, 5%, and 1% levels. SE denotes standard error. Values in square brackets [.] are P-values.

[2] Most countries have no internally displaced persons therefore the value is zero. However, this coefficient becomes significant in the sub-sets of <15% and <5% tertiary education in Table 5.2.

It can be observed from the scatter plot (see Figure 4.2), that the impact of tertiary education on child mortality is much greater when participation in tertiary education is very low - less than or equal to 35%. One way to account for this in the model would be to use a non-linear specification such as the log of the tertiary education rate, but an alternative approach used here is to estimate separate regression models for subsamples with different rates of participation in tertiary education. In particular, the OLS regression was conducted using subsamples of countries with less than 35%, 15%, and 5% tertiary education. Results for these models are presented in table 5.2.

Comparison of equations A, B, C (where the sample was restricted to countries with a less than 35% participation rate in tertiary education) with equations D, E, F (where the sample is restricted to countries where the rate is less than 15%) illustrates the differential impacts. In the full sample, a one percent increase in female participation was estimated to reduce child mortality by 0.63. Table 5.2 indicates that when the sample was restricted to countries with a less than 35% participation rate the effect of a one percent increase in female participation was a reduction of 1.47. When the sample was further restricted to countries with rates below 15%, the marginal effect of female participation was further magnified, with a one percent increase associated with a 5.27 unit reduction in child mortality. Comparison of the estimates in tables 5.1 and 5.2 also indicates that income distribution, as measured by the Gini coefficient, has a more significant impact when the sample was restricted to countries with low participation in tertiary education.

Table 5.2: OLS Estimates for subsamples based on participation in tertiary education

Independent Variables	Equation A		Equation B		Equation C		Equation D		Equation E		Equation F		Equation G		Equation H		Equation I	
Tertiary Education	< 35%	SE	< 35%	SE	< 35%	SE	< 15%	SE	< 15%	SE	< 15%	SE	< 5%	SE	< 5%	SE	< 5%	SE
Constant	+102.66***	23.96	+91.76***	24.47	+110.79***	24.11	+131.12***	37.20	+103.03***	34.22	+124.97***	34.99	+51.28	66.09	+56.77	56.07	+60.74	67.58
	[0.000]		[0.000]		[0.000]		[0.001]		[0.003]		[0.001]		[0.443]		[0.317]		[0.375]	
GDP – per Capita																		
Ln (GDP – per Capita)	-8.96***	2.49	-6.894***	2.55	-10.102***	2.45	-11.715***	3.82	-7.399**	3.64	-10.644***	3.53	-3.807	6.34	-3.583	5.63	-3.648	6.55
	[0.000]		[0.008]		[0.000]		[0.003]		[0.045]		[0.003]		[0.552]		[0.528]		[0.581]	
Sector % from Agriculture	+126.44***	22.58	+119.38***	22.75	+125.48***	22.65	+90.93**	31.59	+89.67***	26.70	+116.48***	29.91	+115.74**	42.79	+99.71**	40.48	+106.14**	48.08
	[0.000]		[0.000]		[0.000]		[0.005]		[0.001]		[0.000]		[0.011]		[0.018]		[0.034]	
Codex Alimentarius	-1.656	6.668	+0.892	6.61	+1.618	6.77	+9.13	10.76	+7.899	9.42	+5.707	9.71	+4.49	18.04	+5.15	15.97	+5.65	19.79
	[0.804]		[0.893]		[0.811]		[0.399]		[0.404]		[0.558]		[0.805]		[0.749]		[0.777]	
Tertiary Education % of Labor Force (Total)	-91.09***	30.40					-379.70***	98.16					-287.5	491.2				
	[0.003]						[0.000]						[0.562]					
Tertiary Education % of Labor Force (Female)			-147.48***	29.24					-527.42***	82.01					-564.9*	400.4		
			[0.000]						[0.000]						[0.166]			
Tertiary Education % of Labor Force (Male)					-96.40***	29.90					-361.07***	89.59					-533.1	491.3
					[0.002]						[0.000]						[0.286]	
Gini Coefficient	+0.491***	0.16	+0.5162***	0.15	+0.435***	0.16	+0.731***	0.22	+0.837***	0.21	+0.606***	0.20	+1.262***	0.34	+1.367***	0.32	+1.185***	0.375
	[0.002]		[0.001]		[0.007]		[0.001]		[0.000]		[0.003]		[0.001]		[0.000]		[0.003]	
Displaced Persons	-11.4	107.7	+4.4	104.4	-15.6	107.3	+890.4*	476.2	+546.3*	296.7	+36.2	134.1	+1378.1*	777.9	+1483.5**	723	+1531.1*	933.1
	[0.916]		[0.967]		[0.885]		[0.065]		[0.069]		[0.788]		[0.085]		[0.046]		[0.110]	
R-Square	64.2%		66.4%		63.3%		61.6%		66.7%		62.2%		65.7%		64.2%		58.7%	

Note: The dependent variable is "Child Mortality per 1,000 live Births." *,**,*** denote statistically significant coefficients at the 20%, 5%, and 1% levels. SE denotes standard error. Values in square brackets [.] are P-values.

CHAPTER VI SUMMARY AND CONCLUSIONS

In the 1940s and 1950s, summer diarrhea accounted for 50% of deaths in the US, UK, and Canada. It was the cause of death in over 50% of children who died during those years. Dr. John Bray first discovered the linkage between the pathogen *E. coli* and summer diarrhea. Bray an English physician, and Dr. Erwin Netar, an infectious disease specialist from New York, created the term "*enteropathogenic E. coli*." This term was later shortened to *E. coli* (Humphries 2008, Crane 2010). In 2010, foodborne illness accounted for 4,983 deaths out of a total of 2.4 million in the US. Therefore, deaths in the U.S. from these pathogens have fallen from 50% to about 0.2% in the past sixty years (CDC-DFWED 2010, CDC 2010).

In many countries around the world however, death rates, and particularly death rates of young children remain high. Reducing high child mortality rates by two-thirds is the Millennium Development Goal Four of the United Nations. In this thesis, I examine variability in child mortality rates across a sample of 212 countries and attempt to explain that variability with reference to a number of socio-economic factors. The statistics cited in the previous paragraph, in addition to data on causes of child deaths, and the author's personal experience in Afghanistan, suggest that illnesses caused by food- and water-borne pathogens are a major factor in high child mortality rates. It was therefore hypothesized that higher standards of sanitation in food handling and processing might have significant potential for reducing high child mortality rates. Unfortunately, it is very difficult to find data that measures food safety standards across countries. The measure used in this study – a dummy variable indicating full or partial adoption of Codex Alimentarius standards – did not, unfortunately, appear to adequately capture food safety standards. In the estimated regression models to explain child mortality rates, the effect of this variable was not found to be significant.

However, a number of other socio-economic variables were found to have significant explanatory effects.

Both the level of income, measured by per capita GDP, and the extent to which income was equitably distributed, measured by the Gini coefficient were both found to have statistically significant associations with the rate of child mortality. Furthermore, education, as measured in this study by labor force rates of tertiary education, was also found to have a statistically significant effect on child mortality. Importantly, female participation rate in tertiary education had a greater impact on reducing child mortality than did the rate for males. Furthermore, the estimated impact of a marginal increase in tertiary education was not constant but was higher, by a factor of almost 8 (0.48 versus 3.79), in countries with low levels of tertiary education.

The findings relative to female education have some support in the literature. For example, Kiros and Hogan (2001) found that illiterate mothers would often succumb to a '*fatalistic*' recognition of the mortality of the child, while a literate mother will practice 'health-promotion' and seek medical assistance. The literate mother had a sense of empowerment that was lacking in the illiterate mother. The difference in child mortality rates was about tenfold between countries where more than 35% of the female labor force had tertiary education and the countries where that rate was below five percent. In a World Bank-Bangladesh child mortality case study, a 20% increase in female secondary education reduced the child mortality rate by fifty percent (Khan 2007). In India, the 12.6% portion of the population that was uneducated accounted for 62.2% of cases of child mortality (Gupta 1990).

While the analysis here does have some shortcomings, in particular the failure to adequately measure a suspected relevant explanatory variable representing food safety standards, the findings relative to other variables conform to prior expectations. The results suggest that efforts to increase economic opportunity particularly for the poorest in society, and efforts to enhance education particularly for females, can aid in the effort to reduce child mortality.

The estimated impact of tertiary education suggests that advanced training of relatively small core groups of nationals in food safety and security has the potential to effect a significant reduction in the rate of child mortality in countries where tertiary education rates are low. Training of such groups can be achieved at relatively low cost. For example, Kastner[3] (personal communication, 2011) described a model in which a core group of Afghan nationals would be trained at U.S. universities in areas including Food and/or Grain Science, Food Safety, Food Processing and Public Health, and related topics with the long term objective of improving the safety and quality of the Afghan food supply. The group, which would include individuals trained at the PhD, Masters, and Bachelors levels, on returning to Afghanistan would begin educating other food scientists and technologists, and conducting educational and outreach programs. The projected cost for training a core group of 13 individuals, including three at the PhD level, and five each at the bachelor and Masters levels, was less than three million dollars.

[3] Dr. Curtis L. Kastner, Director, Kansas State University Food Science Institute.

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APPENDIX A

Tables from the Kiros and Hogan Study:

Table A.1: Age of Mother and Child Mortality Rate in Ethiopia

Age of Mother	Child Mortality Rate (%)
15-19	12.36%
20-24	14.13%
25-29	16.82%
30-34	19.71%
35-39	21.09%
40-44	24.83%
45-49	26.32%
Total	21.00%

Table A.2: Parental Education & Under 5 Years Age Child Mortality Rate in Ethiopia

Parental Education	Child Mortality Rate (%)	Difference in Mortality Rate
Mother		
Illiterate	21.39%	5.87%
Literate	15.52%	
Father		
Illiterate	21.51%	3.84%
Literate	17.67%	
Above Primary	11.80%	Illiterate - Above Primary 9.71%

War Intensity & Parental Education	Child Mortality Rate (%)	Difference in Mortality Rate
Low War Intensity		
Mother		
Illiterate	21.07%	6.86%
Literate	14.21%	
Father		
Illiterate	21.20%	4.73%
Literate	16.47%	
Above Primary	10.72%	Illiterate - Above Primary 10.48%
High War Intensity		
Mother		
Illiterate	21.74%	2.19%
Literate	19.55%	
Father		
Illiterate	21.86%	2.35%
Literate	19.51%	
Above Primary	15.99%	Illiterate - Above Primary 5.87%

Food Crisis & Parental Education	Child Mortality Rate (%)	Difference in Mortality Rate
Minimal Food Crisis		
Mother		
Illiterate	20.68%	5.50%
Literate	15.18%	
Father		
Illiterate	20.82%	3.27%
Literate	17.54%	
Above Primary	11.24%	Illiterate - Above Primary 9.58%
Maximum Food Crisis		
Mother		
Illiterate	23.21%	5.00%
Literate	18.21%	
Father		
Illiterate	23.28	5.07%
Literate	18.21	
Above Primary	13.93	Illiterate - Above Primary 9.35%

(Kiros & Hogan 2001)

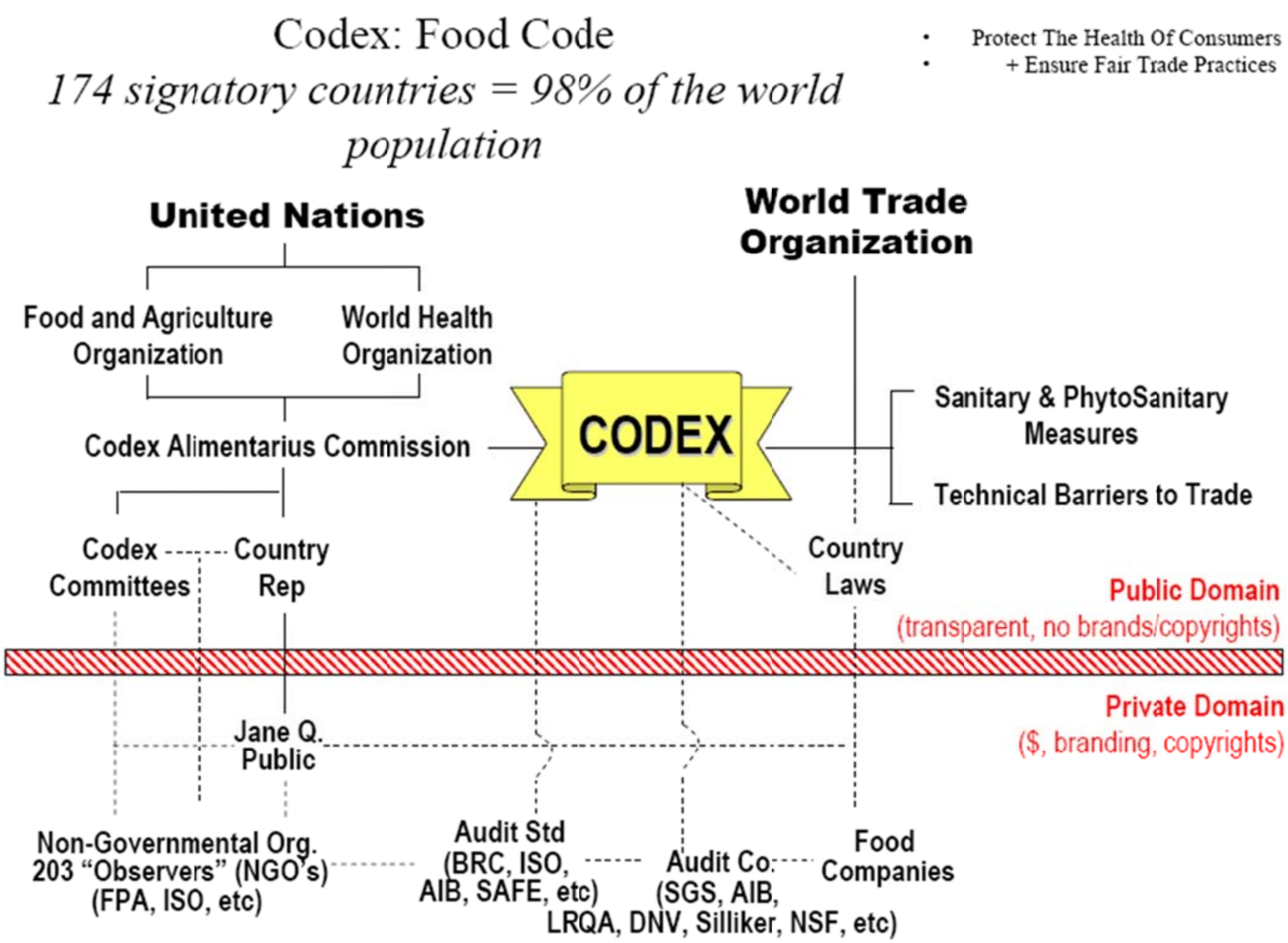
APPENDIX B

	(1) 0		(2) 1-11		(3) 12-59		(4) 0-11		(5) 0-59		(6) 0--59	
Explanatory Variable	Coeff.	T value	Coeff.	T value	Coeff.	T value	Coeff.	T value	Coeff.	T value	Coeff.	T value
Child has siblings who died below age 5	0.375	3.407**	-0.169	1.254	0.150	1.985*	0.206	1.662*	0.216	2.986**		
Child-Care Factors												
Rehydration in case of diarrhea	-0.642	3.874**	-0.380	2.142*	-0.249	1.978*	-0.621	3.926**	-0.504	4.323**		
BCG immunization			-1.524	7.166**	-0.454	5.742**	-1.992	10.189**	-1.405	16.006**		
Pre-natal tetanus immunization	-0.187	1.671*	-0.149	1.381	-0.059	0.732	-0.177	1.871	-0.014	0.169		
Mother's education and autonomy												
Mother's years of schooling	0.007	0.312	-0.001	0.057	-0.029	1.292	0.018	0.997	0.013	0.918	-0.023	2.177*
Husband decides what to cook	0.160	0.599	0.317	1.391	0.184	0.744	0.284	1.091	0.506	2.611**	0.494	3.057**
Sanitation & hygiene												
Mother does not always use soap after toilet	0.044	0.334	0.014	0.134	0.165	2.241*	-0.041	0.382	0.008	0.116	-0.304	0.626
Open source of drinking water	0.323	1.400	-0.310	0.848	0.140	0.822	0.191	0.936	0.087	0.495	0.021	0.174
Toddlers use toilet	-0.630	1.621	-0.284	0.744	-0.626	1.217	-0.509	1.457	-0.091	0.498	-0.013	0.113
Biological factors												
Preceding birth interval less than 18 months	0.167	1.070	0.256	1.993*	0.109	1.245	0.192	1.462	0.217	2.405**	0.265	3.564**
Succeeding birth interval less than 18 months			0.371	2.979**	0.221	2.234*	0.647	6.356**	0.601	7.647**	0.667	9.705**
Household social and economic status												
High caste	-0.156	1.023	0.096	0.609	-0.223	2.428**	-0.004	0.030	-0.098	1.072	-0.204	3.023**
Income per head	0.312	3.155**	0.155	1.721	0.103	2.153*	0.246	2.998**	0.054	1.737	0.054	2.305*
Size of landholding	-0.000	0.926	-0.001	1.555	-0.000	0.381	-0.000	1.067	0.000	0.475	0.000	0.030
Television owned (media exposure)	-0.707	1.346	0.310	1.136	0.070	0.332	-0.035	0.103	-0.007	0.031	0.025	0.185
Child is female	-0.094	0.740	0.306	2.937**	0.405	4.627**	0.037	0.351	0.114	1.722*	0.139	2.672**
Constant	-3.278	4.188	-2.214	3.087	-2.228	6.119	-2.161	3.303	-0.651	2.434	-1.603	8.660
N	2,920		2,924		2,924		2,920		2,924		2,924	
Log_e (H)	-468.326		-341.028		-413.146		-548.294		-826.902		-1,041.423	

Note: (1), (2), and (4) is data on children born before the survey in1984. Columns (3), (5) and (6) were born before the 1990 survey. * 5% significance level & **1% significance level.

All coefficients are significant at P < 0.01 (Kiros & Hogan 2001)

APPENDIX C



(Robach 2008)

APPENDIX D

Country Name	GDP (millions of US $)	Population (millions)	Child Mortality Rate per 1,000 live births	GDP - per capita	Sector % from Agriculture	Codex Alimentarius	Labor Force with Tertiary Education (% of Total)	Female Labor Force with Tertiary Education (% of Total)	Male Labor Force with Tertiary Education (% of Total)	Income Gini Coefficient	% of Internally Displaced Persons
Afghanistan	$12,061	28.139	201	$408	31.00%	1	1.28%	0.50%	1.95%	60	0.82%
Albania	$12,964	3.182	16	$4,126	20.60%	1	8.00%	23.40%	14.94%	33.03	0.00%
Algeria	$159,669	34.800	34	$4,974	8.30%	1	10.00%	19.80%	8.00%	35.3	0.00%
American Samoa	$575	65.628	14	$8,000	34.00%	0	37.30%	40.50%	32.80%	41	0.00%
Andorra	$3,660	83.888	4	$44,291	0.30%	1	10.99%	13.10%	9.02%	-	0.00%
Angola	$83,384	16.808	166	$4,671	9.60%	1	8.20%	0.70%	1.00%	58.6	0.00%
Antigua and Barbuda	$1,256	0.084	12	$13,890	3.80%	1	8.43%	8.40%	8.00%	53	0.00%
Argentina	$326,474	39.746	15	$8,189	8.50%	1	29.50%	36.70%	24.00%	48.8	0.00%
Armenia	$11,928	3.549	23	$3,873	18.60%	1	34.21%	37.30%	31.06%	30.2	0.00%
Aruba	$2,258	103.065	7	$21,800	0.40%	0	32.59%	15.50%	15.50%	-	0.00%
Australia	$1,010,699	21.323	5	$48,499	3.80%	1	32.70%	36.80%	29.30%	37	0.00%
Austria	$415,321	8.290	4	$49,739	1.70%	1	17.70%	15.60%	19.40%	29.1	0.00%
Azerbaijan	$46,378	8.670	36	$5,329	5.80%	0	22.30%	19.50%	24.90%	16.8	6.96%
Bahamas, The	$7,463	0.337	13	$26,877	3.00%	1	25.50%	29.80%	21.30%	-	0.00%
Bahrain	$21,236	0.779	12	$28,240	0.50%	1	29.94%	30.10%	13.90%	36	0.00%
Bangladesh	$81,938	161.915	55	$497	18.70%	1	6.98%	5.00%	14.00%	31	0.00%
Barbados	$3,682	0.276	11	$14,381	6.00%	1	18.40%	22.70%	14.30%	-	0.00%
Belarus	$60,288	9.671	13	$6,277	9.30%	0	72.84%	86.10%	60.13%	28.8	0.00%
Belgium	$506,392	10.750	5	$47,194	0.80%	1	35.20%	41.00%	32.20%	33	0.00%
Belize	$1,381	0.320	19	$4,218	29.00%	1	12.40%	14.61%	9.80%	59.6	0.00%
Benin	$694	8.107	121	$771	33.20%	1	5.85%	16.70%	9.80%	38.6	0.00%
Bermuda	$4,500	0.068	10	$94,908	1.00%	0	29.00%	29.60%	27.90%	-	0.00%
Bhutan	$1,368	0.657	81	$1,841	22.30%	1	6.57%	4.80%	8.18%	46.7	0.00%
Bolivia	$17,413	10.028	54	$1,720	11.30%	1	14.00%	13.40%	14.80%	57.2	0.00%
Bosnia and Herzegovina	$18,469	3.993	15	$4,906	10.20%	0	11.00%	14.00%	9.30%	36.3	3.12%
Botswana	$13,461	1.782	59	$7,050	1.60%	1	5.18%	10.90%	7.06%	61	0.00%
Brazil	$1,572,839	191.870	22	$8,532	6.50%	1	8.60%	10.90%	6.90%	55	0.00%
Brunei Darussalam	$14,553	0.393	7	$50,103	0.70%	1	16.04%	21.50%	10.81%	-	0.00%
Bulgaria	$51,989	7.582	11	$6,798	7.50%	1	24.20%	30.50%	18.90%	29.2	0.00%

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Burkina Faso	$8,103	14.042	169	$528	29.40%	1	3.06%	2.00%	4.06%	39.6	0.00%
Burundi	$1,097	7.949	168	$145	33.30%	1	2.52%	1.40%	3.25%	33.3	1.26%
Cambodia	$11,182	13.668	90	$648	29.00%	1	7.02%	4.90%	9.10%	44.2	0.00%
Cameroon	$23,243	19.383	155	$1,243	19.80%	1	7.82%	6.90%	8.72%	44.6	0.00%
Canada	$1,510,957	33.260	6	$45,003	2.00%	1	46.20%	51.60%	41.30%	32.6	0.00%
Cape Verde	$1,723	0.504	29	$3,071	9.20%	1	11.91%	36.00%	33.70%	50.4	0.00%
Cayman Islands	$1,939	0.049	10	$43,800	1.40%	0	34.80%	47.40%	23.93%	-	0.00%
Central African Republic	$1,997	4.355	172	$458	55.00%	1	2.33%	1.20%	3.41%	43.6	4.52%
Chad	$8,390	9.730	209	$766	57.20%	1	1.92%	0.20%	1.10%	39.8	1.71%
Chile	$169,573	16.750	9	$10,167	4.80%	1	25.20%	30.50%	22.10%	52	0.00%
China	$4,401,614	1,327.658	21	$3,414	10.90%	1	22.05%	23.20%	22.26%	41.5	0.00%
Colombia	$240,654	48.274	20	$5,389	9.10%	1	35.36%	25.90%	24.50%	58.5	6.21%
Comoros	$532	0.652	105	$824	40.00%	0	2.70%	2.30%	3.10%	64.3	0.00%
Congo, Dem. Rep.	$11,589	62.885	199	$180	55.00%	1	5.05%	2.10%	6.02%	44.4	2.32%
Congo, Rep.	$10,774	3.650	127	$3,261	5.60%	1	3.91%	1.20%	6.62%	47.3	0.00%
Cook Islands	$183	0.012	15	$9,100	15.10%	0	5.00%	1.67%	3.33%	-	0.00%
Costa Rica	$29,828	4.533	11	$6,564	6.50%	1	16.80%	22.10%	13.60%	48.9	0.00%
Cote d'Ivoire	$23,508	20.762	121	$1,137	28.00%	1	8.37%	5.60%	11.15%	48.4	3.29%
Croatia	$69,332	4.436	6	$15,637	6.20%	1	18.10%	20.60%	16.10%	29	0.06%
Cuba	$110,800	11.452	6	$5,596	4.30%	1	14.70%	19.20%	12.00%	30	0.00%
Cyprus	$24,943	0.761	4	$31,410	2.10%	1	35.50%	41.10%	30.90%	29	0.00%
Czech Republic	$217,077	10.323	4	$20,729	2.80%	1	14.40%	13.90%	14.90%	25.8	0.00%
Denmark	$342,925	5.476	4	$62,036	1.20%	1	30.60%	33.10%	28.30%	24.7	0.00%
Djibouti	$982	0.784	95	$1,157	3.20%	0	26.30%	2.10%	3.11%	39.9	0.00%
Dominica	$364	0.072	10	$5,116	17.70%	1	3.80%	7.90%	7.30%	-	0.00%
Dominican Republic	$45,597	8.902	33	$4,602	10.50%	1	18.30%	13.30%	8.40%	48.4	0.00%
Ecuador	$52,572	13.922	25	$4,056	6.80%	1	25.90%	30.10%	23.00%	54.4	0.00%

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Egypt, Arab Rep.	$162,164	75.045	23	$1,997	13.10%	1	31.24%	23.80%	30.84%	32.1	0.00%
El Salvador	$22,115	5.784	18	$3,604	11.10%	0	24.56%	28.60%	21.00%	46.9	0.00%
Equatorial Guinea	$18,525	1.240	148	$28,103	2.40%	1	3.26%	0.40%	4.58%	65	0.00%
Eritrea	$1,476	5.006	58	$336	17.30%	1	1.00%	1.00%	1.76%	-	0.00%
Estonia	$23,232	1.343	6	$17,541	3.00%	1	33.70%	42.00%	25.60%	36	0.00%
Ethiopia	$25,658	79.179	109	$321	43.80%	1	3.60%	0.70%	1.50%	29.8	0.00%
Faroe Islands	$1,000	0.049	8	$49,738	27.00%	0	33.50%	37.40%	30.00%	-	0.00%
Fiji	$3,590	0.877	18	$4,224	8.90%	1	15.41%	16.90%	14.03%	-	0.00%
Finland	$273,980	5.270	3	$50,905	3.40%	1	34.80%	40.40%	29.60%	26.9	0.00%
France	$2,865,737	62.277	4	$44,471	2.10%	1	29.40%	32.30%	26.80%	32.7	0.00%
French Polynesia	$4,718	0.287	17	$18,000	3.50%	0	3.00%	1.00%	5.00%	-	0.00%
Gabon	$14,519	1.454	71	$10,037	5.40%	1	25.00%	8.50%	7.10%	41.5	0.00%
Gambia, The	$808	1.630	106	$495	33.50%	1	1.23%	0.50%	1.20%	47.3	0.00%
Georgia	$12,870	4.400	30	$2,919	12.10%	1	29.90%	30.60%	29.30%	40.8	5.50%
Germany	$3,667,513	82.120	4	$44,264	0.90%	1	23.90%	21.40%	26.10%	28.3	0.00%
Ghana	$16,124	22.532	72	$1,222	37.30%	1	6.20%	21.50%	42.70%	42.8	0.00%
Greece	$357,549	11.172	4	$31,174	3.40%	1	25.90%	29.10%	23.70%	34.3	0.00%
Greenland	$2,000	0.058	22	$30,883	1.00%	0	70.00%	55.00%	85.00%	-	0.00%
Grenada	$639	0.106	15	$6,553	5.40%	1	73.00%	72.00%	74.00%	-	0.00%
Guam	$2,500	0.178	8	$15,000	26.00%	0	3.32%	5.19%	1.45%	-	0.00%
Guatemala	$38,956	13.678	41	$2,860	13.50%	1	6.20%	6.60%	6.00%	53.7	0.00%
Guinea	$4,542	10.279	146	$384	23.80%	1	9.22%	4.60%	3.30%	43.3	0.00%
Guinea-Bissau	$461	1.745	195	$538	62.00%	1	2.85%	0.10%	2.90%	35.5	0.00%
Guyana	$1,130	0.764	36	$1,518	24.50%	1	11.51%	13.50%	9.51%	43.2	0.00%
Haiti	$6,952	8.786	89	$649	28.00%	1	1.00%	0.46%	1.54%	59.5	0.00%
Honduras	$14,126	7.667	31	$1,909	14.20%	1	18.65%	20.00%	14.00%	55.3	0.00%
Hong Kong, China	$215,559	7.009	7	$30,863	0.00%	0	25.60%	26.00%	25.40%	43.4	0.00%
Hungary	$156,284	10.055	7	$15,408	3.40%	1	20.60%	24.00%	17.80%	30	0.00%
Iceland	$17,549	0.316	3	$52,932	5.20%	1	31.90%	26.10%	36.90%	28	0.00%

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India	$1,209,686	1,190.451	68	$1,065	17.50%	1	13.48%	11.00%	15.96%	36.8	0.00%
Indonesia	$511,765	227.829	41	$2,245	14.40%	1	6.50%	7.80%	5.70%	37.6	0.00%
Iran, Islamic Rep.	$344,820	72.871	32	$4,700	10.90%	1	15.40%	27.80%	12.40%	38.3	0.00%
Iraq	$90,907	30.413	44	$2,817	9.60%	1	15.70%	11.60%	19.80%	42	8.70%
Ireland	$273,328	4.422	4	$60,178	5.00%	1	33.30%	40.00%	28.10%	34.3	0.00%
Isle of Man	$35,000	0.077	7	$50,594	1.00%	0	31.90%	34.10%	30.00%	-	0.00%
Israel	$201,761	7.113	5	$27,652	2.60%	1	84.00%	89.30%	79.30%	39.2	0.00%
Italy	$2,313,893	59.336	4	$38,385	2.10%	1	15.70%	19.90%	13.00%	36	0.00%
Jamaica	$14,397	2.699	31	$5,301	5.70%	1	19.31%	33.40%	5.22%	45.5	0.00%
Japan	$4,923,761	127.694	3	$38,268	1.60%	1	39.90%	39.40%	40.20%	24.9	0.00%
Jordan	$20,030	5.854	26	$3,905	3.70%	1	37.73%	42.90%	32.56%	37.7	0.00%
Kazakhstan	$132,229	15.553	30	$8,514	5.50%	1	50.00%	54.50%	45.80%	30.9	0.00%
Kenya	$30,236	35.265	86	$775	21.40%	1	2.95%	8.90%	10.80%	47.7	1.15%
Kiribati	$137	0.100	48	$1,372	8.90%	0	10.00%	11.45%	8.55%	-	0.00%
Korea, Dem. Rep.	$40,000	22.665	33	$1,800	23.30%	1	40.00%	30.80%	49.20%	31	0.00%
Korea, Rep.	$947,010	48.553	5	$19,162	3.00%	1	34.45%	30.80%	38.10%	31.6	0.00%
Kuwait	$158,089	3.443	10	$54,260	0.30%	1	16.70%	16.50%	16.80%	30	0.00%
Kyrgyz Republic	$5,049	5.311	38	$974	30.70%	1	2.50%	2.30%	2.70%	33.5	0.00%
Lao PDR	$5,260	6.257	61	$882	39.20%	1	13.37%	11.70%	17.50%	32.6	0.00%
Latvia	$34,054	2.271	9	$14,937	3.60%	1	23.60%	29.50%	47.40%	36.3	0.00%
Lebanon	$28,939	3.799	13	$7,138	5.10%	1	51.53%	57.00%	46.06%	45	1.84%
Lesotho	$1,620	2.451	91	$778	15.90%	1	3.63%	3.90%	3.36%	52.5	0.00%
Liberia	$836	3.942	119	$222	76.90%	1	17.39%	14.80%	19.98%	52.6	0.00%
Libya	$100,071	6.210	19	$14,802	4.20%	1	55.74%	58.30%	53.18%	36	0.00%
Liechtenstein	$4,160	0.035	2	$141,114	8.00%	0	31.19%	25.00%	37.38%	-	0.00%
Lithuania	$47,304	3.358	7	$14,034	5.30%	1	32.10%	38.10%	26.20%	35.8	0.00%
Luxembourg	$54,973	0.486	3	$117,955	0.40%	1	29.20%	30.30%	28.40%	36	0.00%
Macao, China	$18,140	0.560	6	$36,249	0.10%	0	18.90%	19.90%	18.10%	-	0.00%
Macedonia, FYR	$9,569	2.055	11	$4,663	11.90%	0	35.54%	44.20%	26.88%	42.8	0.00%
Madagascar	$9,254	20.215	61	$495	26.60%	1	3.10%	2.20%	4.00%	47.2	0.00%
Malawi	$4,268	13.656	115	$288	35.50%	1	0.49%	0.30%	0.68%	39	0.00%
Malaysia	$222,219	27.297	6	$8,212	13.00%	1	20.30%	36.20%	17.10%	37.9	0.00%

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Maldives	$1,259	0.345	15	$4,132	5.60%	1	0.20%	0.00%	0.40%	37.4	0.00%
Mali	$8,783	13.360	194	$686	45.00%	1	5.44%	3.40%	7.48%	39	0.00%
Malta	$8,338	0.413	7	$18,209	1.40%	1	17.10%	23.30%	14.00%	26	0.00%
Marshall Islands	$134	0.065	36	$2,547	31.70%	0	16.95%	19.10%	14.80%	-	0.00%
Mauritania	$3,161	3.032	118	$1,101	12.50%	1	3.83%	1.80%	5.86%	39	0.00%
Mauritius	$8,738	1.272	17	$7,337	4.70%	1	10.70%	12.00%	10.00%	39	0.00%
Mayotte	$954	0.224	95	$4,900	38.50%	0	2.00%	1.20%	2.80%	-	0.00%
Mexico	$1,088,128	106.316	17	$10,248	4.10%	1	17.30%	19.10%	16.30%	51.6	0.00%
Micronesia, Fed. Sts.	$238	107.434	39	$2,334	28.90%	1	14.10%	16.00%	12.20%	-	0.00%
Moldova	$6,124	3.386	17	$1,696	21.80%	1	39.86%	47.40%	32.32%	37.4	0.00%
Monaco	$976	0.033	4	$211,501	0.00%	0	1.00%	1.00%	1.00%	-	0.00%
Mongolia	$5,258	2.654	31	$1,991	18.80%	1	49.84%	60.90%	38.78%	36.6	0.00%
Montenegro	$4,822	0.672	9	$7,262	11.30%	0	11.70%	14.00%	10.50%	36.9	2.41%
Morocco	$86,394	31.436	39	$2,769	18.80%	1	12.29%	10.70%	7.90%	40.9	0.00%
Mozambique	$9,654	20.747	147	$441	24.00%	1	13.00%	1.00%	25.00%	47.1	0.32%
Myanmar	$27,182	58.799	73	$1,200	42.90%	1	10.74%	12.40%	9.08%	40	0.00%
Namibia	$8,456	2.045	50	$4,211	47.00%	1	7.90%	8.50%	7.50%	70.7	0.00%
Nauru	$60	0.014	45	$5,000	1.00%	0	1.00%	1.00%	1.00%	-	0.00%
Nepal	$12,698	27.643	51	$438	35.00%	1	5.55%	6.50%	4.60%	47.3	0.18%
Netherlands	$868,940	16.704	5	$53,076	1.90%	1	33.00%	28.00%	37.00%	30.9	0.00%
Netherlands Antilles	$2,800	0.227	12	$16,000	1.00%	0	17.70%	18.30%	17.00%	-	0.00%
New Caledonia	$3,158	0.227	13	$15,000	15.00%	0	38.80%	40.50%	37.10%	-	0.00%
New Zealand	$128,492	4.276	6	$27,599	4.50%	1	37.30%	40.50%	32.80%	36.2	0.00%
Nicaragua	$6,350	6.193	27	$1,035	17.80%	1	18.05%	8.40%	5.00%	52.3	0.00%
Niger	$5,379	13.765	167	$364	90.00%	1	0.40%	0.30%	0.50%	43.9	0.00%
Nigeria	$214,403	147.810	143	$1,370	33.40%	1	10.07%	21.00%	32.00%	42.9	0.00%
Northern Mariana Islands	$900	0.051	8	$12,500	6.20%	0	33.20%	33.20%	33.20%	-	0.00%
Norway	$456,226	4.799	4	$94,568	2.40%	1	33.50%	37.40%	30.00%	25.8	0.00%
Oman	$52,584	2.769	13	$21,649	2.10%	1	13.80%	17.70%	9.90%	32	0.00%
Pakistan	$167,640	160.500	89	$987	20.40%	1	22.90%	12.00%	25.70%	31.2	0.10%

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Palau	$164	0.021	15	$8,205	6.20%	0	40.17%	57.10%	23.24%	-	0.00%
Panama	$23,088	3.403	23	$6,821	6.20%	1	24.00%	34.50%	17.60%	54.9	0.00%
Papua New Guinea	$8,092	6.196	69	$1,218	32.80%	1	3.00%	1.00%	5.00%	50.9	0.00%
Paraguay	$16,006	6.154	23	$2,705	23.10%	1	13.50%	17.70%	10.80%	53.2	0.00%
Peru	$127,598	28.657	23	$4,477	8.50%	0	33.90%	32.30%	35.60%	50.5	0.00%
Philippines	$168,580	90.345	34	$1,844	14.70%	1	27.70%	34.40%	23.70%	44	0.00%
Poland	$525,735	38.100	7	$13,857	4.00%	0	21.50%	26.90%	17.10%	34.9	0.00%
Portugal	$244,492	10.631	4	$23,708	3.00%	1	14.10%	18.00%	10.70%	38.5	0.00%
Puerto Rico	$67,870	3.966	11	$17,100	1.00%	0	40.50%	35.00%	46.00%	-	0.00%
Qatar	$102,302	1.098	11	$86,436	0.10%	1	18.60%	32.00%	16.10%	41.1	0.00%
Romania	$199,673	21.489	13	$9,300	8.10%	1	13.30%	14.40%	12.40%	32.1	0.00%
Russian Federation	$1,676,586	142.000	13	$11,743	4.10%	1	52.50%	60.20%	44.80%	43.7	0.63%
Rwanda	$4,459	9.591	117	$458	35.00%	1	3.97%	0.10%	0.50%	46.7	0.00%
Samoa	$537	0.192	26	$3,236	11.60%	1	7.45%	10.80%	4.10%	-	0.00%
San Marino	$1,662	0.030	2	$61,223	0.10%	0	9.65%	10.80%	8.50%	-	0.00%
Sao Tome and Principe	$176	0.160	79	$1,084	14.60%	0	3.90%	4.00%	3.80%	50.6	0.00%
Saudi Arabia	$481,631	24.897	21	$19,152	3.10%	1	29.85%	37.40%	22.30%	32	0.00%
Senegal	$13,350	12.519	95	$1,079	16.00%	1	8.00%	5.60%	10.40%	39.2	0.00%
Serbia	$50,061	7.382	8	$6,647	12.30%	1	48.67%	54.00%	43.34%	28.2	3.06%
Seychelles	$834	0.082	13	$10,647	1.90%	1	3.40%	4.00%	2.80%	-	0.00%
Sierra Leone	$1,955	5.887	198	$352	49.00%	1	2.05%	1.10%	3.00%	42.5	0.00%
Singapore	$181,939	4.668	3	$39,950	0.00%	1	23.70%	24.10%	23.40%	42.5	0.00%
Slovak Republic	$95,404	5.411	7	$18,212	2.60%	1	15.10%	16.70%	13.80%	25.8	0.00%
Slovenia	$54,639	2.013	3	$26,911	2.20%	1	22.40%	26.50%	18.70%	31.2	0.00%
Solomon Islands	$473	0.523	36	$1,265	42.00%	1	5.00%	1.00%	9.00%	-	0.00%
Somalia	$277,188	48.687	180	$600	65.00%	0	3.00%	0.50%	5.50%	30	2.62%
South Africa	$1,611,767	45.618	65	$5,666	3.40%	1	13.40%	15.10%	12.00%	57.8	0.00%
Spain	$39,604	20.085	4	$35,000	3.60%	1	31.80%	36.50%	28.40%	34.7	0.00%
Sri Lanka	$96,830	21.325	15	$2,020	15.50%	1	16.50%	22.50%	12.30%	41.1	2.37%
St. Kitts and Nevis	$555	0.053	16	$11,591	3.50%	0	18.20%	20.00%	16.70%	-	0.00%
St. Lucia	$1,025	0.170	19	$5,793	5.00%	0	8.90%	9.80%	8.10%	42.6	0.00%

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St. Vincent and the Grenadines	$601	0.107	13	$5,331	10.00%	0	6.00%	6.00%	6.00%	-	0.00%
Sudan	$57,911	38.126	109	$1,404	32.90%	1	5.93%	5.70%	6.16%	51	3.15%
Suriname	$2,984	0.533	27	$5,888	10.80%	1	12.32%	15.60%	9.04%	52.8	0.00%
Swaziland	$2,843	1.022	77	$2,432	11.90%	1	4.39%	4.30%	4.48%	50.7	0.00%
Sweden	$484,550	9.179	3	$52,884	1.50%	1	29.80%	35.10%	25.10%	25	0.00%
Switzerland	$492,595	7.310	5	$65,699	1.50%	1	29.70%	22.70%	35.60%	33.7	0.00%
Syrian Arab Republic	$54,803	19.880	17	$2,649	22.50%	1	6.30%	8.80%	5.70%	42	0.00%
Taiwan, China	$392,552	23.037	9	$30,200	1.50%	0	46.00%	45.00%	47.00%	33	0.00%
Tajikistan	$5,135	6.458	64	$751	23.00%	0	10.90%	6.00%	14.50%	33.6	0.00%
Tanzania	$20,721	39.743	111	$503	27.00%	1	1.48%	1.00%	1.96%	34.6	0.00%
Thailand	$273,248	66.398	14	$4,043	11.40%	1	47.00%	49.30%	44.70%	42.5	0.00%
Timor-Leste	$499	1.065	60	$453	32.20%	0	9.81%	12.00%	7.62%	31.9	1.49%
Togo	$2,890	6.625	100	$449	40.00%	1	5.29%	0.50%	10.08%	34.4	0.00%
Tonga	$258	0.103	19	$3,349	25.00%	1	6.38%	8.00%	4.76%	-	0.00%
Trinidad and Tobago	$24,806	1.305	35	$19,443	0.50%	1	7.50%	10.60%	6.40%	40.3	0.00%
Tunisia	$40,348	10.327	21	$3,955	10.80%	1	7.70%	8.90%	6.50%	40.8	0.00%
Turkey	$729,443	69.659	22	$9,881	8.50%	1	13.10%	17.50%	11.50%	41.2	0.00%
Turkmenistan	$32,570	4.885	48	$3,374	10.70%	0	22.00%	8.00%	36.00%	40.8	0.00%
Tuvalu	$15	0.012	36	$1,600	16.60%	0	8.10%	0.93%	15.27%	-	0.00%
Uganda	$14,529	32.042	130	$456	29.00%	1	3.69%	1.70%	3.10%	42.6	0.00%
Ukraine	$179,725	45.847	16	$3,899	9.30%	0	45.20%	51.70%	39.10%	27.6	0.00%
United Arab Emirates	$260,141	4.764	8	$58,272	1.60%	1	16.60%	29.60%	14.60%	31	0.00%
United Kingdom	$2,674,085	61.073	6	$43,361	0.90%	1	31.90%	34.10%	30.00%	36	0.00%
United States	$14,264,600	304.415	8	$47,209	1.20%	1	61.10%	64.30%	58.40%	40.8	0.00%
Uruguay	$32,262	3.200	14	$9,351	9.80%	1	18.70%	24.90%	13.80%	47.1	26.66%
Uzbekistan	$27,918	27.190	38	$1,023	28.20%	0	9.87%	8.00%	11.74%	36.7	0.00%
Vanuatu	$573	0.235	17	$2,648	26.00%	1	4.77%	3.50%	6.04%	-	0.00%
Venezuela, RB	$319,443	28.050	18	$11,150	3.60%	1	78.10%	72.00%	84.20%	43.4	0.00%

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Vietnam	$89,829	86.345	24	$943	19.00%	1	9.68%	8.20%	11.16%	37.8	0.00%
Virgin Islands (U.S.)	$1,577	0.110	10	$14,500	1.00%	0	45.00%	18.91%	71.09%	-	0.00%
West Bank and Gaza	$12,610	2.461	25	$1,123	8.00%	0	22.40%	27.40%	17.40%	-	0.00%
Yemen, Rep.	$27,151	22.978	70	$1,175	9.40%	1	10.23%	7.40%	16.60%	37.7	0.44%
Zambia	$14,323	12.450	145	$1,165	16.70%	1	2.40%	1.50%	3.30%	50.7	0.00%
Zimbabwe	$332	11.393	93	$274	18.10%	1	3.80%	2.90%	4.70%	50.1	0.00%
Mean	$289,203	33.440	43.6840	$15,764	14.57%	0.7736	19.479%	20.627%	18.672%	32.6388	0.43%
Standard Deviation	$1,158,894	126.707	50.8017	25712.51	0.15	0.4195	16.180%	17.734%	16.169%	18.1347	2.13%
Min	$14.94	0.012	2.0000	$145	0.00%	0.0000	0.200%	0.000%	0.400%	0.0000	0.00%
Max	$14,264,600	1,327.658	209.0000	$211,501	90.00%	1.0000	84.000%	89.300%	85.000%	70.7000	26.66%