World Journal of Social Science Research
ISSN 2375-9747 (Print) ISSN 2332-5534 (Online)
Vol. 3, No. 2, 2016
www.scholink.org/ojs/index.php/wjssr

Choking on Structural Adjustment: Dependency and Exposure to Indoor Air Pollution in Developing Countries

Kelly F. Austin[1*] & Kellyn McCarthy[2]

[1] Sociology and Anthropology & Health, Medicine and Society, Lehigh University, Bethlehem, PA, USA

[2] Sociology and Anthropology, Lehigh University, Bethlehem, PA, USA

[*] Kelly F. Austin, E-mail: kellyaustin@lehigh.edu

Abstract

Indoor air pollution represents a global health crisis, leading to 4.3 million deaths annually. Despite widespread variation in solid fuel burning across developing nations, little is known about the large scale socio-economic causes. We draw on theories of political-economy to consider the role of economic, social, and environmental predictors on solid fuel use, with a special focus on structural adjustment, debt service, and agricultural production. Utilizing a sample of 75 developing nations, we find that these economic dependencies increase solid fuel use. Thus, current neoliberal development strategies enhance vulnerabilities to indoor air pollution for millions of people in impoverished nations.

Keywords

development, structural adjustment, solid fuel, indoor air pollution, political-economy, debt

1. Introduction

Despite overwhelming global health attention to issues such as child mortality, tuberculosis and HIV in less-developed nations, few recognize that at least 4.3 million people die every year from exposure to indoor air pollution (WHO, 2014). In fact, the World Health Organization includes household air pollution as one of the ten most important threats to public health (WHO, 2007). Harmful exposure to indoor air pollution is attributed to the burning of solid fuels, such as wood, charcoal, dung and crop residues. Burning these materials results in the release of pollutants such as benzene, carbon monoxide, nitrous oxides, polycyclic aromatic hydrocarbons, and other carcinogens into the air (WHO, 2002, 2010). These toxins directly contribute to a variety of health problems, including pneumonia, stroke, heart disease, Chronic Obstructive Pulmonary Disease (COPD), and lung cancer (Bruce, Perez-Padilla, & Albala, 2002; WHO, 2014). The majority of deaths and disease from indoor air pollution remain concentrated in less-developed nations, as impoverished populations are more likely to use solid fuels to cook and to heat their homes in poorly ventilated rooms (Bruce et al., 2002; WHO, 2007, 2014).

For example, in some nations, particularly in Sub-Saharan Africa and some parts of Asia, over 95% of

the population relies on solid fuels. Examples include Rwanda, Uganda, and Laos. However, in nations such as Ecuador, Djibouti and South Africa, less than 15% of the population uses solid fuels (WHO, 2014). The strong mapping of global development trends on solid fuel use speaks to the probable relevance of political-economic factors in shaping exposure to household air pollution. Indeed, while a wide and growing medical literature documents the risks and harmful consequences of burning solid fuels, much less is known about what might lead some populations to utilize more solid fuels than others. While poverty is most often implicated as a key determinant of biomass burning in many household-level studies (Boadi & Kuitunen, 2005; Hoiser, 2004; Jin et al., 2006), macro-level factors related to economic dependency potentially underlie these trends.

Perspectives in the field of global sociology debate the role of recent development strategies, such as structural adjustment policies, in inciting advancement and well-being (e.g., Oppong, 2013). While some contend that structural adjustment policies increase economic growth and improvements in welfare, others suggest that these reforms have led to economic, environmental, and health declines (e.g., Austin, 2015; McMichael, 2012; Pandolfelli, Shandra, & Tyagi, 2014). The relationship between economic austerity measures and use of solid fuels remains unexamined, despite that many of the aspects of structural adjustment policies, such as currency devaluations, job losses in the public sector, or privatization could impact people's ability to acquire cleaner, safer, and more efficient fuels (e.g., Babb, 2005).

Use of solid fuels represents an important sociological issue because vulnerable and marginalized groups, including poor, non-white, women and children are most likely to suffer the potential negative health consequences (WHO, 2014). Despite extensive differences in reliance on solid fuels across developing nations, little is known about the broader, structural predictors of this damaging activity. Indoor air pollution represents a severe environmental health threat that goes largely unrecognized and is neglected in global health policy and international aid efforts, as well as among social scientists (WHO, 2009). Although diseases such as HIV/AIDS have garnered overwhelming attention in recent years (WHO, 2009), household air pollution leads to more deaths per year than the top five infectious diseases combined, including HIV, TB and malaria (WHO, 2014). Certainly, a deeper understanding of the large-scale, socio-economic causes of solid fuel use is greatly needed.

In this paper, the goal is to begin to examine the association between IMF structural adjustment and reliance on solid fuels using cross-national data on a sample of 75 less-developed nations. We additionally consider the role of a variety of economic, social, and environmental influences, including the level of economic development, health resources, urbanization and availability of forest resources, in order to examine the other potential factors impacting solid fuel use. Drawing on relevant theories of global inequality and development, we also take a particular focus on engaging aspects of political-economy to employ theoretically-informed insights on structural adjustment, multilateral debt service and specialization in agriculture.

1.1 Solid Fuel Use in Developing Countries

Around 3 billion people globally cook and heat their homes using open fires and simple stoves, burning solid fuels such as wood, animal dung, crop waste, and coal. Harmful toxins released into the air when burning solid fuels include benzene, carbon monoxide, particulate matter, dioxins, and polycyclic aromatic hydrocarbons (Bruce et al., 2002; WHO, 2014). Because most kitchens and cooking huts in developing nations offer little or no ventilation, the concentrations of these toxins can be much higher than typical standards (WHO, 2014). For example, overall in comparison to gas stoves, the use of solid fuels emits about 50 times more particulate matter, carbon monoxide and hydrocarbons when cooking an equivalent meal (Bruce et al., 2002; WHO, 2014). Using particular solid fuels like dung or crop residues emits particulate matter and pollutants that exceed the World Health Organization's recommended levels by factors of 10, 20, or more with serious health consequences for those exposed (WHO, 2014).

Among populations in the developing world who burn solid fuels, women and children are most vulnerable to exposure to harmful pollutants (WHO, 2014). In less-developed countries, women are usually responsible for cooking and tending the home, and children accompany and help their mothers during cooking and other chores (Boadi & Kuitunen, 2005; WHO, 2010, 2014). These gendered social roles cause women and children to spend a disproportionate amount of time near solid-fuel burning stoves and fires and face exposure to harmful toxins. In fact, estimates suggest that of all deaths related to indoor air pollution, 59% are among females and 56% are among children under 5 years of age (WHO, 2014). The disproportionate effects of solid fuel burning on females and young children add to the complexity of indoor air pollution and make it a gendered social issue.

Reflecting these trends, a recent investigation by Burke and Dundas (2015) find that increases in women's participation in the workforce leads to less solid fuel burning. Earning an income can enhance the ability to pay for fuels, as well as time away from household tasks for women (e.g., Banik, 2010; Jin et al., 2006). In addition to gender dynamics, a number of studies conducted at the individual or household level suggest that one of the most important predictors of solid fuel use is poverty (Boadi & Kuitunen, 2005; Hoiser, 2004; Jin et al., 2006). Impoverished households are much more likely to rely on the natural environment or crop residues as sources of fuel, or purchase wood or other products cheaply. In general, as the economic status of a household improves, so does the ability of households to purchase or obtain cleaner sources of energy. In other words, increases in household income can lead to climbs up the "energy ladder" (e.g., Burke, 2013; Link et al., 2012; Heltberg, 2004; Pandey & Chaubal, 2011). Similarly, a relatively small body of research conducted at the national level highlights that as GDP per capita increases, use of solid fuels decreases (e.g., Burke, 2013; Knight & Rosa, 2012).

In addition to economic factors, education represents an important predictor of solid fuel use. Access to education provides better opportunities to gain income and potential knowledge of harmful consequences of indoor air pollution (Banik, 2010; Boadi & Kuitunen, 2005). Indeed, a

household-level assessment by Boado and Kuitunen 2005 find that people lacking education have higher levels of exposure to indoor air pollution. It is important to emphasize that the level of knowledge about the negative health consequences of indoor air pollution tends to be fairly low overall among people in developing nations, even among health workers and physicians (e.g., Matinga et al., 2013).

Urbanization may also represent an important predictor of solid fuel use, as more urbanized nations tend to have lower levels of household biomass energy consumption (Knight & Rosa, 2012). One possibility is that rural households inherently live closer to solid fuel sources, such as wood, animal dung and crop wastes. There are also strong links between rurality, poverty and low education levels; thus some of these factors may combine to lead to high reliance on solid fuels in rural, impoverished nations.

While prior research demonstrates that economic development, education and rurality are key predictors of biomass burning, there has been little sociological research on the other potential macro-level causes that lead some populations to burn more solid fuels than others. Within the field of comparative sociology, scholarship increasingly focuses on examining the impacts of political-economic development strategies on a variety of health, environment and social outcomes (e.g., Austin, 2015; Jorgenson, Dick, & Austin, 2010; Pandolfelli et al., 2014; Shandra, C. L., Shandra, J. M., & London, 2011). In particular, garnering debt, undergoing structural adjustment and increasing specialization in agricultural production represent strategies that are intended to motivate successful development in poorer nations. However, careful investigation of these factors begins to suggest that these forms of economic integration may actually represent economic dependencies and increase use of harmful solid fuels. We now originate an in-depth look at these themes through the engagement of modernization and world-systems/dependency perspectives.

1.2 The Political Economy of Solid Fuel Burning

Substantial evidence demonstrates that poorer nations have the highest levels of indoor air pollution (Burke, 2013; Knight & Rosa, 2012; WHO, 2014). However, perspectives on global inequality and development differ as to the causes of underdevelopment in developing nations, as well as the solutions. One body of work based on processes of modernization emphasizes that economic growth is central to development, and that all nations are on a path to advancement (e.g., Rostow, 1960). Economic growth and development lead to improvements in social and physical well-being, which would include transitioning to cleaner fuel use. Current applications of modernization theory emphasize that poorer nations should adopt neoliberal or Washington Consensus models in order to spur economic growth and activity (e.g., McMichael, 2012). Common policies include market liberalization, the reduction of trade tariffs, and privatization as means to development (Babb, 2005). Structural adjustment policies represent a key example of such initiatives, and were first instituted following the debt crisis of the 1980s by institutions such as the International Monetary Fund (IMF) as a means to help poor nations

manage their debt. The underlying logic behind structural adjustment or austerity reforms involves an attempt to intensify economic growth and stimulate currency for debt repayment and overall development by increasing production and exports and decreasing state spending. These policy reforms include devaluing currency, reducing government spending, liberalizing trade and privatizing government programs (Peet, 2003; McMichael, 2012).

Developmental approaches rooted in ideas of modernization fundamentally argue that all underdeveloped nations can advance and reduce reliance on harmful solid fuels by adopting these neoliberal strategies to grow economically (e.g., Rostow, 1960). Some current work suggests that developing nations that have undergone structural adjustment are more integrated into trade networks; this could translate into increased access to safer fuels and more efficient cooking technologies (e.g., Oppong, 2013). Some examples from China and other areas of Asia where air pollution is an especially acute problem demonstrate that some structural adjustment programs are specially targeted to the energy sector to popularize cleaner fuels (ADB, 2012). However, the extent to which this might apply to indoor air pollution in other contexts is unclear. Nonetheless, many structural adjustment policies and development schemes also indirectly lead to increased urbanization, and urban populations tend to have notably lower rates of solid fuel burning (WHO, 2014). Overall, the argument that structural adjustment policies lead to economic growth implies that trickle-down effects on household incomes that will increase use of clean fuels (Oppong, 2013).

While there are some important arguments to be made in favor of structural adjustment policies in reducing reliance on solid fuels, critical approaches deeply question the overall efficacy of structural adjustment and other neoliberal reforms in developing nations. These critiques are rooted in dependency and world-systems perspectives which describe that international inequality, and therefore persistent poverty in poor nations, is central to the functioning of the global economic system (e.g., Amin, 1976). This branch of work emphasizes that unequal international economic relationships maintain the core-periphery hierarchy, constantly reproducing global inequalities (Amin, 1976; Bunker, 1985; Emmanuel, 1972; Frank, 1967; Wallerstein, 1974, 2004). Unlike modernization approaches, successful development is not possible in poor nations according to this body of theory, as patterns in international lending and capitalist development benefit core nations' interests at the expense of poorer, more peripheral nations. Unequal economic relationships facilitated through structural adjustment policies allow core nations to become wealthy by exploiting cheap labor and the natural resources of poor nations, and these also keep poor nations in dependent economic positions (Amin, 1976; Bunker, 1985; Emmanuel, 1972; Rice, 2007).

Unequal exchanges manifest through the international division of labor, where core nations, with their focus on the production of high-value commodities and a highly diversified portfolio of high-value exports and trading partners, have a significant advantage over periphery countries (McMichael, 2012; Rice, 2007; Wallerstein, 1974, 2004). In contrast, poorer, peripheral nations specialize in cheaper,

lower-skill commodities, produce few products (frequently from the primary sector), and have limited trading partners. These patterns trace back to the colonial beginnings of capital accumulation, wherein core nations drained the colonies of their resources and established export plantations (Amin, 1976; Bunker, 1985; Emmanuel, 1972; Frank, 1967). The wealth that was reaped from the colonies funded industrialization in Europe, and affluent nations have used their advantaged positions to maintain international economic programs which allow the most profitable, innovate industries to remain concentrated in the core (McMichael, 2012; Rice, 2007).

A strong emphasis on producing low-value agricultural and raw materials in periphery nations remains under the modernization-based doctrine of "comparative advantage". Many poor nations are located in warm climates, allowing for longer growing seasons or the production of desired commodities not suitable for more temperate climates, such as coffee or cocoa (e.g., Austin, 2010, 2012; McMichael, 2012). Thus, it is more efficient for developing nations to produce these primary commodities for which they have a "niche" in the global market. However, dependency-based ideas illustrate that these primary sector commodities that poor nations produce are not actually very highly valued on the world market (due to a number of factors, such as farm subsidies in the U.S. that drive down the prices of agricultural commodities, high levels of competition with other primary producers in other developing nations, etc.), and have lower labor costs and skill requirements; thus, surplus profit is accrued in core countries through unequal international trade relationships and poor nations remain entrenched in poverty (Wallerstein, 2004).

Dependency/world systems approaches highlight that indoor air pollution is so highly concentrated in periphery nations due to persistent poverty created by the global economic hierarchy, as well as the neoliberal strategies currently used to attempt to increase economic activity in poorer nations. Rather than inciting development, the policy reforms required under structural adjustment programs are likely to further impair developing nations from this perspective. Although structural adjustment loans are designed to resolve the balance-of-payment issues by rescheduling loan payments and renegotiating loan terms (Babb, 2005), many nations continue to remain entrenched in debt or have been issued new loans as a part of the structural adjustment program (McMichael, 2012). A number of comparative studies demonstrate that structural adjustment policies are linked to negative health, social, environmental, and economic outcomes (e.g., Austin, 2015; Bradshaw & Huang, 1991; Coburn, Restivo, & Shandra, 2015; Maynard, Shircliff, & Restivo, 2012; Mohan, 2001; Pandolfelli & Shandra, 2013; Pandolfelli et al., 2014; Shandra et al., 2011; Shandra, Shor, Maynard, & London, 2008). For example, Pandolfelli and colleagues (2014) find that IMF conditionality contributes to maternal mortality by cutting government funds to healthcare and hospitals, leaving women vulnerable to diseases that complicate pregnancy and increase maternal mortality. Additionally, high levels of debt service often take away resources for other basic programs, such as education and healthcare (Austin, 2015; McMichael, 2012), and also have been linked to declines in well-being (e.g., Bradshaw & Huang,

1991; Shandra, J. M., Shandra, C. L., Shircliff, & London, 2010).

There are several ways in which structural adjustment policies and generating revenue for debt servicing potentially enhance solid fuel burning in developing nations. First, structural adjustment reforms require that governments promote economic activity that is compatible with each nations' "comparative advantage" (Peet, 2003). As described above, in periphery nations, often this involves an increase in the production and export of agricultural items. Expansion of crop lands may provide fuel wood fuel for farming or subsistence households, and crop residue itself is also commonly used as fuel (WHO, 2014). Thus an increase in agricultural production may lead to enhanced exposure to indoor air pollution as more material for burning is readily available.

Second, one of the most common strategies of structural adjustment and debt repayment involves currency devaluations. Currency devaluations can increase demand for a nation's exports on the world market by lowering prices (Mohan, 2001). However, imports and other commodities become more expensive. Thus, currency devaluations can greatly upset the purchasing power of citizens for basic goods (e.g., McMichael, 2012), including safer, efficient cooking fuels. Increases in the price of cleaner fuels can encourage poor households to utilize solid fuel sources that tend to be much cheaper or freely available. Additionally, increases in costs for other items, such as medicines, household goods, or food products, may encourage people to use readily-available or cheaper solid fuels to offset the price increases of other commodities due to currency devaluations.

Third, structural adjustment loans and debt repayments usually require deep cuts in government spending in an effort to "earn more and spend less" (McMichael, 2012). Many governments are forced to eliminate staffing and budgets for land conservation and environmental protection agencies (Barbosa, 2001; Tockman, 2001). Decreased monitoring leads to increased foraging and scavenging, making wood an inexpensive and attainable fuel source for local populations.

Fourth, structural adjustment loans can require governments to privatize land and public services, such as schooling, healthcare, and sanitation. These factors can increase poverty among vulnerable populations in a variety of ways. Reduced access to land compromises incomes for many rural people. Privatization of services usually results in enhanced user fees or increasing the costs of services. Additionally, job cuts and layoffs in the public sector are common, leading to unemployment and the loss of steady incomes. Such a strain on household incomes and revenue can promote reliance on cheap or readily available solid fuels as a livelihood strategy.

In summary, modernization and critical approaches differ in their perspectives on structural adjustment policies. Both bodies of theory acknowledge that austerity measures encourage governments to adopt strategies that may generate some economic growth. Indeed, modernization theory argues that the adoption of structural adjustment programs, repayment of debt, and increased exports are central to eliminating underdevelopment and creating economic growth. Increased growth could translate into higher incomes, increasing the purchasing power for cleaner, safer fuels. Also heightened trade

integration and investments in the energy sector could make alternative fuels more widely available.

However, ideas rooted in dependency afford that economic growth achieved through austerity does not benefit the masses, and rather is at the expense of vulnerable populations. Increased relative poverty through currency devaluations, privatization, and other outcomes may actually lead to increased use of solid fuels as the most affordable and accessible fuel source. In addition to providing a critique of structural adjustment programs, world-systems/dependency perspectives highlight that the structure of the world-economy promotes specialization in agriculture in poorer nations. Since debt servicing and structural adjustment policies often emphasize increasing comparative advantages, these forms of dependency likely combine to increase the availability of crop refuge and other material for burning in poor nations. In these ways, a variety of forms of economic dependency are potentially important in explaining why some populations have greater reliance on harmful solid fuels than others.

This study seeks to empirically scrutinize the association between economic dependencies and solid fuel use in order to begin investigation on how current economic trends and developmental strategies promoted by agencies such as the IMF impact exposure to harmful indoor air pollution in poorer nations.

2. Method

2.1 Predictions

Based on the divergent theoretical assumptions, our key predictions represent two opposing hypotheses. Drawing on modernization approaches, we (H1) hypothesize that structural adjustment policies are associated with decreases in solid fuel use across nations, where less-developed nations undergoing structural adjustment tend to have lower rates of solid fuel use in comparison to less-developed nations no under structural adjustment.

Drawing on dependency/world-systems insights, we (H2) hypothesize that structural adjustment policies are associated with increases in solid fuel use across nations, where less-developed nations undergoing structural adjustment tend to have higher rates of solid fuel use in comparison to less-developed nations no under structural adjustment. In addition to structural adjustment programs, we draw on dependency frameworks to also hypothesize that servicing debt to multinational organizations, like the IMF, increases use of solid fuels and biomass burning, as repaying debts and strategies to increase debt repayment take away resources that could be used to increase household economic well-being or access to cleaner fuels.

As previously described, modernization and dependency theories also present contrasting influences of poorer nations' specialization in agricultural production and export. Modernization approaches would promote realization of comparative advantages, and therefore not see this as a factor that would increase solid fuel use, and instead, would likely even do the opposite as rural incomes benefit from increased production. However, dependency scholars note the persistence of poverty among

agriculture-based economies. Fundamentally, crop wastes represent a very common type of solid fuel source, especially among rural households, and it is likely that strong specialization in agriculture enhances the availability of biomass for burning. We therefore hypothesize a positive relationship between specialization in agriculture and dependence on solid fuels.

We also draw on conventional understandings of development to predict that increasing levels of economic development and economic growth in developing nations result in a reduction in the use of solid fuels, as poverty often is cited as a key predictor of exposure to indoor air pollution in household-level studies. As household air pollution represents a major public health threat, it is likely that access to health resources is important in explaining cross-national trends in solid fuel use. We therefore predict that nations with more doctors and health workers will have lower rates of exposure to solid fuels. In addition, we hypothesize that schooling and urbanization represent developmental factors that also negatively influence the level of solid fuel use. Given that women are most responsible for household duties, we predict that participation in secondary schooling among females could represent an especially important factor influencing solid fuel use in developing nations.

We also consider the role of demographic trends and environmental conditions. We predict that population growth, and particularly rural population growth, will be important in leading to increases in solid fuel in developing nations. Availability of wood may also condition use of solid fuels, as firewood is the most common solid fuel source. We thus predict that nations with larger forests will have heightened levels of solid fuel use. Lastly, basic examinations of the data suggest that Sub-Saharan African countries may be more reliant on solid fuels, and also represent the most underdeveloped areas of the world-system. We therefore hypothesize that nations located in Sub-Saharan Africa will have higher rates of solid fuel use than other nations.

2.2 Sample

The sample utilized includes less-developed nations with available data for all indicators included in the analyses. Due to the focus on predictors of political-economy, namely structural adjustment policies that are not instituted in high-income countries, we restrict our analyses to less-developed nations. This results in a sample of 75 nations, which are listed in Table 1 below.

2.3 Estimation Technique

Our research agenda seeks to provide a preliminary investigation of the association between IMF structural adjustment and solid fuel use, in order to understand how austerity measures impact an important dimension of basic well-being in developing nations. In order to gain insight into the cross-national predictors of solid fuel use in developing nations, we utilize OLS regression. OLS regression serves well as a basic method and good starting point for analysis of this under-studied phenomenon and is one of the most widely used methods in comparative research on health and environment outcomes (e.g., Austin & Noble, 2014; Jorgenson et al., 2010; Shircliff & Shandra, 2011; Shandra et al., 2010) (Note 1). In analyzing the data, we use the statistical program STATA. This

program offers regression analysis, as well as the appropriate diagnostic functions for testing adherence to OLS regression assumptions (Note 2). In order to help adhere to conditions of causality, in this study all independent variables are measured during 2010 or 2011 (based on data availability) and the dependent variable of solid fuel use is measured for the year 2013. The time ordering for variables such as structural adjustment and debt service is also substantively important, as it may take several months for these types of reforms to impact solid fuel use.

2.4 Dependent Variable

Our dependent variable is Percent of the Population Using Solid Fuels in 2013. This variable reports what percentage of the population in a given country uses solid fuels, including wood, dung, crop wastes and coal, to cook and heat their homes. This data was obtained from the Global Health Observatory, the data repository of the World Health Organization (WHO, 2015).

2.5 Independent Variables

IMF Structural Adjustment: We utilize data from the IMF Database (2012) to measure whether or not a nation was undergoing structural adjustment from the IMF during the year 2010. IMF structural adjustment represents a dummy variable, where nations under an IMF-imposed structural adjustment program during the year 2010 are coded with a 1 and all other nations are coded with a 0.

Multilateral Debt Service: We use of a measure of debt service to multilateral institutions to maintain a focus on development institutions like the IMF (Note 3). The measure of multilateral debt service captures debt payments to supranational organizations of the IMF and World Bank as a percent of GDP for the year 2010 (World Bank, 2015). This measure was highly skewed and therefore was log-transformed to prevent the influence of extreme outliers.

Percent GDP from Agriculture: To measure specialization in the agricultural sector, we employ a measure of percent GDP from agriculture, which captures the contributions from forestry, the cultivation of crops, and livestock production to the national economy. This variable was measured for the year 2010 (World Bank, 2015).

Table 1. Nations Included in the Analyses (N = 75)

Afghanistan	Ghana	Nicaragua
Algeria	Grenada	Niger
Angola	Guatemala	Nigeria
Armenia	Guinea	Pakistan
Azerbaijan	Guyana	Panama
Bangladesh	Honduras	Paraguay
Belarus	India	Peru
Belize	Indonesia	Romania
Benin	Jamaica	Rwanda

Bhutan	Jordan	Samoa
Bolivia	Kazakhstan	Sao Tome and Principe
Bulgaria	Lebanon	Senegal
Burkina Faso	Lesotho	Serbia
Burundi	Liberia	Seychelles
Cabo Verde	Malawi	Sri Lanka
Central African Republic	Malaysia	Swaziland
Chad	Mali	Tajikistan
China	Mauritania	Thailand
Colombia	Mauritius	Togo
Costa Rica	Mexico	Tonga
Dominica	Mongolia	Tunisia
Dominican Republic	Montenegro	Turkey
Ecuador	Morocco	Ukraine
El Salvador	Mozambique	Uzbekistan
Fiji	Nepal	Zimbabwe

GDP Per Capita: To assess the influence of economic development, we include GDP per capita. This represents the total annual output of a country's economy divided by its population, measured in current international dollars for the year 2010 (World Bank, 2014). More specifically, GDP per capita is the total market value of all final goods and services produced in a country in a given year, equal to total consumer, investment, and government spending, divided by the mid-year population. It is converted into current international dollars using Purchasing Power Parity (PPP) rates, providing a standard measure allowing for comparisons of real price levels between countries (World Bank, 2015).

GDP Growth Rate: To measure economic growth, we calculate the average annual percent change in GDP per capita from 2010 to 2012 using data on GDP per capita PPP measured in current international dollars from 2010 and 2012 (World Bank, 2015).

Number of Physicians: The number of physicians accounts for the number of physicians or trained health care professionals in a given nation per 1,000 people. This variable provides a good estimate of the primary health resources that are available to a population and is measured for the year 2010 (World Bank, 2015).

Percent Urban: We measure the level of the rural vs. urban population by including a measure of percent urban, which is the percent of the population living in urban areas. Using data from the World Bank (2015), any household that is not urban is considered rural. This variable was measured for the year 2010.

Secondary School Enrollment: Secondary school enrollment represents a gross enrollment ratio of total

enrollment, regardless of age, to the age group that officially corresponds to secondary level education. We measure participation in secondary schooling for the year 2010 (World Bank, 2015).

Female School Enrollment: To measure female participation in schooling, we use a measure of female secondary school enrollment, which is the gross enrollment ratio of total enrollment, regardless of age, to the female population of the age group that officially corresponds to secondary level education, for the year 2010 (World Bank, 2014).

Population Growth: To account for population pressure, we include a measure of annual population growth rate for the total population for the year 2010 (World Bank, 2015).

Rural Population Growth: As rural populations are much more likely to be dependent on solid fuel sources, we also examine the role of population growth specifically in rural areas. This variable is measured as the annual population growth rate for the rural population in a country for the year 2010 (World Bank, 2015).

Forest Area: Forest Area measures forest area as a percentage of the total land area in a given country. It includes natural or planted rows of trees that comprise at least 5 meters of land standing together and excludes trees in parks and trees used in manufacturing sites. The variable is measured for the year 2010 (World Bank, 2015) and was log-transformed to prevent the influence of extreme outliers.

Sub-Saharan Africa: We measure location in Sub-Saharan Africa as a dummy variable where countries in Sub-Saharan Africa are coded with a value of one and countries not in Sub-Saharan Africa are coded with a value of zero (Note 4).

3. Results

Table 2 displays the correlation matrix for all of the variables used in the analyses. The high levels of intercorrelation between some of the independent variables suggest that the models should be constructed with caution, as inattention could cause multicollinearity to bias the results. To help circumvent this issue, a limited number of predictors is added to the baseline indicators in each model in a stepwise fashion before investigating more saturated models, and certain variables that have a very high level of association (such as female schooling and total schooling, and rural population growth and total population growth), are never included in the same model together.

Table 3 presents the univariate statistics for all variables included in the models for the sample of 75 less-developed nations. Of particular relevance, the average level of solid fuel use across the sample is 43.8%, and about 48% of nations were under a structural adjustment policy from the IMF in 2010.

Table 4 presents OLS regression results predicting solid fuel use in developing nations. IMF structural adjustment, multilateral debt service, and percent GDP from agriculture are included in the baseline as key independent variables of interest, capturing aspects of economic dependency. Additionally, GDP per capita is included in every model as an important control for level of economic development. Additional predictors are added in a step-wise fashion to help reduce potential issues with

multicollinearity.

Overall, the results presented in Table 4 demonstrate that IMF structural adjustment policies have a significant positive association with solid fuel burning across less-developed nations, net of other factors. In other words, developing nations that are undergoing structural adjustment tend to have higher levels of solid fuel use in comparison to other nations not facing austerity measures. This finding confirms the second key hypothesis rooted in dependency perspectives, and discredits the first key hypothesis rooted in modernization approaches. In Model 1, the unstandardized regression coefficient for IMS structural adjustment is about 15.47; this means that on average (and net of other factors), solid fuel use in nations undergoing structural adjustment reforms is about 15.5 percentage points higher than in nations not under a structural adjustment agreement.

Table 2. Correlation Matrix

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1. Percent Using Solid Fuels	1.0													
2. IMF Structural Adjustment	.49	1.0												
3. Multi-lateral Debt Service (ln)	.45	.20	1.0											
4. Percent GDP Agriculture	.77	.33	.37	1.0										
5. GDP per capita	-.77	-.41	-.51	-.73	1.0									
6. Number of Physicians	-.67	-.17	-.19	-.54	.61	1.0								
7. Percent Urban	-.68	-.16	-.39	-.59	.60	.60	1.0							
8. GDP per capita Growth	.16	.16	-.01	.03	-.06	.01	.04	1.0						
9. Secondary Schooling	-.68	-.37	-.17	-.62	.57	.62	.44	.10	1.0					
10. Female Secondary Schooling	-.68	-.38	-.17	-.63	.55	.59	.45	.09	.99	1.0				
11. Pop. Growth Rate	.62	.32	.27	.60	-.62	-.50	-.38	.09	-.67	-.69	1.0			
12. Rural Pop. Grow Rate	.58	.26	.41	.60	-.59	-.42	-.61	-.05	-.55	-.57	.77	1.0		
13. Forest Area (ln)	.11	.12	-.21	.13	-.05	-.05	.13	.30	-.12	-.15	.19	-.02	1.0	
14. Sub-Saharan Africa	.63	.40	.23	.53	-.43	-.54	-.44	.03	-.69	-.68	.49	.47	-.09	1.0

In the saturated model presented in Model 6 of Table 4, the coefficient for structural adjustment dips to 11.28, still suggesting a difference of over 11 percentage points in solid fuels use between nations who

have adopted IMF austerity measures and those who have not, holding all other factors constant.

In addition to structural adjustment, the results presented in Table 4 further suggest that multilateral debt service and specialization in agriculture enhances reliance on solid fuels and, therefore, exposure to indoor air pollution in developing nations. Specialization in agriculture has particularly robust impacts on indoor air pollution; close examination of the size of the standardized regressions across the models reveals that agricultural production has the largest influence on solid fuel overall. This further confirms central propositions of dependency/world-systems theory.

Table 3. Univariate Statistics

Variable	Mean	Standard Deviation
Percent Using Solid Fuels	43.8	35.13
IMF Structural Adjustment	0.48	0.50
Multilateral Debt Service (ln)	3.77	0.75
Percent GDP Agriculture	17.12	11.98
GDP per capita	3974.51	3116.52
Number of Physicians	1.11	1.09
Percent Urban	48.49	19.18
GDP per capita Growth	4.72	3.12
Secondary Schooling	71.57	24.75
Female Sec. Schooling	71.41	27.25
Population Growth Rate	1.51	1.15
Rural Pop. Growth Rate	0.57	1.49
Forest Area (ln)	9.98	2.26
Sub-Saharan Africa	0.31	0.46

The influence of GDP per capita is also fairly consistent and in the expected direction. Models 1-5 in Table 4 suggest that GDP has a modest, negative influence on solid fuel use, where developing nations with a higher GDP per capita have reduced dependence on solid fuels in comparison to nations with a lower GDP per capita. However, the significant influence of GDP per capita on solid fuels diminishes in the saturated model, Model 6. This perhaps suggests that other factors, such as schooling and living in an urban area, are more proximate in explaining cross-national variability in solid fuel use.

Model 1 includes the number of physicians in the baseline predictors. As expected, we find that the number of physicians has a large impact on solid fuel use, where developing nations with more

physicians have much lower rates of solid fuel use. The formidable impact of physicians on exposure to indoor air pollution remains consistent in the subsequent models in which it is included.

Model 2 adds predictors for percent urban and GDP growth. As expected, urbanization greatly reduces solid fuel use, and consequently nations with large rural populations tend to have higher rates of solid fuel use. Somewhat surprisingly, the results reveal that GDP per capita growth is associated with increases in solid fuel use, where nations experiencing high levels of economic growth tend to have greater exposure to indoor air pollution in comparison to developing nations with low levels of economic growth. This represents an important finding that contradicts basic ideas about modernization and growth.

Model 3 includes the baseline predictor and measures for secondary schooling and population growth, and Model 4 includes the baseline predictors with measures of female schooling and rural population. We find that the total population growth rate and the rural population growth rate have no significant impact on solid fuel use across developing nations. However, results presented in Table 4 illustrate the importance of education and women's participation in education in reducing the use of solid fuels. Models 4 and 5 demonstrate that total participation in secondary school and female participation in secondary school are negatively associated with solid fuel use, respectively. A comparison of the size of the standardized regression coefficients demonstrates that the effects of education for women may be slightly more important in reducing exposure to indoor air pollution; this fits with gendered perspectives discussed earlier.

Table 4. OLS Regression Predicting Solid Fuel Use

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
	.222***	.220***	.185*	.150*	.161*	.159**
IMF Structural Adjustment	15.47	15.15	10.39	10.25	11.29	11.28
	(4.45)	(4.21)	(5.02)	(5.12)	(4.78)	(4.21)
	.130*	.107*	.117^{+}	.120^{+}	.140*	.117*
Multilateral Debt Service	6.05	4.99	5.43	5.54	6.48	5.43
	(2.52)	(2.38)	(2.89)	(3.12)	(2.59)	(2.31)
	.372***	.315***	.324***	.317***	.295***	.233**
Percent GDP from Agriculture	1.09	.954	.949	.929	.864	.682
	(.182)	(.148)	(.246)	(.260)	(.209)	(.201)
	-.148^{+}	-.106^{+}	-.262*	-.258**	-.192*	-.127
GDP per capita	-.002	-.001	-.003	-.003	-.002	-.001
	(.000)	(.000)	(.001)	(.001)	(.001)	(.001)

	-.319***	-.260***			-.245***	-.171*
Number of Physicians	-10.30	-8.39			-7.91	-6.54
	(2.85)	(2.95)			(3.10)	(3.06)
		-.194**				-.192**
Percent Urban		-.356				-.352
		(.131)				(.131)
		.119*				.141*
GDP Growth Rate		1.34				1.59
		(.628)				(.606)
			-.229*			
Secondary Schooling			-.325			
			(.149)			
				-.275*		-.158*
Female Secondary Schooling				-.329		-.203
				(.140)		(.101)
			.040			
Population Growth			1.22			
			(2.81)			
				-.016		
Rural Population Growth				-.381		
				(1.97)		
					.076	
Forest Area					1.18	
					(.907)	
					.172*	.076
Sub-Saharan Africa					12.98	5.80
					(5.76)	(5.76)
R^2	.7827	.8136	.7580	.7573	.7994	.8329
Highest VIF	2.78	3.04	3.00	2.84	3.13	3.33
Mean VIF	1.97	1.92	2.07	2.04	2.03	2.10

Notes. *** $p < .001$, ** $p < .01$, * $p < .05$, $^{+}$ $p < .10$ (two-tailed tests); standardized coefficients flagged for statistical significance; the second number is the standardized regression coefficient; and standard errors are reported in parentheses.

Model 5 takes into account additional environmental and locational factors of availability of forest

resources and Sub-Saharan Africa in combination with the baseline predictors and the number of physicians; the results suggest that forest size does not significantly impact solid fuel use, however, nations located in Sub-Saharan Africa tend to have higher levels of solid fuel burning.

Model 6 represents a more saturated model, including the baseline indicators, as well as all measures found to be significant in predicting solid fuel use in prior models. The results presented in Model 6 continue to establish the importance of IMF structural adjustment, debt service, and specialization in agriculture in enhancing reliance on solid fuels. Additionally, GDP growth remains important in increasing use of solid fuels in developing nations. Conversely, the number of physicians, urbanization, and female participation in schooling are associated with declines in solid fuel use in developing nations, net of other factors. GDP per capita and location in Sub-Saharan Africa are no longer significant in predicting solid fuel use in less-developed nations when taking into account all of the other predictors included in the model.

It is important to note that the R^2 values are particularly high across the models; for example, in Model 1 the R^2 value is .7827, suggesting that over 78% of the cross-national variability in solid fuel use across developing nations is accounted for by structural adjustment, debt service, specialization in agriculture, GDP per capita, and physicians alone. While key dependency/world-systems hypotheses surrounding the importance of economic dependencies in facilitating vulnerabilities to indoor air pollution were substantiated, a number of other measures predicted to have a relationship to solid fuel use did not, such as the population growth measures, forest area, and in more saturated models, GDP per capita and location in Sub-Saharan Africa.

As many developing nations are rapidly urbanizing, the results suggest that population growth trends may matter less in predicting solid fuel use than the distribution of the population across urban vs. rural areas, where solid fuels are more available. In considering the availability of forest resources, it is likely that forest area may not represent an important predictor because solid fuels can include dung, crop refuge, and other materials that often are more abundant and less costly in developing nations (compared to wood). While GDP per capita and Sub-Saharan Africa were important in early models, these measures lost their significance in explaining solid fuel use in more saturated models. This suggests that solid fuel burning is not specific to Sub-Saharan African nations or economically impoverished nations, but rather depends more on the level of urbanization, education, provisions for health services, and forms of economic dependency that keep poor nations underdeveloped.

4. Discussion

The World Health Organization (2014) reports that, "Without a substantial change in policy, the total number of people relying on solid fuels will remain largely unchanged by 2030". The same report also emphasizes that the use of solid fuels poses a major burden on sustainable development. For example, in the area of climate change, black carbon particles and methane emitted by inefficient solid fuel use

significantly contribute to global greenhouse gas emissions (WHO, 2014). The social and economic costs to health and well-being from solid fuel use are immense; not only does indoor air pollution account for over 4.3 million premature deaths per year, but the chronic conditions associated with solid fuel burning, such as lung cancer, stroke, and heart disease, are among the most costly and difficult health concerns to treat, especially among poor nations with under-funded and disorganized health care systems.

In addition to the obvious deleterious health effects of solid fuel burning, fuel gathering consumes considerable time for women and children, limiting other productive activities, such as education and income generation (WHO, 2014). In less secure environments, women and children are even at risk of injury, violence, and sexual assault during fuel gathering (WHO, 2014).

A major goal of this study is to bring more attention to the topic of indoor air pollution, a silent killer that receives little attention despite its profound contribution to illness and premature death in developing nations. This study initiates cross-national research on solid fuel use in an attempt to understand the large scale, socio-economic predictors of indoor air pollution across developing nations. In so doing, we pay particular attention to relevant political-economic strategies to examine how variability in solid fuel use is shaped by current approaches to development.

Overall our results demonstrate that structural adjustment policies are associated with increased use of harmful solid fuels; we find that nations undergoing IMF structural adjustment are more likely to have higher rates of solid fuel use in comparison to nations not under an IMF-imposed structural adjustment agreement, net of other factors. While austerity reforms may generate some revenue for debt repayment, currency devaluations, comparative advantages in agriculture, cutbacks in environmental protection, and the shrinking of the public sector likely impoverishes peoples' ability to acquire clean fuels, leading to a heightened reliance on cheap, readily-available, but more harmful solid fuels.

In addition to structural adjustment, we find that debt servicing to multinational institutions and agricultural production also heighten vulnerabilities to indoor air pollution. These findings fit with prior dependency/world-system theorizing and research highlighting the role that international economic policies and the unequal division of labor play in reproducing conditions of poverty, illness, and underdevelopment in poor nations (e.g., Rice, 2007). Although level of economic development was found to be a significant predictor of solid fuel use in many models, which supports some ideas from modernization perspectives, we also find that economic growth positively influences solid fuel use across developing nations. While somewhat surprising, this finding speaks to the dependency themes under examination, emphasizing that the ways in which economic growth is achieved is at the expense of people and environments in poor nations (e.g., Bunker, 1985; Rice, 2007). Thus, these findings suggest that a narrow focus on generating economic growth, including through austerity measures and specialization, does not necessarily lead to enhanced well-being and successful development.

Rather, we find that increasing access to doctors and schooling, especially for women, is paramount to

facilitating reductions in exposure to indoor air pollution in developing nations. While nations with larger rural populations tend to have higher dependence on solid fuel burning, the beneficial influences of education and healthcare suggest that some of these factors may be overcome with a focus on targeting more inclusive and socially-oriented development strategies in impoverished rural areas. Indeed, these findings suggest clear policy implications with respect to expanding education opportunities and public health resources, as well as the need for targeted public health lessons on the risks of solid fuel burning. As women tend to be environmental managers for rural households in developing nations, it is essential to target women in health education, as well as policies or interventions that introduce cleaner fuel sources.

The findings reveal that specialization in agriculture and percent urban are among some of the strongest influences of solid fuel use across developing nations. Thus, it is likely that the basic access and availability to solid fuel sources, such as dung and crop residues, that comes with a farming or rural subsistence lifestyles is important in explaining why some populations burn more biomass than others. As education levels and healthcare access tend to be lower in rural areas (e.g., Van de Poel, O'Donnell, & Van Doorslear, 2007), it is clear that tackling indoor air pollution will be a significant challenge in years to come. Rural areas thus must be the key site of education, health and clean fuel interventions; targeting easy to reach populations, even within rural districts, is insufficient. Policy efforts must be made to include remote and hard to reach populations in solid fuel burning interventions. Perhaps even educating populations on the health consequences of solid fuel burning and simple ways to ensure or promote ventilation when cooking could be viable, low-cost strategies.

Development agencies such as the IMF contend that neoliberal restructuring and economic specialization according to comparative advantages in agriculture will improve economic growth, and therefore successful development in poor nations (e.g., World Bank, 2008; Babb, 2005). This study adds to the growing body of literature that negates these suggestions, and instead illustrates that structural adjustment reforms, debt servicing, and specialization in agriculture are associated with increases solid fuel use and exposure to indoor air pollution—consequences that negatively impact successful development (WHO, 2014). In considering future development policy, developing nations should be extremely cautious in adopting neoliberal austerity measures, and should instead focus on enhancing government support and services, especially in areas of education, healthcare, and conservation.

This study represents a preliminary analysis, and has a number of limitations that caution against extensive causal assertions. There are a number of steps for future research, now that this initial work validates a cross-national connection between structural adjustment and solid fuel use. One avenue of inquiry could involve investigating the different types of structural adjustment policies, as protocols designed for the energy sector could improve clean fuel availability in some contexts. Although the structural adjustment data publically available through the IMF does not denote which type of

structural adjustment program a given country is under, World Bank data does have this feature, and future studies could utilize and examine the influences of different types of World Bank structural adjustment on solid fuel use. Additionally, as monitoring of solid fuel use by agencies such as the World Health Organization continues to improve, longitudinal data may become available. Preforming longitudinal analyses would greatly improve the causal validity of the findings suggested here. Additionally, evaluative frameworks may be approachable if more nuanced data on solid fuel use were to be collected or become available.

Exposure to indoor air pollution falls predominately on poor, rural households, and the most vulnerable within them, including women and children. Despite the relevance of solid fuel burning for social scientists and the importance of this phenomenon as one of the most serious current global health threats, little attention has been devoted to indoor air pollution. It has been over 25 years since the debt crisis and the institution of the first structural adjustment policies, yet patterns in global inequality remain relatively unchanged; this study contributes to mounting evidence that such austerity strategies are not helping, but instead hurting, populations in poor nations. If a significant re-prioritization on social conditions and human well-being in global economic policy is not achieved, basic problems such as solid fuel burning will continue to plague impoverished populations and exacerbate underdevelopment.

References

Amin, S. (1976). *Unequal development: An essay on the social formation of peripheral capitalism*. New York: Monthly Review Press.

Asian Development Bank (ADB). (2012). *Toward an environmentally sustainable future*. Philippines: ADB.

Austin, K. F. (2010). Soybean exports and deforestation from a world-systems perspective: A cross-national investigation of comparative disadvantage. *The Sociological Quarterly*, *51*(3), 511-536.

Austin, K. F. (2015). Dependency, urban slums, and the forgotten plagues: A cross-national analysis of tuberculosis and malaria in less-developed nations. *Sociological Perspectives*, *58*(2), 286-310.

Austin, K., & Noble, M. (2014). Measuring gender disparity in the HIV pandemic: A cross-national investigation of female health resources, income inequality, and disease in less-developed nations. *Sociological Inquiry*, *8*(1), 102-130.

Babb, S. (2005). The social consequences of structural adjustment: Recent evidence and current debates. *Annual Review of Sociology*, *31*, 199-222.

Banik, B. K. (2010). Female perceptions of health hazards associated with indoor air pollution in Bangladesh. *Journal of Sociology and Anthropology*, *2*(9), 206-212.

Boadi, K. O., & Kuitunen, M. (2005). Factors affecting the choice of cooking fuel, cooking place and

respiratory health in the Accra metropolitan area, Ghana. *Journal of Biosocial Science, 38*(3), 403-412.

Bradshaw, Y. W., & Huang, J. (1991). Intensifying global dependency: Foreign debt, structural adjustment, and third world underdevelopment. *The Sociological Quarterly, 32*(3), 321-342.

Bruce, N., Perez-Padilla, R., & Albalak, R. (2002). *The health effects of indoor air pollution exposure in developing countries*. World Health Organization (WHO). Retrieved November 9, 2014, from http://www.whqlibdoc.who.int/hq/2002/WHO_SDE_OEH_02.05.pdf

Bunker, S. (1985). *Underdeveloping the Amazon: Extraction, unequal exchange, and the failure of the modern state*. Urbana: University of Illinois Press.

Burke, P. J. (2013). The national-level energy ladder and its carbon implications. *Environment and Development Economics*, *18*(4), 484-503.

Burke, P. J., & Dundas, G. (2015). Female labor force participation and household dependence on biomass energy: Evidence from national longitudinal data. *World Development*, *67*, 424-437.

Coburn, C., Restivo, M., & Shandra, J. (2015). The African Development Bank and women's health: A cross-national analysis of structural adjustment and maternal mortality. *Social Science Research*, *51*, 301-321.

Emmanuel, A. (1972). *Unequal exchange*. New York: Monthly Review Press.

Frank, A. G. (1967). *Capitalism and underdevelopment in Latin America*. New York: Monthly Review Press.

Heltberg, R. (2004). Fuel switching: Evidence from eight developing countries. *Energy Economics*, *26*(5), 869-887.

Hosier, R. (2004). Energy ladder in developing nations. *Encyclopedia of Energy*, *2*, 423-434.

International Monetary Fund Data Base. (2012). *IMF member financial data*. Retrieved July 1, 2012, from http://www.imf.org/external/data.htm#data

Jin, Y., Ma, X., Chen, X., Cheng, Y., Baris, E., & Ezzati, M. (2006). Exposure to indoor air pollution from household energy use in rural China: The interactions of technology, behavior, and knowledge in health risk management. *Social Science & Medicine, 62*, 3161-3176.

Jorgenson, A., Dick, C., & Austin, K. (2010). The vertical flow of primary sector exports and deforestation in less developed countries: A test of ecologically unequal exchange theory. *Society and Natural Resources*, *23*(9), 888-897.

Knight, K. W., & Rosa, E. A. (2012). Household dynamics and fuelwood consumption in developing countries: A cross-national analysis. *Population and Environment*, *33*(4), 365-378.

Link, C. F., Axinn, W. G., & Ghimire, D. J. (2012). Household energy consumption: Community context and the fuelwood transition. *Social Science Research, 41*(3), 598-611.

Matinga, M. N., Annegarn, H. J., & Clancy, J. S. (2013). Healthcare provider views on the health effects of biomass fuel collection and use in rural Eastern Cape, South Africa: An ethnographic

study. *Social Science & Medicine*, *97*, 192-200.

Maynard, G., Shircliff, E., & Restivo, M. (2012). IMF structural adjustment, public health spending, and Tuberculosis: A longitudinal analysis of prevalence rates in poor countries. *International Journal of Sociology*, *42*(2), 5-27.

McMichael, P. (2012). *Development and social change: A global perspective* (5th ed.). Los Angeles, California: Sage Publications.

Mohan, G. (2001). The environmental impacts of adjustment. In G. Mohan, E. Brown, B. Milward, & A. B. Zack-Williams (Eds.), *Structural adjustment: Theory, practice, and impacts* (pp. 95-117). New York: Routledge.

Oppong, N. Y. (2013). The good and the bad of structural adjustment programme in Africa: Evidence from Ghanaian gold mining industry. *International Journal of Business and Behavioral Sciences*, *3*(10), 27-41.

Pandey, V. L., & Chaubal, A. (2011). Comprehending household cooking energy choice in rural India. *Biomass and Bioenergy*, *35*(11), 4724-4731.

Pandolfelli, L. E., & Shandra, J. M. (2013). The African Development Bank, structural adjustment, and child mortality: A cross-national analysis of sub-Saharan Africa. *International Journal of Health Services*, *33*, 337-361.

Pandolfelli, L. E., Shandra, J., & Tyagi, J. (2014). The International Monetary Fund, structural adjustment, and women's health: A cross-national analysis of maternal mortality in sub-Saharan Africa. *The Sociological Quarterly*, *55*, 119-142.

Peet, R. (2003). *The unholy trinity: The International Monetary Fund, World Bank, and World Trade Organization*. London: Zed Books.

Rice, J. (2007). Ecological unequal exchange: Consumption, equity, and unsustainable structural relationships within the global economy. *International Journal of Comparative Sociology*, *48*(43), 42-72.

Rostow, W. W. (1960). *The stages of economic growth: A non-Communist manifesto*. London: Cambridge University Press.

Shandra, C. L., Shandra, J. M., & London, B. (2011). World Bank structural adjustment, water, and sanitation: A cross-national analysis of child mortality in sub-Saharan Africa. *Organization & Environment*, *24*(2), 107-129.

Shandra, J. M., Shandra, C. L., & London, B. (2010). Non-governmental organizations, structural adjustment, and debt service: A cross-national analysis of maternal mortality. *Journal of World System Research*, *16*, 217-245.

Shandra, J. M., Shor, E., Maynard, G., & London, B. (2008). Debt, structural Adjustment, and deforestation: A cross-national analysis. *Journal of World System Research*, *14*(1), 1-21.

Shircliff, E. J., & Shandra, J. M. (2011). Non-governmental organizations, democracy, and HIV

prevalence: A cross-national analysis. *Sociological Inquiry*, *81*(2), 143-173.

Van de Poel, E., O'Donnell, O., & Van Doorslear, E. (2007). Are urban children really healthier? Evidence from 47 developing countries. *Social Science and Medicine*, *65*(7), 1986-2003.

Wallerstein, I. (1974). *The modern world-system, volume I: Capitalist agriculture and the origins of the European world-economy in the 16th century*. New York: Academic Press.

Wallerstein, I. (2004). *World-systems analysis: An introduction*. Durham, NC: Duke University Press.

World Bank. (2015). *World development indicators*. Retrieved August 22, 2015, from http://www.data.worldbank.org/data-catalog/world-development-indicators

World Health Organization. (2007). *Indoor air pollution: National burden of disease estimates*. Retrieved June 18, 2014, from http://www.who.int/indoorair/publications/nationalburden/en/

World Health Organization. (2009). *Where did all the aid go? An in-depth analysis of increased health aid flows over the past 10 years*. Retrieved June 5, 2014, from http://www.who.int/bulletin/volumes/87/12/08-058677/en/

World Health Organization. (2010). *WHO guidelines for indoor air quality: Selected pollutants*. Retrieved May 25, 2014, from http://www.euro.who.int/__data/assets/pdf_file/0009/128169/e94535.pdf?ua=1

World Health Organization. (2014). *Household air pollution and health*. Retrieved September 2, 2015, from http://www.who.int/mediacentre/factsheets/fs292/en/

World Health Organization. (2015). *Global health observatory data repository*. Retrieved August 10, 2015, from http://www.apps.who.int/gho/data/?theme=home

Notes

Note 1. Also, longitudinal data on many of the key predictors used in this analysis, including solid fuel use, are not available, making longitudinal techniques unfeasible.

Note 2. One key assumption of OLS regression requires that all variables are normally distributed. Skewness statistics revealed that two variables, multilateral debt service and percent of forest area were highly skewed; thus these indicators were log-transformed to address this concern. Results from the Breush-Pagan and Modified White's tests revealed some potential problems with heteroscedasticity in some models, thus robust standard errors are used. A comparison of these results with models using conventional standard errors shows no significant difference. Other diagnostics (e.g., Cook's D) revealed no problems with outliers or other assumption violations.

Note 3. We also considered the role of total debt service and total external debt. Total external debt had similar effects on solid fuel use as the multilateral debt service measure used here, but was less robust (we did not report these results due to parsimony, but are available upon request). We prefer to maintain a focus on debt service, as it is the resulting effects of the servicing of debts which is likely to most impact availability of fuels (e.g., cutbacks in the public sector). Among measures of debt service, we utilize a

measure of debt service to multinationals of the IMF and World Bank to preserve a focus on supra-national development banks in the research. In early models, we did find that the effects of multinational debt service and total debt service were consistent (we did not report these results due to parsimony, but are available upon request).

Note 4. We also tested for the influence of additional control variables, such as urban population growth, latitude, domestic investment, FDI, location in Latin America, SE Asia, etc. None of these had a significant impact on solid fuel use.