Development Assistance for Noncommunicable Diseases: Political, Socioeconomic, and Health Indicators of Foreign Aid for an Emerging Global Crisis

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Abstract: As a result of global economic development, noncommunicable diseases, also known as NCDs, have become an emerging pandemic and a wide scale economic burden that is not being adequately addressed. Despite the lack of alignment between NCDs burden and funding by donor groups to low and middle-income countries, there is limited quantitative research on how states choose to allocate development assistance for health (DAH), especially for NCDs. This report focuses on bilateral foreign aid, and models the correlations between economic, political, social, and epidemiological indicators of recipient countries and the level of foreign aid for NCDs given by donor countries. I conclude that there is evidence of no association between disease burden of a country and received funding while their trade openness was positively correlated. DAH was also surprisingly negatively correlated with the level of democracy of a recipient country, revealing the potential for further research into the determinants of foreign aid for NCDs.

Keywords: health economics, global health, noncommunicable diseases, chronic diseases, foreign aid, development assistance for health, grants, political economy, macroeconomics.

Introduction

Purpose:
The consequences of noncommunicable diseases (NCDs) are resulting in a major global epidemiological and economic burden. International health policy advocates and healthcare providers are calling for greater funding to reduce the impacts of NCDs. However, the majority of development assistance for health, or DAH, is directed towards other diseases, resulting in a severe lack of funding for this emerging pandemic. This work aims to investigate the misalignment of DAH and NCD burden through examining the relationship between NCD funding and the economic, political, and health characteristics of recipient countries. Using a unique data set focused on bilateral development assistance, I observe how the amount of DAH given by a donor country for NCDs is associated with country characteristics of recipient states in order to gather evidence of fund allocation based on state-level political and economic incentives rather than health burden.

Background on Noncommunicable Diseases:

The consequences of noncommunicable diseases (NCDs) are resulting in a major global epidemiological and economic burden. Also known as chronic diseases, NCDs are caused by genetic, environmental, behavioral, and physiological factors. NCDs include such significant conditions as cardiovascular disease, cancer, diabetes, chronic pulmonary disease, and mental health disorders. In 2018, the World Health Organization stated that NCDs were the leading cause of mortality worldwide as they were responsible for 70% of all global deaths as well as a considerable source of preventable illness and related disability. NCDs disproportionately burden low and middle-income countries, with three quarters of global NCD deaths occurring in the developing world because of a combination of population size and increased exposure to risk factors without the support of effective healthcare (Word Health Organization, 2019). Typically, residents of very poor countries incur high rates of premature deaths, or deaths before the age of seventy, from infectious diseases. However, as their economies experience development and initiate basic healthcare, these diseases tend to become more controlled. This same economic development is associated with the adoption of "Western" behaviors along with environmental and market factors which expose their populations to risk factors for NCDs. This includes tobacco use, physical inactivity, unhealthy diet, and abuse of alcohol. Historically high-income countries such as European nations and the United States have already experienced this shift in disease burden and have had the time and resources to develop the healthcare architecture to control and sometimes curb NCDs. However, states in economic transition lack the health system and government framework to address this NCD pandemic, sometimes with the double burden of still experiencing infectious disease crises (Banerjee, 2012).

There is a demonstrated health disparity between world income groups for NCDs. As countries develop, they experience a demographic change of longer life expectancy. Thus, some of the increased incidence rate of NCDs is explained by an increased life span as ageing is a major risk factor for many noncommunicable diseases. However, a longer life expectancy does not necessarily indicate an appropriate life span as defined by the World Health Organization. The WHO estimates that NCDs globally cause two thirds of premature deaths (2019). Moreover,

these premature deaths are not equally distributed across global income groups. In 2012, the probability of dying prematurely from NCDs was 10 percent in developed countries versus 60 percent in developing countries. The same year, it was estimated that 82 percent of premature deaths caused by NCDs occur in developing countries. The WHO concludes that up to half of these deaths are associated with ineffective local health systems that do not respond equitably or efficiently to those at risk or to those that are already diagnosed with NCDs (2013). In this way, there are global structural inequalities for the same set of diseases, with NCDs disproportionately hindering lower income regions. Despite the existence of many treatments to manage or cure NCDs, these health disparities cause undue suffering for many populations. For these reasons, the WHO lists reducing premature mortality from NCDs as a specific target of the United Nations Sustainable Development Goals (2015).

In addition to its major health burden, NCDs have significant economic consequences for populations on the household level as well as on a global scale. The United Nations states that addressing the economic burden of NCDs is a major step to address global poverty (United Nations Development Progamme, 2018). When individuals in resource-poor settings are diagnosed with NCDs, paying for treatment can impoverish families. However, not receiving treatment leads to disability and lower productivity for the individual and their caretakers, consequently reducing human capital. While the out-of-pocket cost of treatment is typically high for uninsured patients, many insured individuals also face incomplete covered healthcare and must pay for the majority of related costs. For example, catastrophic expenditure associated with NCDs in India account for more than 40 percent of non-food household expenditure (Kastor & Mohanty, 2018). Experts in health system financing state that costs associated with health goods and services are not defined as a direct source of utility, and instead divert spending from the consumption of market goods on the local and global scale (World Health Organization, 2009). Moreover, paying for treatment for NCDs is related to impoverishment, with the highest reported incidence rates of catastrophic expenditure associated with low-income patients in Tanzania, India, China, Iran, Nigeria, and Vietnam (Jan et al., 2018). The African Union reports that the high costs of NCDs are annually sending 100 million people in Africa into poverty (2013). In this way, NCDs are considered a barrier to development, as both a driver and result of poverty (Islam, 2014). The healthcare costs and lost productivity of NCDs due to inefficient health systems and access are projected to lead to a cumulative output loss of roughly US $47 trillion over the next two decades. As this loss is equal to three quarters of total world GDP in 2010, health economists consider addressing NCDs an urgent issue (World Economic Forum, 2011). Concurrently, reducing the disease burden of NCDs offers economic benefits. A report by the World Health Organization (2018) finds that every $1 USD invested in healthcare and services targeting NCDs in low- and lower-middle income countries returns at least $7 USD in increased employment, life expectancy, and productivity. In this way, experts state that investment in health systems and prevention campaigns for NCDs is necessary and valuable on a global level (Nugent, 2015).

To effectively address this emerging health crisis, developing countries require major external financing (World Health Organization, 2018). However, despite the burden of NCDs, the majority of development assistance for health (DAH) goes towards other health issues, such as infectious diseases. In 2007, while external donors provided only about $0.78/disability-adjusted life year (DALY) for NCDs, $23.9/DALY went to HIV, TB, and malaria. DALYs are a

metric of overall disease burden commonly used in public health assessments. One DALY is usually interpreted as one year lost of "healthy" life, as a combination of premature mortality and the consequences of living with a significant disease or disability (World Health Organization, 2014). According to the University of Washington's Institute for Health Metrics and Evaluation, NCDs received only 2% of total global health financing in 2017 despite causing 67% of global deaths (2017). Additionally, the Bill and Melinda Gates Foundation, the World Bank, and USAID each commit roughly only 2% of their annual budgets to NCDs (Maher & Sridhar, 2012). Health policy experts thus attest that this clear misalignment between disease and economic burden and funding "reveals the potential for improvement in resource allocation" for NCDs (Dieleman et al., 2014, p. 878).

Health economists attribute the significant discrepancy between NCD disease burden and funding to donor groups lacking awareness of the impact of the diseases in low- and middle-income countries (Dieleman et al., 2014). In addition, curbing NCDs on a mass scale requires highly complex responses in comparison to the more proven and evidence-based approaches for many infectious diseases. However, due to the lack of transparency in the foreign aid allocation process, these explanations are often anecdotal. As NCD funding is already limited, it is crucial for policymakers and recipient countries to understand the conditions that motivate DAH. Further explanation of the impetus for this report is explored in the following section.

Motivation for Research:

There is currently a limited understanding of how donor groups, including states, multilateral aid groups, NGOs, and foundations decide how to allocate their funding. The Center for Global Development states that foreign assistance for health is uncoordinated in its objectives and strategies and that many donor entities are not transparent in their decision-making (Radelet, 2011). While there are some qualitative frameworks provided by political scientists that state funding decisions are both based in human welfare and international relations, they do not provide an empirical understanding of how donor groups prioritize factors when they disburse health aid, such as if commercial interests are valued more than other factors (Apodaca, 2017).

Leaders in countries with NCDs crises cannot effectively request aid if they do not understand the determinants that donor groups prioritize when deciding which recipient states to provide DAH. Moreover, public health researchers, policymakers, economists, and other academics cannot accurately assess or direct global financing trends if they do not understand the decision-making that causes changes in these patterns. Thus, there is a significant need in the field of health economics to explore the determinants of DAH and macro-level donor incentives for NCDs, especially for specific categories of financing, such as bilateral aid. With further research of DAH patterns and its correlations with socioeconomic and health measurements, key stakeholders will be able to more efficiently provide guidance to prevent and control NCDs and curb this collective pandemic.

Hypothesis and Economic Mechanisms

In this report, I categorize donor entities into the aforementioned three classes of aid by

NGOs/foundations, bilateral aid, and multilateral aid. Evidence suggests that each of these groups prioritize different factors in determining how much money to give to a specific country for its NCD burden, which I explore further in the following section. Although there are descriptive publications of total global health funding, explorations of macroeconomic donor behavior are generally focused on flows of foreign aid between states rather than nongovernmental organizations. Additionally, there is very limited data available on funding from multilateral and private donors, which I will address in the methodology section. Therefore, due to the constraints of available data and existing literature, I concentrate on examining patterns of bilateral aid, or a single donor country giving to a recipient country.

In regard to economic theory, I expect that in the context of bilateral aid, donor countries prioritize political and economic factors that serve their interests in the face of scarcity. Thus, I employ a variation of the microeconomic model of maximizing a constrained altruistic utility function. I apply aspects of the concept of impure altruism, in which an individual contributes to a social cause to gain personal benefits (Andreoni, 1990; Simon, 2016). Adapting this theory to the context of NCDs, a donor country will allocate funding according to what it views as most efficiently promoting its own interests rather than just what it views subjectively as improving the health and associated poverty of the recipient. For example, providing aid to a recipient country may offer a donor country support in the United Nations to pass legislation or build a stronger trade relationship. While these benefits cannot be measured as a traditional monetary price, I believe the donor country considers how to maximize these returns in how much they decide to donate, or their costs. I use the assumption that donor countries will choose a recipient country and how much to donate to them based on the perceived benefits for themselves and that these choices will be optimized to the donor's costs by using socioeconomic and political variables as inputs into their maximized output, donation, or function. In this way, donor countries do not necessarily provide foreign aid based on the disease burden of NCDs or the poverty level of the recipient country.

Therefore, I hypothesize that the trade openness of a recipient country will be positively associated with higher funding as donor countries are interested in developing economic ties. As literature suggests that donor countries are most interested in the political and indirect economic returns of their foreign aid rather than the health needs of the recipient, I do not predict a significant relationship between the level of funding and disease burden of NCDs, which I measure in DALYs. Moreover, I predict that there will not be a meaningful relationship between the level of democracy of a recipient country and funding for NCDs. The level of democracy of a country is often considered a proxy for good governance and lower corruption and thus perhaps how effectively aid will be used. However, I do not expect this to be a priority for bilateral DAH as I theorize that states give DAH for the indirect development of political and economic relationships rather than in an attempt to optimize health outcomes. Following the same logic that donor countries view foreign aid as an indirect investment, I expect that the amount of foreign direct investment (FDI) in a recipient country will positively predict the level of NCD funding. Moreover, based in the evidence that NCDs affect populations across all income levels, and my assumption that donor countries are not prioritizing poverty levels and thus resource availability in their allocation process, I hypothesize that there will not be a substantive relationship between the gross domestic product (GDP) of a recipient country and its NCD funding.

Review of the Literature on Development
Assistance for Health

There is limited research into the motivations behind aid allocation from donor groups for health, let alone specifically for NCDs. This section summarizes the existing health financing literature as well as relevant research about the motives of donor countries providing assistance for economic development. In the conclusion of this section, I will explore the potential limits in the literature and how I will attempt to address these issues in my own research.

In the context of health research and care, one might expect financial donations to be based in evidence, proportional to the impact of each disease. However, donor behavior, whether on the small scale of the individual or on the larger scale of a state or international foundation or organization, is not necessarily objective. Experts in donor psychology explain that decision-makers relevant to NCDs cannot rely on purely epidemiological rates to predict how much a donor will provide to a certain cause. In addition, one must deconstruct the more complex "attitudes, interests, and motivations of relevant national, international, and transnational actors in global health" (Maher & Sridhar, 2012, p. 9).

In one of the most comprehensive global health aid studies relevant to NCDs, Dieleman and co-authors (2014) track financial flows from donor countries to recipient countries from 1990 to 2013, concentrating on eight different disease groups, including NCDs and tobacco use prevention and control, a risk factor of NCDs. They attempted to identify previously unrecognized funding gaps in DAH and the causes of austerity towards some disease groups versus others. The study utilized international databases of grants to track channels of assistance, aggregating bilateral and multilateral flows, NGOs, and foundations from 1990 to 2013 using empirical financial and epidemiological data. To assess the relationships between DAH, disease burdens, and economic development, they regressed GDP data, overall global health spending, and DALYs per disease, which is a proxy for loss of life due to a disease using a least squares method of estimation. The analysis finds that overall disease burden and GDP of a recipient country are significantly associated with DAH. However, for NCDs, neither GDP nor level of disease-specific DALYs are systematically related to DAH. Additionally, low-income countries received two-hundred times the funding for HIV/AIDs than for noncommunicable diseases despite higher prevalence rate of NCDs.

While this study provides a broad view of NCD funding patterns, it does not isolate donor groups and observes correlations for all DAH. Dieleman acknowledges the limits of this model, stating that aid allocation for health is not determined "merely by the needs of the population," but also by factors such as historical or regional ties between countries or the "perceived corruption" of a recipient government, which together influences which countries donors give to, how much they provide, and for what cause (p. 884). This theory is supported by the World Health Organization (2003) that states that different donor types hold different priorities. Additionally, the Overseas Development Group finds that bilateral channels are systematically more politicized than multilateral channels (Gulrajani, 2016). Other sources support that bilateral organizations historically provide low amounts of funding for NCDs in contrast to intergovernmental organizations, indicating a difference in priorities between donor groups (Feigl & Nugent, 2010). There is thus evidence that disaggregating donor groups could reveal

more coherent patterns.

Further research in development assistance for health is limited, but findings on general bilateral aid patterns can be applied in this setting. In one such paper, Alesina and Dollar (2000) investigate whether donor countries provide funding for macroeconomic growth to recipient countries for "economically correct incentives" such as according to income levels or "good institutions" (p. 34). They find that the literature surrounding the topic is largely tautological. They used empirical financial data from international databases from 1990 to 1994 to test the correlation between aid and trade openness, level of democracy, civil liberties, colonial status, direct foreign investment, initial income, and population. These authors find that foreign aid is correlated with political variables, while foreign direct investment is related to economic incentives such as protection of property rights. Recipient countries that have a colonial relationship with a donor state are also more likely to receive funds.

In another study that focuses on the determinants of aid given by German donors, the authors explore whether the self-interest of donors influences the heterogeneity of aid disbursement (Nunnenkamp & Öhler, 2011). Using the variables of GDP per capita, civil liberties indexes, and voting alignment between the recipient country and Germany, they analyzed empirical grant data from Germany's federal databases. They find that most of the state's ministries do not disburse aid purely based on the "poverty" of recipients but that their distributions tend to be "blurred by other (political or strategic) objectives" (p. 318). These political motives are elucidated by what the authors call "recipient merit" variables, such as "good" economic policies, less human rights abuses, and greater democracy. These are often rewarded and are jointly significant for donor countries France, Germany, Japan, and the United States (p. 319).

Other researchers view aid allocation as more pragmatic. In an international study by the St. Louis Federal Reserve, they questioned the different motives of developed nations in providing aid to developing states (Bandyopadhyay, 2013). Using a large time range from 1960 through 2012, they used empirical data from international grant databases, the United Nations, and the World Bank to test the variables of voting alignment in the UN, indexes of the level of trade between the donor and recipient country, and indexes of historical relationships. They observe a correlation between donor "self-interest" and foreign aid (p. 333). All of the donor countries included in their analysis provided more aid to their trading partners than other countries. Moreover, all donors except for Germany gave more aid to states that regularly voted in line with them in United Nations legislation. They conclude that donors primarily allocate aid according to historical relationships and then adjust for other criteria in their model.

While the ability to integrate and generalize the results of the aforementioned literature is limited, each of the papers investigates how foreign aid is distributed. Dieleman explores determinants concerning how health aid is allocated through objective causes of poverty and health crises. However, the paper fails to consider many socioeconomic and political variables in the disbursement of health aid when these factors appear to be highly correlated with funding in other types of development assistance. Additionally, the report does not isolate donor groups to observe their specific correlations with the relevant determinants, despite evidence that this is necessary to accurately understand donor funding patterns. Other authors explored more

comprehensive factors in how economic aid is allocated outside of the narrow scope of NCDs. Moreover, while all the studies found that most donor countries give more aid to lower-income recipient countries, their results varied significantly both in elasticity and significance country to country. Thus, there appears to be a lack of consistency in empirical results within the development field. In the following section, I will propose a combination of the methodology of the aforementioned papers and apply a variety of epidemiological, socioeconomic, and political factors to an NCD-related dataset.

Study Data and Methods

For my model, I am replicating Dieleman's regression, in which DAH for NCDs is the dependent variable with GDP and DALYs caused by NCDs as independent variables, alongside adding covariates that are typically found to be significant in foreign aid and health funding literature, which I will explain in the following sections.

To estimate these variables, I use data from several different sources, for which I have received permission to use or of which are publicly accessible. As a panel dataset, each unit of observation includes the average DAH given by a specific donor country to a specific recipient country for NCDs alongside other country characteristics from 2010 to 2015, for a total range of six years. Each observation in the dataset includes these features:

1. Recipient country.
2. Donor country.
3. Year the aid was disbursed.
4. Logged mean of the DAH per capita that year adjusted to 2018 USD. (original unit is the value of each individual grant in millions adjusted to 2015 USD).
5. Population of recipient country that year.
6. Logged GDP per capita of recipient country as defined by the World Bank adjusted to 2018 USD.
7. Logged total FDI per capita in the recipient country adjusted to 2018 USD
8. Disability adjusted life year (DALY) that year caused by NCDs relative to total DALYs in the recipient country.
9. Level of democracy of recipient country as observed that year as an index, where 1 is high level of democracy.
10. Level of trade openness of recipient country as observed that year as an index, where the higher the value, the more open the country is to trade.

The data on grants that I use in this report derives from the database formed by the Global Noncommunicable Diseases Initiative of RTI International's Seattle location that I contributed to and have been given permission to use (RTI International, 2017). I chose to use this dataset as it is the most comprehensive tracking of foreign aid for NCDs categorized by donor groups that is accessible as of this time. This source provides information on individual grants and thus includes the recipient country, donor group, year, value of the aid, and the four World Bank-categorized income groups, Low Income, Lower-Middle Income, Middle Income, or Upper-Middle Income. These four income groups are often summarized as Lower-Middle Income Groups (LMICs; World Bank Country and Lending Groups). The World Bank defines 137

recipient countries as currently falling into the Low-Middle Income Groups out of its 189 member countries (2018). Although I use GDP to formally measure economic level for the recipient country, so as to maintain consistency with Dieleman's model. I use this World Bank income group information in my explanatory statistics to provide context for the relationship between NCD burden and socioeconomic level.

This dataset originated from the literature developed by Rachel Nugent, the current Vice President of the Global Noncommunicable Diseases Initiative, and her peer at the Organization for Economic Cooperation and Development (OECD), Andrea Feigl. Their first report, written in 2011, "Where Have All the Donors Gone? Scarce Donor Funding for Non-Communicable Diseases," included an original database on DAH for NCDs from 2001-2008. In May 2017, Nugent, Feigl, and other colleagues submitted a report to the WHO Global Coordination Mechanism on NCDs, "Donor Funding to Address Chronic Non-Communicable Diseases in Low- and Middle-income Countries: Too Little, Too Late." The dataset for this paper was developed by the Seattle team at RTI International.

The RTI International NCDs DAH dataset obtained its data from multiple sources, national and international. Using a search of 256 keywords and direct correspondence, the team and I searched the following data sources for different funding flows for NCDs. Feigl and Nugent clarify that funder commitments for specific funds and actual disbursements are not always equal. However, after 2010 they found the differences between the two in the OECD database, specifically from the Credit Reporting Standard, are not statistically significant. Moreover, they only had access to disbursement information from the non-CRS sources. Thus, they only use disbursement data. For further details of their data collection methods, see Donor Funding to Address Chronic Non-Communicable Diseases in Low- and Middle-Income Countries: Too Little, Too Late (Feigl, Andrea B, et al 2017).

Since the outcome of interest here is the relationship between aid recipient characteristics and aid received, I aggregate the data by recipient country and year. My outcome variable therefore becomes a country-level estimate of the average of total aid directed toward NCDs for each year. Moreover, although the literature suggests that historical ties are crucial to determining the allocation of foreign aid, there was no available data on dyadic observations that represent these relationships for the appropriate time range as of the development of this work. I thus acquired data from the following sources:

In acknowledgement of how recipient countries have varying population sizes and national income levels, I included the population of the recipient country that year to standardize GDP, FDI, and DAH per capita. I also included this standardization to maintain consistency with Dieleman's model. I derived the data on country populations for the years between 2010 to 2015 from the World Bank Open Data catalog (2019). As I used this data in an intermediate step of wrangling the data, population is not included as a variable in the regression model. The values of gross domestic product (GDP) for the recipient country and foreign direct investment (FDI) are extracted as well from the World Bank Open Data catalog. All monetary data has been adjusted to 2018 USD per capita as well as logged. The epidemiological data in this report comes from the Institute for Health Metrics and Evaluation (2017), a global health statistics research

branch of the University of Washington. IHME offers a public database with NCD prevalence statistics through its Global Burden of Disease Tool. This report uses the DALYs caused by NCDs as a proportion relative to DALYs from all other causes per country. There is data available for the years between 2010 and 2015. I derived political data from the Economist Intelligence Unit (EIU), the research division of The Economist Group, which provides international business intelligence. The EIU provides a publicly accessible database through the World Bank that includes "Voice and Accountability" (V&A), an index that provides a multifaceted understanding of uncorrupt democracy in a country (The World Bank Group, 2019). V&A is comprised of an average of five other measures by the EIU: the country's democracy index, vested interests, accountability of public officials, human rights, and freedom of association. The dataset formulates a score for V&A on an index of 0 to 1, in which 1 is a high level of democracy. There is information for the years pertinent to my model. I refer to this index of V&A as level of democracy throughout this report for the sake of clarity. However, in the context of global DAH, I understand this variable as a comprehensive proxy for corruption rather than simply as a position on the international political spectrum. This interpretation is based in standard procedure of political economy literature (Drury, Krieckhaus, & Lusztig, 2006). I used economic data from the World Bank Open Data catalog to quantify the level of trade openness of the recipient country. The World Bank offers a public database of what it calls the Openness Index, which is the ratio of a country's total trade (sum of exports and imports) divided by its gross domestic product. The higher the value, the more open the country is to trade, signifying that trade relationships influence domestic activities. There is data for each year within my time range. After cleaning the data, there are 461 observations in my dataset. Due to the limited nature of funding data, there is not six full years of data for every country, creating an unbalanced panel. To provide a context of the dataset and give support for the motivation for this paper, please see Table A.1 in the appendix for the recipient countries with the highest NCD burdens and their respective World Bank income group. Additionally, Table B.1 and B.2 in the appendix summarizes donor countries that provided the highest DAH for NCDs as both a sum and average through the years of the dataset. Please also refer to Table C.1 and C.2, which compiles the recipient countries that obtained the highest DAH with the same calculations and time range.

Econometric Model: As an extension of Dieleman's regression, I have constructed a multivariate linear regression:

j=recipient country
t=the year of the aid disbursement
jt= total funding per year disbursed to a recipient country by a donor country.

(logged per capita DAH)jt = β1(trade openness)jt + β2(logged per capita GDP) jt + β3(logged per capita FDI) jt + β4(DALY)j t + β5(level of democracy) jt + β6(logged GDP) jt*(DALY) jt + αj + αt + ujt.

I have included a continuous interaction term between the DALYs caused by NCDs and the GDP of the recipient country. I chose to form this interaction term to explore if donor countries provide more funding to a higher disease prevalence in a recipient country if they are in a particularly low-income group, as they have minimal funds to address the crisis. However,

according to my hypothesis that health and economic needs are not as highly valued, I do not expect this to be a significant interaction. I have also included fixed effects for time and recipient country to account for country specific levels of DAH that do not vary across the years and for yearly variation in DAH that is common across all countries. Finally, as the error terms are not independent across countries, I cluster my heteroskedastic-corrected standard errors at the country level.

To run this regression, I used the "plm" package in R, which is a linear model specifically for panel data that makes robust inferences (R Documentation, 2019). As to maintain consistency with previous literature, I have chosen this package as it was used by Dieleman's team to assess his model. I have further developed this model by using the "within" and "two-way" methods in the function, which allow for fixed effects for time and recipient country. Additionally, I used the Beck-Katz panel corrected standard errors to cluster my standard errors by country (Beck & Katz, 1995). This model also supports unbalanced panels as my dataset does not have values for every year for each country, which I will explain further in the below section.

Moreover, I ran this regression with the unfiltered dataset, in which I included DAH provided by all of the donor groups in the original dataset, which consists of bilateral countries, multilateral organizations, and NGOs/foundations. With this data, only the covariate of Trade Openness was statistically significant. Please see Table E.1 in the appendix to view these results. I also ran the same regression on the dataset filtered for DAH given only by multilateral organizations and then for only NGOs/foundations. For each of these sets of data, none of the variables were statistically significant. Please see Tables E.2 and E.3 in the appendix for these regression results.

In addition to my main model, I also produced a regression with the same independent variables lagged by one year as previously discussed. Please see Table F.1 in the appendix for the results.

Study Results

	Coefficient Estimate	Standard Error	P-value
Logged GDP per capita	-0.05414	0.06279	0.3816
Logged FDI per capita	-0.6389	2.0951	0.7605
Percent of DALYs	0.0003	0.0062	0.9606
Trade Openness	0.0009	0.0005	0.0898 *
Level of Democracy	-0.5013	0.1143	6.162e-05 ***
Logged GDP per capita * Percent of DALYs	0.0389	0.1014	0.7048

Significance codes: 0.001 '***' 0.01 '**' 0.05 '*' 0.1

R-Squared: 0.065584 Adj. R-Squared: -0.22459 F-statistic: 4.10593 on 6 and 351 DF, p-value: 0.00053477

In this model, two variables, Trade Openness and Level of Democracy, are statistically significant. Trade Openness is statistically significant at $P < 0.10$ *ceteris paribus*, consistent with econometric standards. Level of Democracy shows strong statistical significance as the P-value is less than 0.01. Trade Openness has a positive correlation with DAH while Level of Democracy has a negative correlation. The R_2 is 0.0656, indicating that the predictors in the model explain 6.56% of the variation in the outcome variable. The remaining variation cannot be explained by the other independent variables included in this model.

Discussion

The results of this model provide evidence for and against different aspects of my hypothesis. As I predicted, the GDP and the percent of total DALYs caused by NCDs does not significantly correlate with the amount of DAH provided. Additionally, the interaction term between these two covariates is not significant, providing evidence that donor countries are not taking a more complex understanding of economic need and disease burden into account.

Moreover, the results of Trade Openness followed my hypothesis as this coefficient was statistically significant with a positive correlation. To interpret this covariate with the log-transformed dependent variable, I exponentiated the coefficient and calculated the percent change. Thus, on average for each country, a one unit increase in the index of trade openness increases DAH per capita by 8.93%.

Interestingly, Level of Democracy was a highly statistically significant coefficient despite what I theorized, with a P-value less than 0.01. This model provided evidence of a strong negative relationship between the level of democracy in a recipient country and the amount of DAH it received from bilateral aid flows. To interpret the results, I again exponentiated the

coefficient and calculated the percent change. On average for each country, a one unit increase in the level of democracy correlates with 39.42 % decrease in DAH. A possible explanation for this relationship is that a higher level of democracy signifies that a country could be better representing its people's interests and thus already addressing a potential NCD epidemic by diverting internal funds towards addressing this health burden. In this way, donor countries may believe it is less necessary to provide funding for NCDs versus other causes in the country or they believe that their funding is more impactful in other countries. Additionally, this relationship could have occurred because of the limited funding data available and may misrepresent the population. Moreover, FDI was not statistically significant, which provided evidence against my hypothesis. A potential explanation for this is that donor countries do not treat foreign aid for health as an indirect form of investment as I theorized but rather see it as a more complex process in relation to health outcomes. However, this relationship may also be occurring because of the limited available data on funding.

Given the context of current funding levels and needs, these results are also economically meaningful. The WHO (2018) states that implementing their Best Buys, which are targeted cost-effective interventions for risk factors for NCDs, would cost an additional investment of up to $1.27 USD per capita per year in lower- and middle- income countries. This investment if continued from 2018 to 2030 would combat NCDs enough to achieve Sustainable Development Goal 3.4, associated with reducing global premature mortality from NCDs by one third by 2030. Using a case study from this report's dataset, in 2015 Ghana received an average of about 19 cents 2018 USD per capita in DAH for NCDs. Thus, for a country like Ghana, the model results suggest that a one unit increase in trade openness is associated on average with in an increase to 21 cents in DAH. Moreover, on average, a one unit increase in level of democracy is associated with a drop to 12 cents 2018 USD per capita. As further illustration of these results, a significant political or economic event that drastically changes the evaluation of a recipient country's trade openness or level of democracy by several units would be associated with a substantive adjustment in DAH ceteris paribus. Therefore, in the context of NCDs, in which small increases in foreign aid substantially combat the disease burden, these results demonstrate that changes in a recipient country's socioeconomic evaluations are associated with consequential changes in funding.

Although not the focus of this report, I will briefly address the aforementioned regression results listed in the appendix. As the regression results including all donor groups in the dataset were less statistically significant and offered substantively different coefficients than the results of only bilateral DAH, there is evidence that specifying the donor groups allows for a more meaningful model. Furthermore, for the results derived from only multilateral organizations as well as the results of just NGOs/foundations data, the lack of statistical significance for Trade Openness and Level of Democracy supports the assertion that different donor groups prioritize different factors. Additionally, I will also concisely acknowledge results of the bilateral data model with the independent variables lagged by one year recorded in the appendix. As these results were not substantively different than the regression without lagged variables, there is no evidence to support that this regression is more effective in modeling donor country priorities than the main regression I selected for this paper.

There are many important questions that stem from this work, such as how the

determinants of DAH provided to recipient countries to combat contagious diseases contrast with foreign aid for NCDs. Additionally, there is a plethora of conditions included under the umbrella of NCDs, such as disabilities stemming from paralysis or blindness. One study by health economists postulates that donor groups may view these conditions more sympathetically than cardiovascular disease or type II diabetes as the latter can be caused by lifestyle choices that some societies view as a person bringing on themselves (Nugent and Feigl, 2010). In fact, this report finds that blindness receives the highest amount of funding out of all NCDs while diabetes receives the twelfth amount of funding. With this broad inclusion of conditions in NCDs and their varying degrees of funding, overall NCDs financial data points are not entirely representative of NCD funding patterns as changes in aid year by year for less-funded diseases may be buried within the larger amounts of more funded diseases, thus hiding significant decreases or increases for specific disease groups. However, as stated previously, there is unfortunately not enough data on individual diseases to accurately test if there are variations in how different NCDs are viewed, if this correlates with how much funding specific diseases receive, and if that skews general NCD funding at some points in time.

Moving forward, it would be useful for researchers to develop a unified dataset that includes both categorizations of donor groups including bilateral, multilateral, and NGO/foundations for funding for NCDs as well as total health funding. This would offer a more complete understanding of DAH patterns for NCDs in comparison to other foreign aid for health. Given the availability of this data, it would be meaningful to develop specified models for NGO/foundation and multilateral organization priorities as these groups are significant funders for NCDs and DAH in general. Gathering data for a larger range of years would also be meaningful in incurring more observations and more accurately observing changes in patterns over time. It would also be valuable to procure quantitative measurements of dyadic relationships for historical, trade, and political ties as previously discussed. Future studies could also include variables to represent local healthcare spending in the recipient country as this may offer insight into demands for external funding through DAH. Additionally, developing a model that includes social, political, and economic factors of the donor country in addition to the recipient country may offer meaningful results. However, this regression could also hold potential issues with multicollinearity as mentioned earlier. It may also be worthwhile to explore lagging the independent variables by more than one year as it is unclear how recent of statistics state agencies are considering when allocating aid. Moreover, if a larger range of years of data was available, it would be useful to regress a lagged time series to see if previous disbursements meaningfully affect how much is allocated in future years.

These results provide interesting policy implications for bilateral aid for NCDs. While we cannot assume causality, the associations between DAH and the different political, epidemiological, and socioeconomic variables suggest significant relationships. This model provides evidence that state agencies are not considering health burdens or poverty in their allocation process. Given the significant health and socioeconomic impacts of NCDs, these results provide further incentive for recipient states and local and global health organizations to convince donor countries to disburse foreign aid in a manner that more effectively aligns with current disease burdens. Moreover, as this regression provides evidence that donor countries value trade openness, recipient countries can demonstrate a willingness to develop economic relationships with donor states to potentially increase the DAH they receive for NCDs. However,

this paper offers an incomplete model of the complex priorities and patterns of bilateral funding for NCDs. Further studies investigating political, health, and socioeconomic factors for all donor groups are necessary to understand the discrepancy between disease burden and DAH levels. Research that provides transparency into how organizations allocate funding will improve policymaking to better address the emerging NCD pandemic.

Conclusions

This paper investigates the varying epidemiological, political, and socioeconomic factors that donor countries consider when providing foreign aid for noncommunicable diseases (NCDs). Using data from RTI International and publicly available sources, I model the relationship between development assistance for health (DAH) allocated to recipient countries with their associated level of democracy, trade openness, disease burden of NCDs as estimated through disability adjusted life years (DALYs), gross domestic product, total foreign direct investment, and the interaction between GDP and DALYs. I find that there is a marginally statistically significant positive correlation between DAH and trade openness and a strongly significant negative relationship between level of democracy and DAH. I conclude that economic and political ties are prioritized to develop an indirect gain for the foreign aid disbursed. Moreover, I consider that recipient countries with high levels of democracy may be already working to effectively allocate internal funds to represent the needs of their populations, such as disease burdens, and thus are not viewed as requiring foreign assistance for NCDs. Given these results, I recommend that recipient countries and health organizations work with donor countries to disburse DAH in greater alignment with NCD burdens and poverty. I also suggest that recipient countries promote the possibility of political and economic ties to increase their external funding. Further studies on all donor groups, including multilateral organizations and NGOs and foundations are necessary to understand how organizations allocate DAH and more effectively address the NCD pandemic.

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Appendix

Table A.1:
Top 20 Countries with Highest Percentage of Average DALYs caused by NCDs (2010-2015)

Country	Average Percentage of DALYs due to NCDs	Income Group
Serbia	86.40%	Upper Middle Income
Croatia	85.46%	High Income
Bosnia and Herzegovina	85.18%	Upper Middle Income
Montenegro	84.28%	Upper Middle Income
Armenia	83.19%	Lower Middle Income
Georgia	82.91%	Lower Middle Income
Mauritius	81.38%	Upper Middle Income
Ukraine	81.33%	Lower Middle Income
Turkey	81.31%	Upper Middle Income
China	80.50%	Upper Middle Income
Chile	80.19%	Upper Middle Income
Albania	80.16%	Upper Middle Income
Belarus	80.16%	Upper Middle Income
Moldova	79.25%	Lower Middle Income

Table B.1 and B.2:
Top 20 Bilateral Donor Countries in DAH from 2010-2016

Donor Country	Average of DAH	Donor Country	Sum of DAH
United Arab Emirates	7.7974648	United Arab Emirates	148.1518312
France	1.872048772	United States	1.05E+02
Kuwait	1.845646112	France	82.37014597
Switzerland	0.7097310597	Australia	67.46602058
Australia	0.6550099085	Canada	41.08764589
United States	4.34E-01	Korea	28.64887982
Ireland	0.3241027986	Germany	23.24572452
Luxembourg	0.2975127373	Italy	22.63911065
Korea	0.2557935698	United Kingdom	22.11081149
Denmark	0.2250306027	Norway	20.6935262
New Zealand	0.2197501233	Switzerland	16.32381437
Sweden	0.202071446	Ireland	15.23283154
Belgium	0.1964195468	Belgium	12.76727054
United Kingdom	0.1889812947	Sweden	12.7305011
Austria	0.1420620104	Luxembourg	11.60299676
Italy	0.1301098313	Kuwait [KFAED]	11.07387667
Canada	0.1019544563	Spain	11.0490896
Norway	0.09449098722	Japan	8.217688505
Finland	0.08049995421	Finland	7.164495925

Table C.1 and C.2:
Top 20 Recipients of Bilateral DAH from 2010-2016

Recipient	Average of DAH		Recipient	Sum of DAH
Morocco	2.262708265		Morocco	126.7116629
Fiji	2.043874482		Kenya	70.12533983
Somalia	1.308929562		Fiji	47.00911308
Jordan	1.273857888		Jordan	31.84644721
Iraq	1.063379273		Tanzania	28.64493429
Kenya	0.8765667479		Haiti	27.60242494
Dominican Republic	0.8287295668		Afghanistan	22.85733573
Uzbekistan	0.7764661037		Uzbekistan	21.7410509
Afghanistan	0.7142917415		Dominican Republic	15.74586177
Haiti	0.6732298767		India	14.92420884
Central African Republic	0.3886793645		South Africa	13.58374127
Armenia	0.3790046281		Uganda	13.51903334
Pakistan	0.3299729489		Mongolia	12.95319605
Bosnia and Herzegovina	0.3181988869		Zambia	12.68600674
Gabon	0.3		Cambodia	11.33504655
Zimbabwe	0.2941763908		Bosnia and Herzegovina	11.13696104
Zambia	0.281911261		Pakistan	10.55913437
Nigeria	0.2789607479		China	10.29078176
Tanzania	0.2754320605		Vietnam	9.602251949

Table D.1:
Bilateral Regression Results with Myanmar Data Point Removed

	Coefficient Estimate	Standard Error	P-value
Logged GDP per capita	5.6564e-03		0.920234
Logged FDI per capita	2.2172e+00	1.8714e+00	0.237166
Percent of DALYs	-4.4570e-03	5.3349e-03	0.404235
Trade Openness	2.0108e-05	4.5436e-04	0.964735
Level of Democracy	-2.9363e-01	1.0297e-01	0.004697**
Logged GDP per capita * Percent of DALYs	-9.9425e-02	9.1694e-02	0.279223

Significance codes: 0.001 '***' 0.01 '**' 0.05 '*' 0.1

R-Squared: 0.048733
Adj. R-Squared: -0.3048
F-statistic: 2.22848 on 6 and 261 DF, p-value: 0.040883.

Table E.1:
Regression Results with all Donor Groups

	Coefficient Estimate	Standard Error	P-value
Logged GDP per capita	-0.09163859	0.07366062	0.21416
Logged FDI per capita	-3.66166350	2.48311425	0.14105
Percent of DALYs	0.00110470	0.00640897	0.86323
Trade Openness	0.00070503	0.00057099	0.21761
Level of Democracy	-0.36322164	0.14537924	0.01285*
Logged GDP per capita * Percent of DALYs	0.18141200	0.11945244	0.12958

Significance codes: 0.001 '***' 0.01 '**' 0.05 '*' 0.1

R-Squared: 0.019699
Adj. R-Squared: -0.2535
F-statistic: 1.43009 on 6 and 427 DF, p-value: 0.020146

Table E.2:
Regression Results with Multilateral Donors

	Coefficient Estimate	Standard Error	P-value
Logged GDP per capita	-0.04109771	0.11116979	0.7119
Logged FDI per capita	-1.53364501	3.93720063	0.6972
Percent of DALYs	0.00092709	0.00797623	0.9076
Trade Openness	-0.00065665	0.00075227	0.3835
Level of Democracy	0.25085233	0.21173418	0.2371
Logged GDP per capita * Percent of DALYs	0.09364867	0.193335082	0.6285

Significance codes: 0.001 '***' 0.01 '**' 0.05 '*' 0.1

R-Squared: 0.014233
Adj. R-Squared: -0.35457
F-statistic: 0.688235 on 6 and 286 DF, p-value: 0.6593.

Table E.3:
Regression Results with NGO/Foundation Donors

	Coefficient Estimate	Standard Error	P-value
Logged GDP per capita	0.03408456	0.06929381	0.6238
Logged FDI per capita	0.39309639	2.17542483	0.8570
Percent of DALYs	0.00021217	0.00614848	0.9726
Trade Openness	-0.00040020	0.00070090	0.5692
Level of Democracy	-0.15750970	0.18755551	0.4029
Logged GDP per capita * Percent of DALYs	-0.04332306	0.10641005	0.6847

Significance codes: 0.001 '***' 0.01 '**' 0.05 '*' 0.1

R-Squared: 0.027283
Adj. R-Squared: -0.56196
F-statistic: 0.486175 on 6 and 104 DF, p-value: 0.81736.

Table F.1:
Bilateral Regression Results with Independent Variables Lagged by One Year

	Coefficient Estimate	Standard Error	P-value
Logged GDP per capita lagged	0.00625644	0.05625457	0.911529
Logged FDI per capita lagged	2.19514963	1.86509151	0.240273
Percent of DALYs lagged	-0.00426167	0.00531500	0.423382
Trade Openness lagged	0.00011142	0.00043500	0.798045
Level of Democracy lagged	-0.27862657	0.10086437	0.006143 **
Logged GDP per capita lagged * Percent of DALYs lagged	-0.09808717	0.09136924	0.284020

Significance codes: 0.001 '***' 0.01 '**' 0.05 '*' 0.1

R-Squared: 0.046853
Adj. R-Squared: -0.30831
F-statistic: 2.15466 on 6 and 263 DF, p-value: 0.047781

Table G.1:
Regression Results without FDI as Independent Variable

	Coefficient Estimate	Standard Error	P-value
Logged GDP per capita	-0.05372836	0.06225330	0.38869
Percent of DALYs	-0.63002534	2.08590651	0.76280
Trade Openness	0.00089638	0.00047586	0.06043 .
Level of Democracy	-0.50129533	0.11311328	1.482e-05***
Logged GDP per capita * Percent of DALYs	0.03841951	0.10094564	0.70373

Significance codes: 0.001 '***' 0.01 '**' 0.05 '*' 0.1

R-Squared: 0.065576
Adj. R-Squared: -0.22112
F-statistic: 4.9405 on 5 and 352 DF, p-value: 0.0002195.