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「發展糧食援助」對受援國營養不良的影響：動態面板分析

The Impact of Development Food Assistance on Undernourishment in Recipient Countries: A Dynamic Panel Analysis

明剛

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Abstract

A topic that remains hotly debated in the field of development economics is how effective food aid from wealthy donor nations is when used to address complex problems of food security in developing countries. This paper seeks to answer the primary question of whether increased development food assistance actually reduces the overall number of hungry people in recipient countries. Secondary questions addressed are a) whether food assistance provided by the United States, other OECD countries, or the international community is most effective at alleviating hunger, and b) to which factors is food assistance most respondent? A panel dataset containing indicators for 62 developing countries during the time period 2005-2015 is analyzed using fixed-effects and Arellano-Bond generalized methods of moments (GMM) models that control for time-invariant heterogeneity and autocorrelation. Aid flows are disaggregated by donor group, and examined individually within the same econometric framework to uncover differences. The study finds that increasing development food assistance to a country resulted in a reduced undernourished population during the 11-year time period. Further, development food aid from multilateral donor groups like the UN proved more effective in reducing hunger in beneficiary nations than similar assistance from bilateral donors. Finally, aid from the examined donor entities responded dissimilarly to metrics such as undernourishment, world commodity prices, and political stability and violence indicators in the target country.

Key words: development food assistance, undernourishment, food security, fixed-effects model, generalized method of moments, Arellano-Bond estimator

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Acronyms

DAC	Development Assistance Committee
FAO	Food and Agricultural Organization
FEM	Fixed-Effects Model
GMM	Generalized Method of Moments
IFPRI	International Food Policy Research Institute
LDC	Least Developed Country
MNO	Multinational Organization
NGO	Non-Governmental Organization
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
PSV	Political Stability and Violence
SSA	Sub-Saharan Africa
UN	United Nations
USAID	United States Agency for International Development
USD	United States Dollars
WFP	World Food Programme

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1. Introduction

A quote by Mark Green, the current administrator of the United States Agency for International Development (USAID) is featured prominently on the government agency's official website. It reads, "The purpose of foreign aid is to end the need for its existence" (USAID, 2019). Since 1960, wealthy developed nations have provided over 4.5 trillion dollars in net official development assistance (ODA) to nations in the developing world (World Bank, 2019). Development assistance transfers are intended to help the governments of the world's least developed countries (LDCs) provide a basic standard of living for their citizens, and ultimately break vicious cycles of poverty that hinder economic advancement. In the decades since, the annual amount of development aid flows has trended up, with a dramatic acceleration at the turn of the century from 70 billion United States dollars (USD) in 1999 to 160.8 billion USD in 2017 (World Bank, 2019).

i. Motivations for the Study

Recent political sentiment in Western countries has lead to a rise of nationalism and backlash against international political institutions. In the United States, the Trump administration has proposed deep budget cuts to the State Department and USAID in order to offset increased defense spending and tax cuts. The White House's proposed 2018 budget reduced the total State Department budget from 52.8 billion USD to 37.6 billion, a nearly 29% reduction from the year before (Morello, 2017). Foreign aid spending, both directed bilaterally to partner countries and multilaterally through international organizations like the United Nations, accounts for a sizable portion of the proposed spending reductions.

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Public sentiment in the United States during the lead up to the most recent presidential election was split on the issue of whether or not foreign aid to developing countries should be increased, with 50% opposed and 48% in favor according to an April, 2016 poll on American involvement in the global economy (Pew Research Center, 2016). The American public is not alone in its skepticism of the value of foreign aid. A prominent contemporary critic of development aid is Zambian economist Dambisa Moyo. Her 2009 book *Dead Aid* argues that large-scale and prolonged cash injections into economies that are at early stages of development most often results in negative unintended consequences, such as crowding out of bourgeoning domestic industries, increased price volatility, and creating dependencies that thwart sustainable economic progress. Though she acknowledges and respects the good intentions motivating aid donations from wealthy nations, she sees the international aid system in its current form as broken. Moyo asserts that the current development industry mainly serves the bottom line of non-government organizations (NGOs) vying for contracts, while addressing persistent poverty with meaningful solutions has become an afterthought. She advocates instead for private sector financing, microcredit, and south-south cooperation as the foundation for a new development strategy for African countries going forward (Moyo, 2009).

The complexity of challenges central to international development ensure that there are no easy answers to questions of how best to alleviate hunger and poverty while also promoting prosperity and self-determination for all people around the world, regardless of the political and economic circumstances they are born into. This paper aims to unpack the intricate and nuanced relationship between developmental food assistance and undernourishment rates in recipient countries by positing three questions: First, have increased flows of development food assistance to recipient countries improved the food security situation within those countries, in terms of the

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total number of people afflicted by hunger in the population? Second, are there differences among donors in the measurable impact of their respective food assistance contribution on undernourishment in recipient countries? And third, do the drivers of food assistance differ depending on the donor entity? Determining a causal relationship between food assistance and undernourishment is the primary objective of this paper, while the second and third questions are regarded as secondary objectives.

ii. Overview of Development Assistance

In order to qualify as official development assistance (ODA), aid flows must go to developing countries with incomes under $12,276 (constant 2010 USD) and meet explicit structuring criteria. Principle among these is that funds must be directed toward economic development and welfare, and take the form of either full grants, "soft" loans with a grant element of no less than 25% of the loan, or be used for technical assistance and exchange (OECD, 2019). The majority of ODA is provided either bilaterally by a donor government's foreign development assistance department or agency (e.g. USAID), by nongovernment organizations (NGOs) contracted by governments to carry out aid projects (e.g. Oxfam International, Doctors without Borders, etc.), or multilaterally by international organizations (MNOs), such as the United Nations or the World Bank and their respective implementation divisions (e.g. the World Food Programme (WFP)). MNOs derive the majority of their funding from member nations. Independent charitable organizations with private donors, such as the Bill and Melinda Gates Foundation, account for the remaining fraction.

ODA is directed toward improving an assortment of development objectives. These include the enhancement of social infrastructure like education and public health, funding for the

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construction of economic infrastructure such as tangible bridges, roads, and information technology hardware, and humanitarian assistance following natural and manmade disasters. One of the oldest components of development assistance dating back to before the Second World War is food aid provided to combat global hunger. Food aid[1] is defined by the Organization for Economic Cooperation and Development (OECD) as ODA qualified resource flows delivered in one of three forms: 1) program assistance – balance of payments transfers that provide budgetary support for the procurement of food, 2) project assistance – targeted assistance designed to alleviate a specific hunger challenge at a regional or group level, or 3) relief food aid – aid that is freely distributed in the wake of a natural disaster or conflict (OECD, 2019).

A further distinction combines program and project assistance together under the designation of *development food assistance* because of the tendency of this type of aid flow to be longer-term and seek to preemptively address food security challenges, in contrast to the abrupt and reactionary characteristics of relief aid. According to data collected by the OECD, relief food aid has consistently outstripped development food assistance, with the totals in 2015 at $3.43 billion to $1.43 billion (constant 2017 USD), respectively. Figure 1 on the next page shows the relative amounts of development versus relief food ODA for all donors from 2005 to 2015. A greater portion of total food aid began to be allocated to development food assistance beginning around 2008, but the trend reversed in 2012, perhaps because of the Syrian refugee crisis and flare-ups of other manmade conflicts around the same time.

[1] In 2010 the United Nations began a concerted effort to redefine *food aid* as *food assistance* because of connotations of dependency that accompany the former. The term *food assistance* better reflects the cooperative intent of this type of ODA in meeting complex issues of systemic food insecurity (World Food Program, 2010). Because the term *food aid* is still included in the OECD definition, the terms are used synonymously in this paper.

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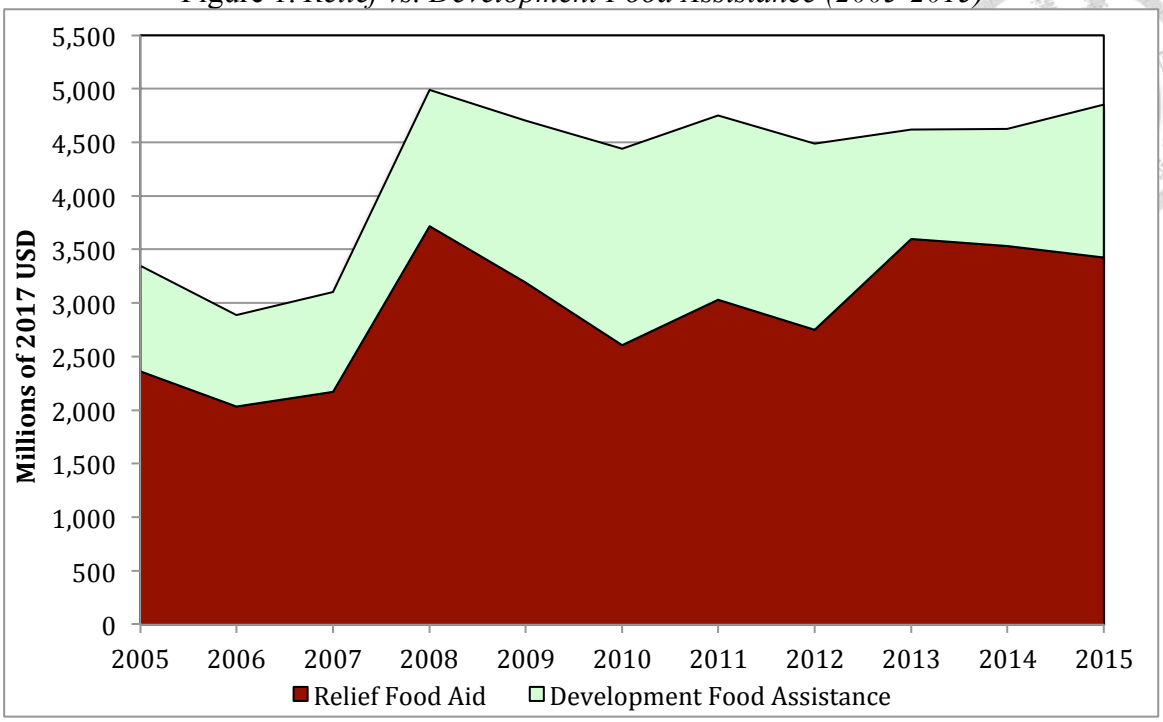
Figure 1. *Relief vs. Development Food Assistance (2005-2015)*



Though great progress has been made in reducing hunger over the past decades, today 820 million people around the world remain undernourished (FAO, 2019). Food assistance is therefore still regarded as an integral tool in combating food insecurity and achieving the UN's Sustainable Development Goal #2 of zero hunger by the year 2030 (WFP, 2019). The methods of delivering aid have evolved in recent decades, with a growing consensus building amongst practitioners that cash-based transfers are a more effective modality of delivery than traditional in-kind transfers of surplus food products grown in donor nations and then shipped to recipient countries (Hildrobo et al., 2014). Since 2000, direct transfers of in-kind commodities from donor to recipient have made up less of the total portion of food aid by delivery mode (WFP, 2012). Instead, donors are increasingly implementing assistance procurement schemes that allocate ODA funding for the purchase of foodstuffs from local producers in the target country, thereby supporting local markets. If local markets are unable to support the added demand from procurement funding, a method known as triangular purchasing is becoming increasingly

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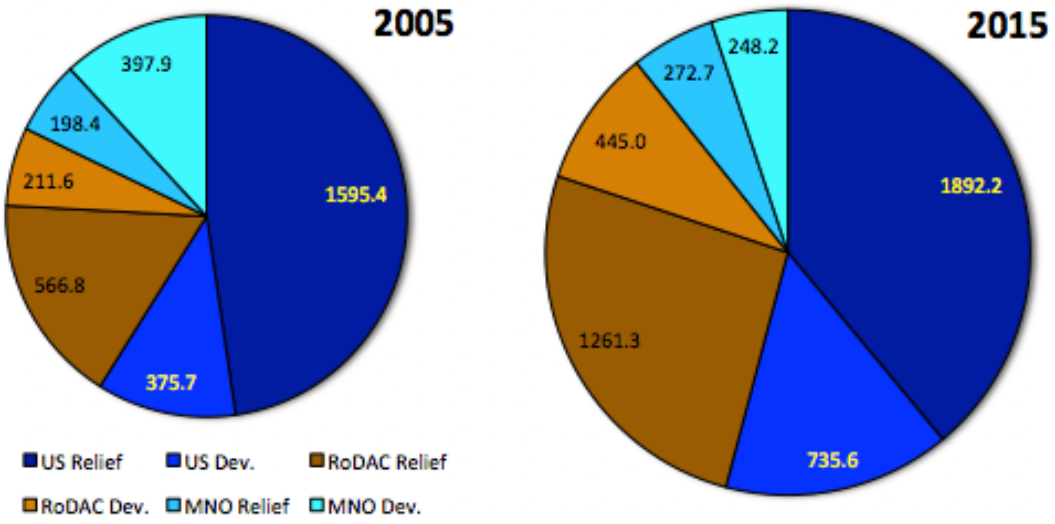
utilized. In this type of delivery mode, agricultural products are bought from a proxy country (usually geographically near to the target country), and then are sent to the beneficiary nation (WFP, 2013).

The largest development food assistance provider is the United States of America, donating over $2.5 billion in ODA food aid in 2017 (OECD, 2018). However, only $670 million of that total figure was in development food assistance (i.e. program or project food assistance), with the rest designated as relief food aid. The pie charts in figure 2 breakdown total food assistance in 2005 and 2015 by the three donor groups examined, and then within each group by how much was relief aid versus development assistance in each respective year.

Figure 2. *US, DAC, and MNO Food Assistance in 2005 and 2015 (millions 2017 USD)*



Source data: OECD

The United States has been slow to adopt proven alternative delivery modes to in-kind direct transfers. In 2012, 94% of American food assistance was still in the form of direct transfers. By contrast even though 92% of its food assistance was for the purpose of emergency relief, only 31% of food aid delivered by the United Nations was classified as direct transfer during the same year, with local and triangular purchases accounting for 30% and 39% of the

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international body's food assistance, respectively (see figure 3). Many top donor nations and members of the Organization for Economic Cooperation and Development also have shifted away from direct transfers in favor of local and triangular purchases regardless of the type of aid, whether it be project, program, or relief.

Figure 3. *Food Aid Profile of Main Donors in 2012 (percentages)*

	Canada	China	Japan	United Nations	U.S.A.
FOOD AID CATEGORY					
Emergency	76	100	44	92	54
Project	24	0	18	8	46
Program	-	-	38	-	-
FOOD TYPE					
Cereals	78	99	93	89	84
Non-Cereals	22	1	7	11	16
FOOD AID CHANNELS					
Bilateral	-	99	43	-	3
Multilateral	88	1	57	70	48
NGOs	12	-	-	30	49
DELIVERY MODE					
Direct transfer	0	99	44	31	94
Local purchase	33	0	30	30	5
Triangular purchase	67	1	26	39	1

Source: WFP, 2013

Discrepancies between aid from the top donor country and the rest of the aid-providing community lend credence to questions of whether or not disparities exist in the drivers that most determine the scope and scale of food aid committed by the US and other main aid providers, and more importantly whether outcomes in countries predominately targeted by the US differ in comparison to those where other donors are more active. This paper seeks to shed more light on these questions by examining developmental food assistance flows provided by the US, other top bilateral donor nations, and Multinational Organizations to 62 developing countries between 2005 and 2015. This thesis examines one primary question and two secondary questions:

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Primary – Does a discernable causal relationship exist between increased volumes of development food assistance dispersed to a recipient country and a reduction of the total number of people afflicted by undernourishment within the recipient country?

Secondary #1 – If a causal relationship exists, does the impact of food assistance on undernourishment differ depending on the donor entity that provides the ODA?

Secondary #2 – Does the amount of development food assistance provided by each of the three donor groups respond differently to certain driving factors, including the prevalence of undernourishment within a recipient country?

iii. Literature Review

The Food and Agricultural Organization (FAO) of the United Nations regularly publishes reports that assess the scope and scale of the food security situation around the globe, which include detailed data and trend analysis of development assistance flows. FAO reports are useful in profiling the unique challenges a particular country faces as it seeks to address both immediate and longer-term hunger related issues, tracking the volume and dissemination of food ODA flows, and understanding strategies and frameworks applied by donors in their implementation of development food assistance. Though these reports quantify well the breadth of food assistance operations in terms of mouths fed, measuring the marginal effect of increased aid on food security indicators most often remains outside purview of these papers.

The body of empirical evidence that seeks to establish a causal effect between food assistance and systemic hunger is somewhat scant. A clear consensus on whether or not food aid actually brings about improved food security does not exist, as the findings of different studies often contradict one another. The methodology employed by most researchers examining

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impacts from development food aid deal with case studies at the local or regional level within a country, and most often use survey data of households during a given timeframe.

A recent case study from Mali examined whether differences in nutritional outcomes existed between household that received food assistance and those that did not in between 2012-2017, a period when widespread conflict and sectarian violence increased sharply. The researchers applied a difference-in-difference model to survey data collected in locations across the vast, arid North African country. Their results suggested that there was indeed higher consumption of key nutrients, improved dietary diversity, and better outcomes in terms of childhood stunting observed within the groups that received aid than those that did not over the five-year period. The authors surmise that, " . . . in settings characterized by chronic food insecurity and conflict, food transfers may have a protective effect on food security of vulnerable populations." (Tranchant et al., 2019). Conclusions from this study support the case that short-term, targeted relief food aid can be effective in alleviating severe and sudden food insecurity, but do not address impacts from sustained development food assistance.

A 2005 study conducted by the International Food Policy Research Institute (IFPRI), a Washington D.C. based agricultural economics think tank, examined whether or not food aid had a disincentive effect on crop production at the individual level in Ethiopia, then expanded the findings to all of sub-Saharan Africa (SSA). According to Abdulai, Barrett, & Hoddinott (2005), an inverse relationship between food aid volumes and crop yield rates seems apparent when examining the baseline data of these two variables. However, once controlling for the endogeneity of food aid, they concluded that no evidence existed to suggest that food aid had a disincentive effect on aid recipients. To the contrary, their findings suggested that a *positive*

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relationship between aid and agricultural productivity might exist, whereby areas that received higher amounts of food assistance often experienced increased yield rates (Abdulai et al., 2005).

The contrarian nature of research on this topic is exemplified by the findings of Abdulai et al. (2005) being directly refuted in a later study conducted by Kirwan & McMillan (2007) examining the link between food aid and poverty. The latter examined data from 99 developing countries over the last three decades of the 20th century, and compare the findings to subsets of the developing countries list based on income level. They find that except during the 1980's, consumption of in-kind cereal food aid as a percentage of total cereal consumption was higher in the upper income brackets of the developing countries than in the lowest income tier, even though these lowest income countries are more reliant on food imports. This finding was most pronounced in sub-Saharan African (SSA) nations, where many countries that once were food exporters became food importers, and where citizens on average allocated a higher percentage of their income to food, yet received less food assistance than other more well-off developing countries. The study concludes that, "Food aid is unreliable and has not delivered long-term developmental benefits to the poorest countries." (Kirawan & McMillan, 2007, 1159). The authors directly address concerns with the previously mentioned 2005 IFPRI study in a footnote, arguing that the positive relationship between food aid and food production identified in Ethiopia by Abdulai et al. (2005) is attributable to short-term cyclical trends, and therefore cannot be used as justification that food aid has long-term beneficial effects (Kirawan & McMillan, 2007).

Using the data from Ethiopia, the authors reveal another interesting finding regarding incentives for food aid. They highlight the existence of a strong inverse relationship (-0.761) between the price of wheat in the US and the total tonnage of food aid sent to Ethiopia between 1983-2003 (Kirawan & McMillan, 2007, 1154). This suggests that at least in the case of

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America, domestic commodity prices in home markets dictate food aid flows to a greater extent than do the needs of undernourished populations in the recipient country. If this were indeed the case, there would be a major misalignment between the stated goals of development food assistance and the apparent incentive of expanding markets for surplus products, a practice that could be considered tantamount to dumping.

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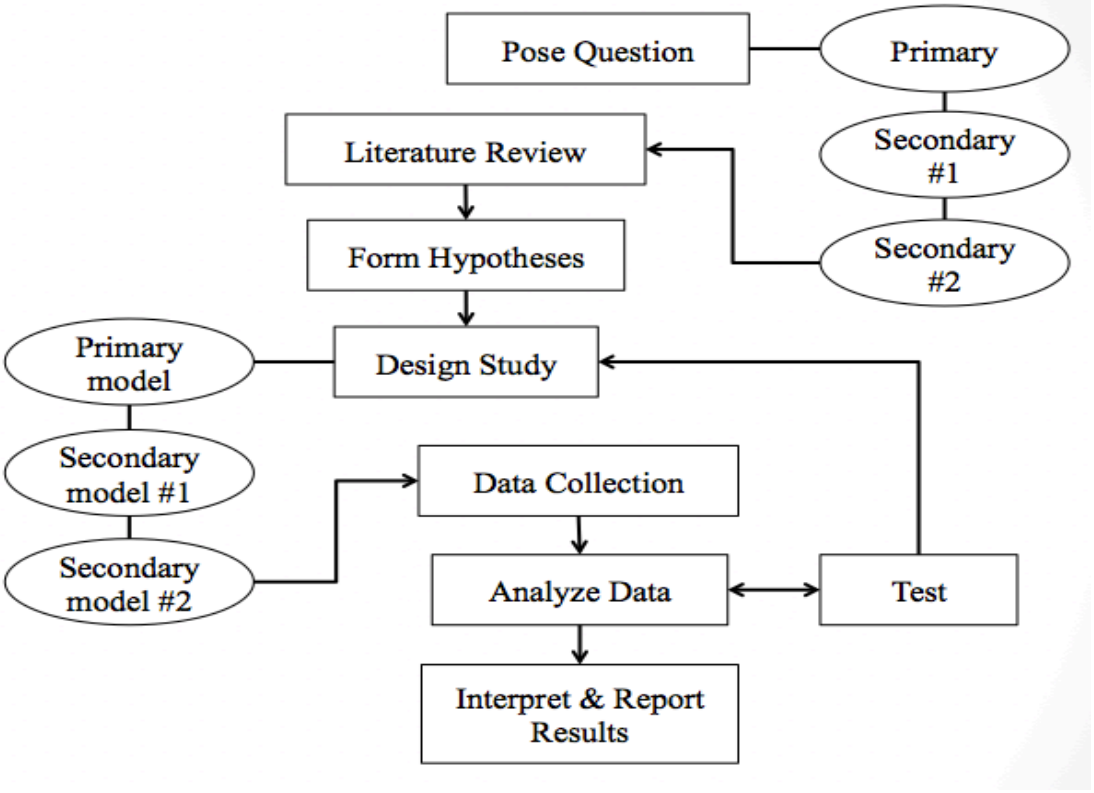
2. Methodology

In order to answer the primary and two secondary research questions posed on the relationship between development food assistance and undernourishment, panel data at the national level was assembled and examined using econometric models that both control for endogenous variables and eliminate time-invariant differences between recipient countries. The steps taken in the research process are depicted below.

Figure 4. *Research Process*



Separate econometric models are applied to each of the three research questions. During the analysis stage, tests beyond basic significance testing are applied in order to assess the appropriateness of each panel data technique used. If poor results from these tests were revealed, the model was modified until acceptable appropriateness of the model could be established. Such modifications included expanding the data set, or introducing or removing control variables, while still carefully considering the relevance and necessity of each variable's inclusion.

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i. Conceptual Framework

The metric the United Nations uses to broadly measure hunger is undernourishment. According to the Food and Agricultural Organization, an individual is considered undernourished if he/she consistently consumes dietary energy levels below a country-specific threshold deemed satisfactory to conduct low-intensity activities (FAO, 2008). A proper consideration of factors that most contribute to the prevalence of undernourishment at the country level requires the accurate identification of both short and long-term variables likely to prohibit adequate dietary intake.

Food security issues are usually viewed through the four categories of availability, access, utilization, and stability (WFP, 2019). Availability concerns overall supply in a geographic region, either via local production or the capacity to bring food into local markets. Good indicators to measure availability might include domestic crop yields, agricultural import flows, the state of road infrastructure, potential food storage capacity, etc. Access pertains to economic factors that enable or restrict an individual's procurement of foodstuffs. Per capita income and food prices are the important variables regarding access. Third, the nutritional makeup, storage, and sanitation practices fall under the designation of utilization. Variables that might be good indicators of utilization could include dietary variety scores, or data detailing the amount of food loss/waste at each node along the supply chain from grower to consumer. The fourth and final component of food security is stability, which often depends on the prevalence of natural or man

made disasters. Destabilizing events such as these often adversely impact the other three dimensions of food security in the short run (FAO, 2008).

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The primary aim of this study is to ascertain if there is indeed a statistically significant causal relationship between development food assistance and undernourishment at the country level. To answer this question, prevalent macroeconomic indicators as determined by the researcher that vary over time are chosen as control variables. These include per capita income, cereal production per capita, cereal imports per capita, a country's rural population, and a score measuring political stability and violence within the recipient country. The dependent variable, development food assistance, is comprised of ODA funding for programs and projects that focus on improving the long-term food security outlook of the recipient country. This indicator excludes emergency food aid that is dispensed indiscriminately in the short run to quell sudden hunger crises that are triggered by natural or manmade shocks. Relief food aid is categorized as humanitarian assistance by the OECD, so disaggregating this type of food aid from other disaster response funding proves challenging, especially after 2012 when the World Food Programme discontinued its Food Aid Information System (FAIS) database as part of a concerted effort to move away from the notion of food assistance as "aid." For the sake of consistency, this paper will only examine program and project food assistance from 2005 to 2015, which can still come in a variety of forms, including cash-based transfers, vouchers, in-kind food transfers, and funding for technical knowledge exchange.

Establishing a clear causal relationship between development food assistance and undernourishment across many distinct countries over time proves challenging for two primary reasons. The first is due to inherent dissimilarities between countries that could potentially explain differences of their respective levels of undernourishment. Innate characteristics that differ between groups and do not significantly fluctuate over time are referred to in the economic literature as, "unobserved time-invariant individual effects" (Finkel, 1995). In datasets where

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variables are grouped by country, such as those used for this analysis, time-invariant differences might include, but are not limited to, geographic factors (e.g. coastline, arable land area, access to water, etc.), and/or historical and cultural differences (e.g. colonial past, openness to the international community, etc.). Time-invariant heterogeneity between countries proves problematic because a) it is often unobservable, and b) it can conflate the effect of a change in the explanatory variable of interest X on the depended variable Y. Therefore, pooling the data and using ordinary least squares (OLS) regression analysis will yield bias results. The unobserved time-invariant differences between countries must be controlled for to properly examine the relationship between fluctuations of the variables of interest.

The second challenge in establishing a causal relationship with panel data arises from identifying the presence of a trend component, and then quantifying to what extent this trend can explain the observed changes of the outcome variable from one period the next. If the prevalence of hunger in a country during subsequent time periods is highly predictive of hunger rates in the present, autocorrelation exists in the time series component of the data, and should be corrected for using a dynamic model. Remedies used to suppress the effects of the trend term often introduce problems of endogeneity and reciprocal causality (Finkel, 1995). A convincing model that establishes one-way causality will have to incorporate components that sufficiently deal with the disturbances in the data that may arise from these challenges.

Taking these challenges into consideration, the model employed to address the primary question (i.e. whether development food assistance is effective in reducing undernourishment) will assign the undernourished population as the dependent variable and the total volume of development food assistance provided in a given year as the independent variable of interest. Previously mentioned explanatory variables will be included as control variables. The applied

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analysis used to answer secondary question #1 (i.e. whether there are differences in the effectiveness of food assistance across donor groups) will utilize the same model, but differentiate the independent variable of interest based on donor. US food aid, DAC food aid, and MNO food aid will each be substituted in as the independent variable of interest in separate models so that differences in the results may be easily compared. Finally, the approach used to examine secondary question #2 (i.e. whether food assistance from different donors is respondent to different factors) will reverse the causal relationship of the previous models around the equal sign, making development food aid the dependent variable and undernourishment an independent variable of interest, among other new variables such as world grain prices, import dependency, etc. Again, food aid figures for each respective donor group will be examined individually.

ii. Econometric Models

As was previously stated, the existence of unobserved heterogeneity across countries requires a more rigorous model than standard pooled OLS regression, which would yield biased results. A superior approach is to apply a fixed-effects style model, which separates the error term into a group and an individual component. Observations with unobserved time-invariant effects can be modeled by the equation:

$$y_{it} = \beta_i x_{it} + \alpha_i + \varepsilon_{it} \qquad [2.1]$$

Here, y is the outcome variable, x are explanatory variables, i represents individuals, t represents time period, β is the estimator term for a given explanatory variable, and the error term is divided between an individual time-invariant error α that remains constant, and an idiosyncratic error ε

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that corresponds to each distinct observation. In the case of countries as groups, a fixed-effects model (FEM) is the preferred panel data analytical tool as opposed to a random-effects approach that regards the time-invariant term as stochastic rather than a function of each group's innate characteristics. Fixed-effects eliminates the constant error component α_i by subtracting the within group average to leave time-demeaned variables.

$$y_{it} - \bar{y}_i = \beta_i(x_{it} - \bar{x}_i) + \alpha_i - \alpha_i + \varepsilon_{it} - \bar{\varepsilon}_i$$

$$\ddot{y}_{it} = \beta_i \ddot{x}_{it} + \ddot{\varepsilon}_{it} \qquad [2.2]$$

This transformation allows only the variation within groups to be compared, better capturing how changes of variables relate to one another regardless of country specific factors (Wooldridge, 2009).

Utilizing a fixed-effects model is important to eliminate the unobservable time-invariant differences between countries that might contribute to differences in the undernourishment rate, such as geography, cultural norms, and colonial history. However, the FEM in its current form does not adequately correct for the dynamic nature of the model. Specifically, autocorrelation of the dependent variable with previous years may conflate estimates for independent variables of interest, leading to bias (Finkel, 1995). This can be corrected for by introducing a lagged dependent variable y_{it-1} as a regressor.

$$y_{it} = \beta_i y_{it-1} + \beta_i x_{it} + \alpha_i + \varepsilon_{it} \qquad [2.3]$$

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Again, a transformation is needed to eliminate the fixed-effects term α_i. Similar to the previously discussed FEM, first differencing can be applied to equation 2.3 in order to hone in on within variation, yielding the following marginal effect model.

$$\Delta y_{it} = \beta_i \Delta y_{it-1} + \beta_i \Delta x_{it} + \Delta \varepsilon_{it} \quad [2.4]$$

However, this model too is not ready for use due to endogeneity of the lagged dependent variable, along with any other explanatory variables that may be endogenous. In the absence of obvious and strong instruments, previous lagged values of the dependent variable can be used as instrumental variables as long as they remain uncorrelated with the error term (Anderson & Hsiao, 1982). For panel data with many groups but few time periods, an Arellano-Bond generalized methods of moments (GMM) approach can be applied which takes advantage of second-lagged values of the dependent variable by including them as instrumental variables (IVs), along with lagged values of other exogenous variables. This in conjunction creates a powerful predictive dynamic panel model.

In order to introduce instrumental variables Z into a GMM framework, the assumption that instruments are exogenous must be true, where the equation $E(z_i u_i) = 0$ holds. GMM works by finding an estimator β that sets the moment conditions as close to zero as possible. Each IV is regarded as a moment condition (Baum et al., 2002). According to its founder Lars Peter Hansen[2], GMM is an advantageous model when distributions are not fully known because GMM is consistent and asymptotically normal under the assumption that, "observable variables are stationary and ergodic" (Hansen, 1982). Rather than first differencing, GMM takes advantage of orthogonal transformations, making it efficient and robust.

[2] Hansen shared the 2013 Nobel Piece Prize in Economics for his work on GMM.

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In order to practically apply this model in STATA, the proprietary command structure **xtabond2** written by David Roodman (2009) is available. This command structure allows for increased flexibility in specifying an Arellano-Bond GMM model due to its many built in options, such as two-step and orthogonal transformation commands (Roodman, 2009).

In conclusion, the approach applied to examine the impact of development food assistance on undernourishment, as posed by the primary and secondary question #1, is first, to use pooled OLS linear regression to identify general relationships between variables. Then, a FEM model is applied to eliminate time-invariant heterogeneity across groups. Next, the first-difference model with a lagged dependent variable instrument expressed by equation 2.4 is applied for the purpose of contextualizing the approach taken to control for time invariant heterogeneity and autocorrelation previously described. The final and most comprehensive model used to examine the impact of food assistance on undernourishment is the Arellano-Bond GMM dynamic panel model.

The second secondary question regarding differences in drivers of food assistance across donors will be tackled by using a fixed-effects model (equation 2.2). There is more variance from year to year in the amount of development food assistance provided by each donor group, so controlling for autocorrelation is not necessary. However, country specific fixed-effects that might impact ODA volumes still must be controlled for, such as physical distance between the donor and recipient county, geopolitical importance of the recipient country to the donor, etc.

iii. Tests

In all output tables the statistical significance of variables is reported using p-values at the 1%, 5%, and 10% confidence intervals. A modified Wald test is used to determine the presence

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of heteroskedasticity for the FEM. If variables are heteroskedastic, the model is adjusted by applying robust standard errors. As explained by Bauman et al. (2002), GMM models are already robust to heteroskedasticity, so this post-estimation test does not apply to the Arellano-Bond estimations.

Regarding fixed vs. random effects, a Hausman test can be used in order to confirm the theoretical assumption that a fixed-effects model is more appropriate than a random-effects model when controlling for unobserved time-invariant heterogeneity between countries. This test compares the residuals of the two models in order to determine whether the individual error term ε_i is correlated with the regressors (Greene, 2008). The null hypothesis is that they are not, and if they are not that random-effects should be applied. If the result from this test is significant at the 5% level, it can safely be assumed that a fixed-effects model should be used.

Tests that accompany the Arellano-Bond GMM regression are Arellano-Bond tests for auto correlation in the first and second differences, denoted as AR(1) and AR(2) respectively in the reporting tables. These tests determine whether the lagged-values used as instruments are correlated with the errors, and therefore are poor instruments. The null hypothesis is that they are uncorrelated. Since only second lagged values and beyond are used as instruments in the dynamic GMM model, only the results from AR(2) are of concern for the reporting purposes of this study.

Along with autocorrelation, the other main concern for Arellano-Bond estimation is over-identification, where moments substantially exceed parameters. This typically occurs when too many instruments are included in the model. A general rule of thumb when specifying an Arellano-Bond model is to not let the number of IVs exceed the number of groups in the dataset. Beyond the IV to group ratio, there are two tests for over identification reported in the STATA

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output for the **xtabond2** package: the Sargan test and the Hansen test. For two-step robust GMM estimations, the Hanson test is most relevant. The lower the value of this statistic the better, with an acceptable threshold being under 0.25 (Roodman, 2009, 129). Instrument proliferation can weaken the dependability of the Hanson statistic, so the Sargan statistic is also reported even though it is not robust to heteroskedasticity or autocorrelation. (Roodman, 2009, 97) Again, lower is better for this test. When considered in tandem, the Sargan and Hansen statistics can give a fairly accurate reading of whether or not the researcher should be concerned about over-identification.

Finally, classifying variables as either endogenous or exogenous is important for designating correct instruments in the Arellano-Bond framework. For this analysis, this is simply achieved by examining a variable correlation matrix and intuitive inference based in economic theory about the relationship between included variables.

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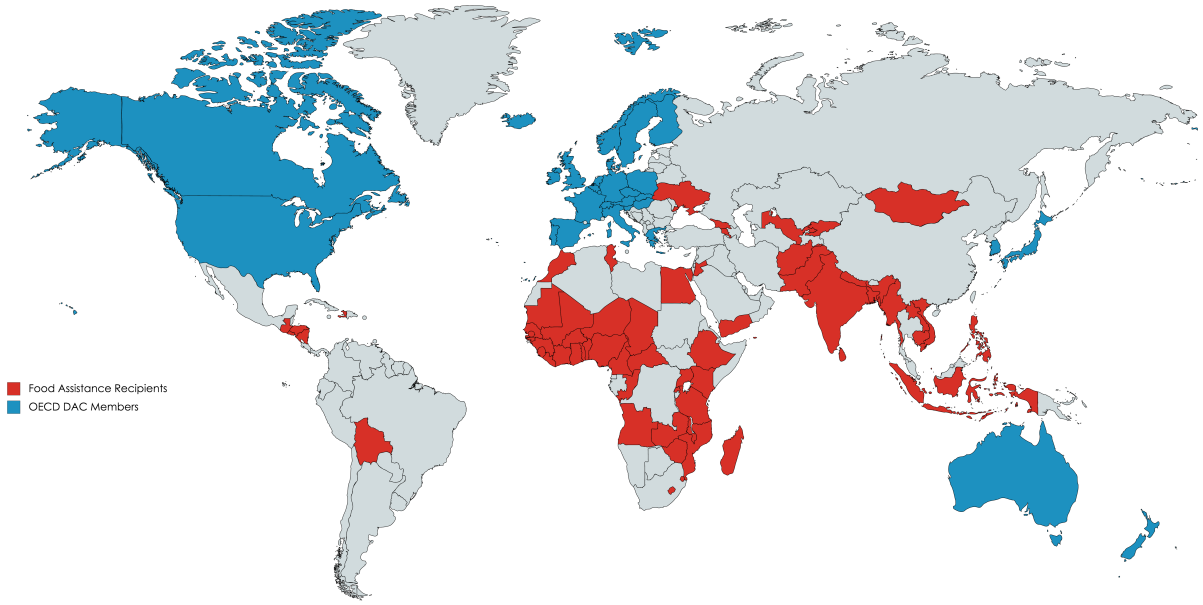
3. Data

For this study a panel dataset comprising 62 groups (i.e. countries) over 11 years was constructed by collecting from various open source and well regarded databases, such as the Food and Agricultural Organization's FAOSTAT, World Bank Open Data, and OECD statistics.

Figure 5. *Donor & Recipient Countries Examined*



(Figure generated by researcher using mapchart.net)

Countries depicted in blue in figure 5 are the permanent members of the OECD's development assistance committee. These 29 countries comprise the majority of ODA, both bilaterally and multilaterally. Notable absences are Brazil, and China, who along with other countries are not permanent DAC members, but are still significant contributors to the budget of United Nations and other MNOs.

The 62 countries in red are the ODA recipient countries examined for this analysis. The most important criteria for choosing these countries were that there was a significant prevalence of undernourishment, that they were net recipients of ODA between 2005-2015, and that adequate data existed for these two main indicators. Notable absences are Sudan, South Sudan,

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Somalia, the Democratic Republic of the Congo, Iraq, and Syria. Though they all are significant aid recipients and have sizable undernourished populations, data for these countries is either non-existent or has substantial gaps and inconsistencies. These are some of the most violent and war-torn countries in the world, so data collection is challenging. Though the inclusion of these countries in the dataset would undoubtedly be beneficial to research such as this on food security and aid, their omission from the study is not expected to adversely bias the results because of the large availability of data from other developing countries.

The panel data is strongly balanced and contains 682 observations. Data for development food assistance comes from the OECD.*stat* database. Due to the comprehensive annual reporting of this database, zero values are regarded as donation values of $0 rather than missing values. The mean, standard deviation, and range of the pooled dataset of development food assistance are provided for reference in the figure below. For statistics on undernourishment and food assistance flows by individual country, see Appendix A.

Figure 6. *Descriptive Statistics for Development Food Assistance*

Donor Group	Observations	Mean	Standard Deviation	Minimum	Maximum
Total (mil. US$)	682	17.9	30.9	- 0.5	303.4
US Food Aid (mil. US$)	682	8.5	14.6	0	135.6
DAC Food Aid (mil. US$)	682	5.5	14.9	- 0.5	188.5
MNO Food Aid (mil. US$)	682	3.7	8.2	0	73.9

When choosing which variables to include in the analysis, careful consideration was taken to use units of measurement for each indicator that would be intuitive when comparing the

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relationships between variables. The definition, unit of measurement, and source for each variable used in all analyses are listed here:

1. Food Assistance – The total amount of official development food assistance disbursements that a recipient country receives, denoted in constant 2017 USD. Does not include relief food aid, only project and program assistance. Source: OECD.*stat.*

2. Undernourished Population – The total headcount of people in a country whose dietary energy consumption does not meet a sufficient level for positive health outcomes. Source: FAOSTAT.

3. Gross Domestic Product per capita – The total value of goods and services produced within a country in a given year divided by the population. Denoted in 2011 international dollars, and adjusted for purchasing price parity. Source: The World Bank.

4. Cereal Production Per Capita – The volume of cereal grains produced annually within a country divided by the total population in that year. Metric tonnes. Source: FAOSTAT

5. Rural Population – total number of people living in rural areas, as opposed to urban areas. Source: The World Bank.

6. Political Stability and Absence of Violence/Terrorism Indicator – A measurement of perception that politically motivated violence is likely to occur. Scores are normally

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distributed and range from approximately - 2.5 (poor) to 2.5 (good). To represent this indicator in log form, a constant term was added to the raw data in order to make all terms positive with the minimum value equal to 1 before applying the natural log transformation. Source: The World Bank.

7. Displaced Persons – Total headcount of displaced persons residing within a country in a given year. Includes asylum-seekers, refugees, internally displaced persons, and stateless persons. Source: United Nations High Commissioner for Refugees.

8. World Grain Prices – Index of aggregate global grain prices, where 2010 is the base year. Source: FAOSTAT.

9. Import Dependency – cereal imports by volume as a percentage of domestic cereal production by volume. Source: FAOSTAT.

Variables 1 through 6 are used in the analysis of food aid's impact on undernourishment. The analysis on the drivers of food aid includes variables 1-4 and 6-9. In order to use marginal analysis to compare incremental changes of variables, logarithmic transformations are applied to all variables not already in percentage terms. Another transformation used in the fixed-effects model with development food assistance as the dependent variable is a three-year moving average smoothening of each donor group's aid contributions. The codes used in the applied analysis along with descriptions are given in figure 7, where *ln* preceding a variable code reflects natural log, and *ma* is indicative of three-year moving average.

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Figure 7. *Variable Codes and Descriptions*

Variable Code	**Description**
lnunpop	Natural logarithm of the number of undernourished people in a country.
lnfood	Natural logarithm of total development food assistance disbursements from all OECD official donors (constant 2017 USD per capita).
lnmafood	Natural logarithm of the 3-year moving average of total development food assistance disbursements (constant 2017 USD per capita)
lnUSf	Natural logarithm of bilateral development food assistance disbursements from the United States (constant 2017 USD per capita).
lnDACf	Natural logarithm of combined bilateral development food assistance disbursements from 28 other permanent members of the OECD Development Assistance Council (constant 2017 USD per capita).
lnMNOf	Natural logarithm of development food assistance disbursements from multinational organizations (constant 2017 USD per capita)
lnGDPpc	Natural logarithm of annual income per capita (2011 international dollars, ppp).
lnyldpc	Natural logarithm of annual cereal production (metric tonnes).
lnPSV	Natural logarithm of a political stability and violence score ranging from -2.5 (bad) to 2.5 (good). (Adjusted so that minimum value = 1, then logged).
lndispop	Natural logarithm of displaced population residing within a country.
lnprice	Natural logarithm of the world grain price index (2010=100).
lnimport	Natural logarithm of the import dependency ratio (percentage)

Note: for the sake of redundancy, the moving average variations of individual donor food assistance variables are not included. As with ***lnmafood***, individual donor variable codes simply include *ma* after *ln*.

Digging into the data for the two main variables of interest, undernourishment and food assistance, the logged values of both follow a normal distribution, as seen in figure 8. This figure also shows the positive correlation between the pooled data of two variables, affirming that countries with higher undernourished populations tend to receive more dollars of food assistance.

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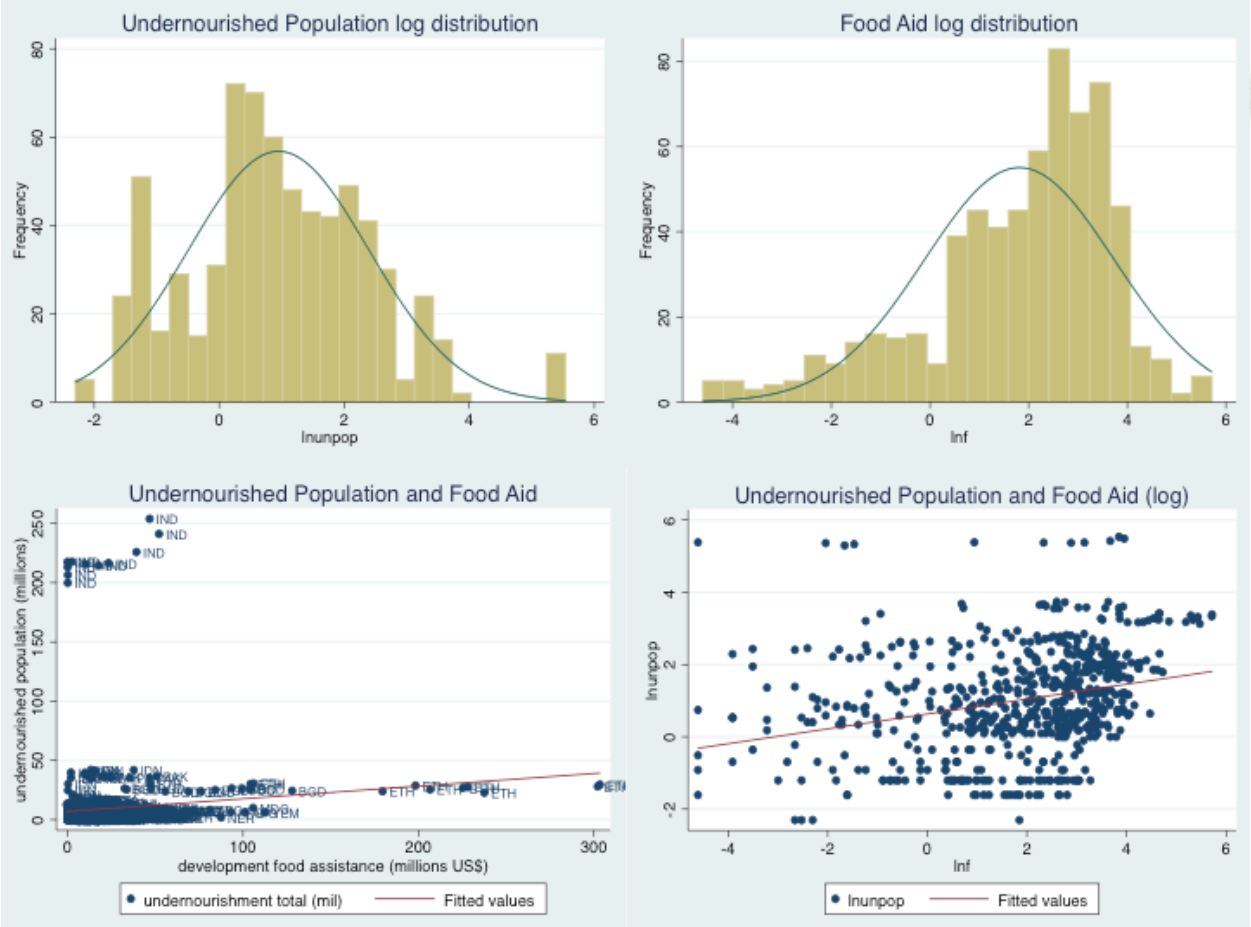
Figure 8. *Distribution and Relationship Between Food Aid and Undernourishment Data*



A notable outlier in the data is India. The second most populous country had an undernourished population of over 200 million during the examined time frame, dwarfing the rest of the developing world, none of whom had even a quarter of this number. Yet, India receives less development food assistance then other nations like Ethiopia, Bangladesh and Nigeria. This could be due solely to the difference in scale of food security issues facing the South Asian colossus. Donor nations may believe that their dollars would have more impact in smaller countries. Hopefully, the drastic progress China has made in recent decades toward reducing its undernourished population is indicative of the potential of India to achieve similar results in coming decades.

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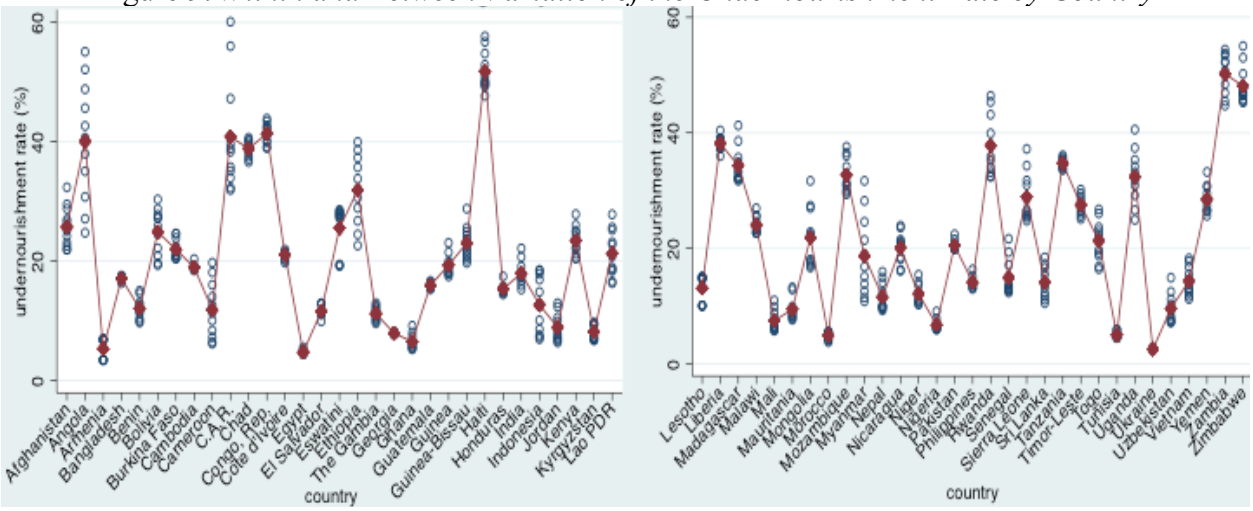
The levels of undernourishment in the 62 examined countries vary greatly, both in terms of the absolute size of the population afflicted by undernourishment, and the percentage of the total population that is undernourished, synonymously referred to as the undernourishment rate. Because the range of the latter is smaller, spanning from 3% to 51%, it is more useful in visually comparing the within and between country variation of undernourishment in one figure, as seen below.

Figure 9. *Within and Between Variation of the Undernourishment Rate by Country*



Each hollow blue dot represents the value of the undernourishment rate for a given year between 2005 and 2015, while the red diamonds are the mean value for each country over the 11-year period. Some countries experienced a large change in the undernourishment rate during this period (e.g. Angola, Central African Republic, Myanmar, etc.), though whether the variation was due to a decrease or increase in the undernourishment rate is not discernable from figure 9. For this information refer to Appendix B, where individual trend lines of the undernourishment rates for all 62 examined developing nations are included. Figure 9 is also useful in visualizing the intuition behind fixed-effects models. In FEM analysis, the data is demeaned by subtracting the mean value from each discrete observation, so that only the within variation is described by the model, therefore enabling the direct comparison of variables that fluctuate over time.

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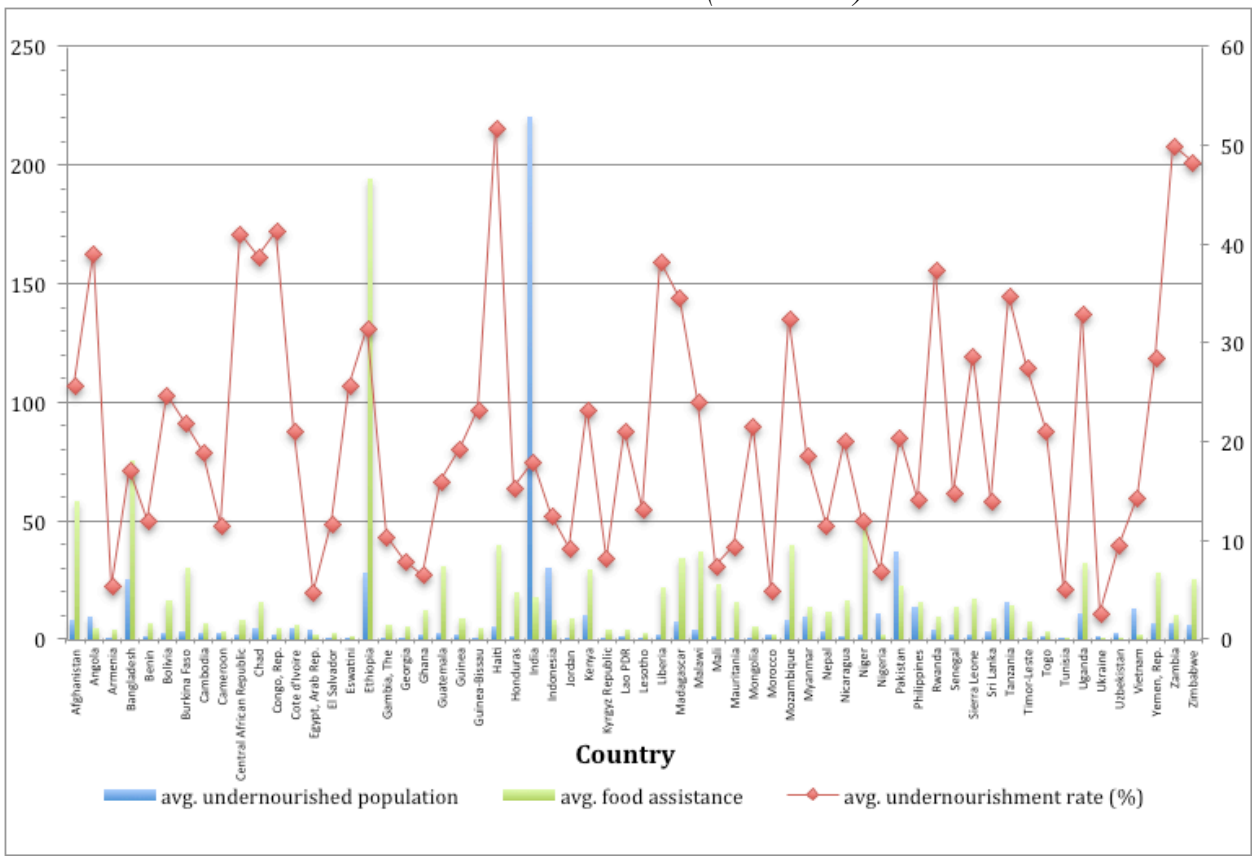
The mean connecting line from figure 9 can also be seen in the next figure, along with the absolute value for the undernourished population of each country in millions, and the total dollar amount in millions of food assistance.

Figure 10. *Average Annual Food Assistance, Undernourished Population, and Undernourishment Rate (2005-2015)*



Note: The left vertical axis represents both millions of people and millions of 2011 international dollars (ppp), while the right-hand metric denotes percentage. Data source: OECD, FAO.

The sharing of an axis denoted in millions by average undernourished population and average food assistance funding should not be thought of as an attempt to directly compare the two indicators, as no substantive insights are gained from a dollar to person ratio. Rather, including these two figures in one graph is meant only to provide a comparison of the relative differences between countries in terms of total undernourished population and total annual food ODA transfers. On average the total dollar amount a developing country receives in program or project food assistance exceeds the raw number of undernourished people in the country.

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4. Results

The primary objective of this paper is to determine if a causal relationship exists between the scale of food aid given to a country and the prevalence of undernourishment within the population. This is the subject matter of concern for the first econometric analyses within this section, followed by evaluations for both secondary questions related to the impact and incentives of individual donor groups. This chapter is therefore divided into two sections: one detailing findings in regard to the impact of food aid on food security, and the other explaining results on the drivers of food aid.

i. Impact of Food Assistance on Undernourishment

To gain a preliminary understanding of each independent variable's general relationship with the undernourished population, a pooled OLS regression is first fitted to the total dataset.

$$lnunpop = -1.06 + .059lnfood - .342lnyldpc - .123lnGDPpc + .978lnrurpop + .127lnPSV + u_{it}$$
$$(.278)^{***}\ (.013)^{***}\ \ (.025)^{***}\ \ \ (.030)^{***}\ \ \ \ (.015)^{***}\ \ \ \ (.127)^{*}$$
$$n = 644,\ R^2 = 0.878 \qquad [4.1]$$

In these numeric results expressed as an equation, the numbers in parentheses below the coefficient estimates are the robust standard error terms. Three stars indicate a p-value that is significant at the 1% confidence threshold, while two stars indicate a 5% significance level, and one star results are significant at 10%. Here, all results are significant at the 1% level except for the political stability and violence indicator, which is significant at 10%. The signs of all variables are as expected in this pooled data analysis. The positive relationship between total

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food aid and undernourished population can simply be interpreted in terms of countries with a greater number of hungry people in a given year are expected to receive larger sums of development food assistance, *ceteris paribus*. However, pooled OLS does not account for time-invariant heterogeneity, and therefore falls well short of revealing the true relationship between variables that fluctuate over time, such as food assistance and the undernourished population.

Next, a fixed-effects model is applied to examine within variation by eliminating time-invariant unobserved heterogeneity across countries.

$$lnunpop = 3.254 + .007lnfood - .084lnyldpc - .502lnGDPpc + .680lnrurpop + .085lnPSV + \varepsilon_{it}$$

$$(1.08)^{***} \quad (.007) \quad (.046)^{*} \quad (.176)^{***} \quad (.369)^{*} \quad (.083)$$

$$n = 644, \text{ within } R^2 = 0.165 \qquad [4.2]$$

In equation 4.2, the constant term represents the conflated average of individual country intercepts, while the error term ε_{it} denotes only individual idiosyncratic error, as the fixed-error term α_i has been eliminated consistent with the transformation shown by equation 2.2 from chapter 2. The food aid coefficient remains positive (albeit statistically insignificant with robust standard errors) after correcting for differences between countries. The results of a Hausman test where H_0: random-effects model is most appropriate, is rejected, thereby confirming the presence of country specific time-invariant heterogeneity.

The next model applied to the dataset is a first-differences regression with a lagged dependent variable on which the second lagged dependent variable is instrumented. This approach is used to both eliminate time-invariant error term through first-differencing transformation, and present the rational behind using a lagged dependent variable in the right-

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hand side of the equation in order to parse out the amount of change attributable to autocorrelation. Results from this regression are given in figure 11 as marginal effects.

Figure 11. *Results from First-Differences IV Regression with a Lagged Dependent Variable*

Dependent Variable: *lnunpop*	
Independent Variables	**Coefficient/Robust Standard Errors**
Δ*lnunpop*$_{t-1}$	.129 (.217)
Δ*lnfood*	-.004 (.003)
Δ*lnyldpc*	.002 (.024)
Δ*lnGDPpc*	-.497* (.243)
Δ*lnrurpop*	.351 (561)
Δ*lnPSV*	.077 (.048)
constant	.013 (.010)
Insturumented: *lnunpop*$_{t-1}$ Instruments: *lnunpop*$_{t-1}$ *lnf lnyldpc lnGDPpc lnrurpop lnpsv lnunpop*$_{t-2}$	
N = 451, Within R^2 = 0.297 Robust Standard Errors in parenthesis *** p < 0.01, ** p < 0.05, ** p < 0.1	

The *t-1* preceding a variable code indicates the lagged value of one time period, in this case year, while a two-year lag is denoted by *t-2* subscript. Results in figure 11 immediately stand out for their lack of statistical significance. Regardless, the coefficient sign for food aid changing to negative shows how a dynamic approach that includes lagged-dependent variables as

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instruments may have the potential to reveal the expected causal relationship that higher development food assistance flows lead to reduced prevalence hunger.

Finally, a systemized GMM model is applied in which many more lagged variables can be incorporated as instruments in order to both correct for bias from endogenous variables and increase efficiency. Along with the time-lagged dependent variables, all other independent variables must be designated as either endogenous or exogenous. Of the explanatory variables included, only *rural population* and *political stability and violence* are classified as strictly exogenous variables. Therefore, they can be treated as instrumental style variables in the GMM model. The endogenous variables are used as instruments in the model for all lags prior to that preceding the endogenous independent variable used in the core equation. These later lags should not be correlated with the idiosyncratic error term, making them viable instruments.

Instead of applying the traditional first-difference equation typically used in difference GMM to deal with fixed-effects, an orthogonal transformation that subtracts the mean of all future values for each variable from the current variable is utilized. This enables the preservation of a larger N value because fewer observations are dropped due to gaps in the data (Roodman, 2009). The logged values of food aid data has many gaps resulting from years with no aid, especially after separating out aid contributions by donor group.

Another option incorporated in the model's specification is two-step command, which enhances the feasibility of the GMM estimator (Roodman, 2009, 94). Also, the collapse option is applied to reduce redundancy of lagged instruments so that over-identification may be avoided by keeping the number of instrumental variables below the number of groups. The model is run using total food assistance figures, then again for food assistance from the US, DAC, and MNO separately.

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Figure 12. *Results from Dynamic Arellano-Bond System GMM Linear Panel Model*

Dependent Variable: *log(unpop)*				
Variable	**Total Food Aid**	**US Food Aid**	**DAC Food Aid**	**MNO Food Aid**
log(unpop t-1)	.873*** (.015)	.882*** (.010)	.934*** (.029)	.847*** (.024)
log(food aid)	- .010*** (.002)	- .002** (.001)	- .004*** (.001)	- .009*** (.002)
log(yldpc)	- .087*** (.009)	- .080*** (.008)	- .082*** (.031)	- .135*** (.013)
log(GDPpc)	- .063*** (.018)	- .028*** (010)	- .016 (.031)	- .037 (.023)
log(rurpop)	.128*** (.013)	.127*** (.011)	.072*** (.021)	.171*** (.024)
log(PSV)	- .017 (.018)	- .003 (.011)	- .015 (.016)	.043** (.019)
constant	.220 (.144)	.080 (.087)	- .346 (.254)	- .198 (.189)
Arellano-Bond AR(1) test	0.133	0.243	0.122	0.208
Arellano-Bond AR(2) test	0.294	0.251	0.306	0.316
Sargan test	0.000	0.002	0.000	0.000
Hansen test	0.229	0.532	0. 255	0.708
Observations Groups/IV	586 62/46	388 56/46	509 61/46	427 58/46
Standard Errors in parenthesis, *** p < 0.01, ** p < 0.05, ** p < 0.1				

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In assessing how well this model is specified, the first important indicator to note from the results is that the lagged dependent variable's coefficient is within the 1.045 to 0.733 sweat spot range described by Roodman (2009), suggesting the presence of a trend where the dependent variable is converging toward an equilibrium value (Roodman, 2009, 103). Autocorrelation between the regressors and lagged variables used as instruments does not appear to be problematic, as affirmed by both the AR(1) and AR(2) Arellano-Bond figures. For all results, each fails to reject the null hypothesis that lagged instruments are uncorrelated with the regressors. Next, the ratio of groups to instruments is acceptable for each regression, though the Hansen statistic for over-identification is approaching the concerning threshold of > 0.25 for the Total and DAC results, and exceeds that level for US and MNO results, which each have fewer available observations.

Results from this model appear insightful, as most indicators are statistically significant at 5%. Regarding the interpretation of the independent variable of interest for answering the primary question of this paper, a 1% increase in total development food assistance disbursements can be expected to result in a .01% decrease of the undernourished population within the recipient country. In comparison to the other explanatory variables examined, a 1% increase in domestic cereal production is expected to reduce undernourishment by 0.09%, where as the same marginal increase in income (i.e. GPD per capita) can be expected to reduce hunger by about 0.06%. According to the results, a higher rural population is also strongly associated with a higher undernourished population. For every 1% decline of the rural population, the undernourished population would be expected to fall by 0.128%, all else equal. Last, though the coefficient estimators do not meet the threshold for statistical significance in the total food aid

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regression results, the expected relationship that increased political stability will coincide with less undernourishment is observed.

Moving on to a comparison of aid effectiveness across donor groups, these results suggest that in marginal terms at the country level, development food assistance from multilateral organizations are most effective in reducing hunger, followed by bilateral contributions from DAC countries excluding the US, with those provided by the United States being least effective. A 1% increase of development food assistance provided by the US is expected to result in only a 0.002% reduction in the undernourished population. This ranking of donor group in terms of the impact of their respective aid is consistent with the research literature (see Hildrado et. al, 2014) that find the project and program methodologies favored by the United Nations development agencies, such as cash-based transfers, to be more effective in improving food security outcomes than in-kind food aid. As in-kind food aid accounted for the majority of US food assistance schemes during the examined period (figure 3), the lower effectiveness of American food aid does not come as a surprise. Also, it is interesting that even aggregated together, the bilateral development food aid from the rest of the 28 OECD development assistance committee member countries is twice as effective at reducing undernourishment than that disbursed by the United States, again likely due to the embrace of alternative transfer methods by the major donors in this group.

ii. Drivers of Development Food Assistance

The next model places undernourishment on the right-hand side of the equation alongside new independent variables in a fixed-effects model.

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$$lnmafood_{it} = \beta_i X_{it} + \boldsymbol{\varepsilon}_{it} \quad [4.3]$$

Here, X represents a vector of all independent explanatory variables and $\boldsymbol{\varepsilon}_{it}$ is the idiosyncratic error term. Development food assistance is now the dependent variable, and has been transformed into a three-year moving average. Results from this FEM are given in figure 13.

Figure 13. *Results for Fixed-Effects Model for Drivers of Food Aid*

Dependent Variable: *log(food aid) three-year moving average*				
Independent Variable	**Total**	**US**	**DAC**	**MNO**
log(unpop)	.663 (.585)	**2.298***** (.761)	.572 (1.008)	.516 (.793)
log(world grain price)	- .735 (.483)	**- 2.769***** (.621)	- .043 (.576)	**- 1.560**** (.773)
log(GDPpc)	- 1.252 (1.102)	- .684 (1.625)	- 1.032 (1.139)	.077 (1.224)
log(grain yield pc)	.338 (.358)	.240 (.412)	.441 (.341)	.380 (.364)
log(import depend)	**.340**** (.134)	.222 (.150)	.214 (.145)	**.200*** (.109)
log(displaced)	**.063**** (.031)	- .009 (.059)	.037 (.051)	.013 (.040)
log(PSV)	**- 1.383**** (.572)	- 1.039 (.759)	**- 1.964***** (.726)	- 1.359 (.837)
constant	**15.45**** (7.573)	24.86 (11.82)	10.51 (7.414)	8.636 (7.404)
Observation Within R-squared	529 0.146	416 0.265	491 0.071	454 0.091
Robust Standard Errors in parenthesis *** p < 0.01, ** p < 0.05, * p < 0.1				

Equation 4.3 yields a number of interesting results. First, the prevalence of undernourishment in a developing country is only a statistically significant driver of US food

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assistance, though the coefficient sign is positive for all four groups, as expected. Further, it appears that undernourishment is a substantial driver of US food assistance contributions, with a 1% increase in undernourishment corresponding to about a 2.3% increase in development food assistance.

The other statistically significant variables at the 5% threshold that drive the total three-year moving average of food ODA are import dependency, the annual displaced population, and the state of political stability and violence in the recipient country. Countries that are more dependent on food imports tend to receive more food aid. A 1% increase in the population of displaced persons residing within a country in a given year is expected to correspond to a 0.063% uptick in the undernourished population. Last, if the score measuring political stability and violence within a developing nation marginally improves by 1%, the number of undernourished people in that country can be expected to drop by roughly 1.4%. The signs for all other indicators are as expected, but none are statistically significant after the application of robust standard errors. The R-squared value for this regression is 0.146, indicating that 14.6% of the variation of total food aid over the examined period can be explained by the model.

Along with the undernourished population, movements of world grain prices appears to be the only other explanatory variable that is statistically significant in the second iteration of the regression that examines US food assistance. Just as with the case of the undernourishment rate, this indicator also induces substantial fluctuations in the three-year moving average of US food aid flows, with a coefficient of -0.277. The R-squared value of this version is the highest of all four, at 0.265.

Comparing horizontally along the same variable row in figure 13, the three-year moving average of food aid contributions from MNOs also is highly respondent to world grain prices.

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Given the different approaches to development food assistance taken by the US and MNOs described in this paper thus far, the magnitude and significance of the inverse relationship between grain prices and food aid shared by these two donors is perplexing. The finding that US food aid would increase sharply if world grain prices fall is consistent with the study by Kirawan & McMillan (2007) that describes this phenomenon during the 1970's, 80's, and 90's. Intuitively, lower global demand for farm commodities would lead to surpluses in large exporting countries such as the United States. These surpluses may then be shipped to developing countries as in-kind food aid. However, the UN and other MNOs are not large suppliers of in-kind grains, so this explanation seems faulty. An alternative theory that might explain the strong relationship between MNO food aid and commodity world grain prices could be that drops of commodity prices may adversely impact farmers in the developing world. This would create a situation where many small-scale producers, unable to compete at the lower price level, may be forced to shut down. Decreased domestic production would logically follow, increasing food stress that could warrant intervention from the international aid community.

A final point of interest illuminated by these results is the high correlation coefficient of DAC food aid to political stability and violence. The collective amount of development food assistance from these OECD countries excluding the US is expected to increase by nearly 2% for every 1% drop of the PSV score in a developing country. A possible explanation for this relationship, along with apparent altruistic intentions to help citizen of nations in turmoil, might be that many of the key aid contributors in the DAC are European nations that have seen a large influx of refugees from nations embroiled in conflict over recent years. During the examined time period of 2005-2015, many manmade disasters in North Africa and the Middle East intensified, causing the largest migrant crisis since World War II (UNHCR, 2016). European

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nations have a vested interest in cultivating stability in the countries of origin for these political and economic refugees.

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5. Conclusion

Examining the nuanced relationship between food assistance provided by wealthy donor nations to the developing world and undernourishment rates in aid recipient countries is a timely topic where clear cut inferences are scarce, and controlling for a host of confounding variables proves challenging. The results put forth in this paper were mixed in their reliability, but collectively further the dialogue on this important issue that has wide reaching impact for the lives of the poorest and most marginalized members of society. Ultimately, identifying what works and what does not when it comes to development aid is the most important objective for any research on the subject, not reaffirming the virtue of donors, nor vilifying those in the West for perpetuating the dependency of the Rest.

In its search for insights through objective analysis, this paper concluded that increased flows of development food assistance to recipient countries between 2005 and 2015 contributed to reductions of the total number undernourished people within these countries, after controlling for country specific time-invariant differences and autocorrelation. However, the causal effect of development food assistance was small when compared to that of other variables, such as income, and domestic grain production. Aid from multinational organizations had the highest positive impact on food security at the macro level, while bilateral US food aid was shown to be least effective of the three donor entities examined.

On the question of what factors most influence the amount of food aid each donor group contributed to a country, the findings suggest that food ODA from the United States was most associated with undernourishment, but also responded drastically to global commodity price fluctuations over the 11-year time period. World grain prices were also the most significant

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driver for MNOs, while bilateral development food assistance from DAC countries excluding the US responded most to changes in the political stability of recipient nations.

i. Findings in the Context of Existing Literature

It makes sense intuitively that developing countries which are beneficiaries of larger amounts of program and project food assistance will make quicker strides toward alleviating hunger. Yet the targeted nature of development food assistance schemes has made showing this relationship on a macroeconomic level challenging for researchers. However, studies at the household level have shown that food assistance does not have a disincentive effect on crop production (Abdulai et al., 2005) and that emergency food aid can serve as a bulwark against malnutrition for populations caught up in armed conflicts (Tranchant et al., 2019). The primary finding of this paper that development food assistance improves food security is inline with existing literature detailing the benefits of food ODA.

Criticisms leveled against development assistance often echo concepts from world systems theory, commonly describing dependencies created by aid donations that undermine local economies. Few however succinctly quantify the extent to which high levels of aid negatively impact recipient countries or their citizens. Where the findings of past studies critical of aid do tend to hold water are in their exposure of aid misallocation, inefficiencies, and ulterior motives that guide contributions.

This study finds that US food aid is less effective than most other bilateral and multilateral food assistance, a result that is congruent with existing literature detailing the shortcomings of in-kind direct transfers of agricultural commodities as effective aid. Hidrobo et al. (2014) showed that while in-kind donations still improve the food security situation of

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recipients, nutritional and cost-effectiveness outcomes lagged well behind those associated with cash-based transfers and vouchers. Reports from the FAO and other multilateral organizations have offered a steady stream of evidence supporting these findings in recent years, and more and more practitioners of development food assistance are embracing these alternative modes of delivery (FAO et al., 2019). The US has been slow to pivot away from in-kind transfers, but if it does reform its food aid delivery practices the gap between US food aid effectiveness in reducing undernourishment and that of MNOs detailed in this papers results can be expected to narrow in a future follow-up analysis of data over the subsequent 11-year period.

ii. Potential for Continued Study

The findings of this study, while useful in providing further insight into the relationship between development food assistance and the prevalence of hunger, fall well short of being conclusive. The intricacy of the Arellano-Bond GMM method ensures that the model could be recalibrated a number of ways to be a more efficient and robust. Introducing new instrumental variables and expanding the panel dataset to include both more groups and time periods might also improve accuracy. Applying more rigorous post estimation techniques, such as Granger causality, would also surely enhance the overall reliability of the findings.

Conducting a study using countrywide data has its own inherent limitations. Aid typically only reaches a fraction of the population of a recipient country. Therefore, comparing it to national figures for undernourishment may not be the best approach. One way to address this challenge may be to spend time compiling reliable data for relief food assistance so as to bolster the scale of contributions studied. The lines distinguishing different types of food assistance are often blurred (OECD, 2018), and since relief food aid is roughly double development food aid,

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the combined figures would likely lead to more easily discernable results. Another approach would be to hone in on data for undernourishment and other variables of interest at a regional or communal level. Applying the fixed-effects dynamic panel model approach used in this study on a rich micro data set would likely yield a result that more closely mirrors real world outcomes.

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References

Abdulai, A., Barrett, C., & Hoddinott, J. (2005). Does food aid really have disincentive effects? New evidence from sub-Saharan Africa. *World Development, 33*(10), 1689-1704.

Anderson, T.W. & Hsiao, C. (1982) Formulation and estimation of dynamic models using panel data. *Journal of Econometrics, 18*, 47-82.

Arellano, M. & Bond, S. (1991) Some tests of specification for panel data: Monte Carlo evidence and applications to employment equations. *The Review of Economic Studies, 58.*

Baum, C.F., Schaffer, M.E., & Stillman, S. (2002) Instrumental variables and GMM: Estimation and testing. Boston, MA, US: Boston College.

FAO (2008) An introduction to the basic concepts of food security. Rome, Italy: Food and Agriculture Organization of the United Nations.

FAO, IFAD, UNICEF, WFP & WHO (2019) The state of food security and nutrition in the world 2019: Safeguarding against economic slowdowns and downturns. Rome, Italy: Food and Agriculture Organization of the United Nations.

Finkel, S.E. (1995) Causal analysis with panel data. *Quantitative applications in the social sciences,* (07), 105. Thousand Oaks, CA, US: Sage Publications, Inc.

doi:10.6342/NTU201904091

Greene, W.H. (2008) Econometric analysis. 6th ed. Upper Saddle River, NJ, US: Prentice Hall.

Hanson, L.P. (1982) Large sample properties of generalized methods of moments estimators. *Econometrica, 50*(4), 1029-1054.

Hidrobo, M., Hoddinott, J., Peterman, A., Margolies, A., & Moreira, V. (2014) Cash, food, or vouchers? Evidence from a randomized experiment in northern Ecuador. *Journal of Development Economics, 107*, 144-156.

Lentz, E., Barrett, C., Gómez, M.I., & Maxwell, D.G. (2013) On the choice and impacts of innovative international food assistance instruments. *World Development, 49*, 1-8.

Morello, C. (2017) State department's 28 percent cuts hit foreign aid, U.N. and climate change. *The Washington Post*.

Moyo, D. (2009) Dead aid: Why aid is not working and how there is a better way for Africa. Vancouver: Douglas & Mcintyre. Print.

OECD (2018) OECD statistics. Paris, France. Organization for Economic Cooperation and Development. stats.oecd.org.

doi:10.6342/NTU201904091

Pew Research Center (2016). Views of impact of global economic involvement, policies toward developing countries. Washington, D.C.

Roodman, D. (2009) How to do xtabond2: An introduction to difference and system GMM in Stata. *Stata Journal 9*(1), 86-136.

Tranchant, J.P., Gelli, A., Bliznashka, L., Diallo, A.S., Sacko, M., Assima, A., Siegel, E.H., Aurino, E., & Masset, E. (2019) The impact of food assistance on food insecure populations during conflict: Evidence from a quasi-experiment in Mali. *World Development, 119*, 185-202.

UNHRC (2016) Global trends: Forced displacement in 2015. Geneva, Switzarland: United Nations High Commitioner for Refugees.

USAID (2019) Website Homepage. Washington, DC. United States Agency for International Development. usaid.gov.

Wooldridge, J.M. (2009) Introductory econometrics: A modern approach. 4ed. Mason, OH, US: South-Western Cengage Learning. Print.

World Food Programme (2013) 2012 food aid flows. Rome, Italy: Food and Agriculture Organization of the United Nations. 1-39.

doi:10.6342/NTU201904091

World Food Programme (2019) What is food security? Rome, Italy: Food and Agriculture Organization of the United Nations.

doi:10.6342/NTU201904091

Appendix A

Figure 14. *Recipient Country Undernourishment and Food Aid Statistics*

Country	Population (mil)	Undernour-ished Pop (mil)	Undernour-ishment Rate (%)	Avg. Food Assistance (mil USD)	US Avg. Food Ass. (mil USD)	DAC Avg. Food Ass. (mil USD)	MNO Avg. Food Ass. (mil USD)
Afghanistan	29.62	7.60	25.7	58.09	26.74	21.19	9.75
Angola	23.48	9.15	39.0	4.48	1.23	1.82	1.43
Armenia	2.91	0.15	5.3	4.07	1.20	0.17	2.70
Bangladesh	147.66	25.21	17.1	74.97	41.07	10.65	22.96
Benin	9.23	1.10	11.9	6.40	1.37	4.22	0.69
Bolivia	10.05	2.48	24.7	16.52	10.30	1.94	4.27
Burkina Faso	15.67	3.42	21.8	29.71	14.00	6.94	8.65
Cambodia	14.35	2.72	18.9	6.62	0.99	3.14	2.46
Cameroon	20.41	2.34	11.4	3.29	1.60	1.16	0.53
C.A.R.	4.33	1.77	41.0	8.03	2.13	5.01	0.88
Chad	12.02	4.65	38.7	15.32	4.61	7.76	2.84
Congo, Rep.	4.25	1.75	41.2	4.42	2.53	1.54	0.35
Cote d'Ivoire	20.64	4.35	21.1	5.86	0.51	4.59	0.77
Egypt	83.31	3.93	4.7	1.66	0.00	0.70	0.45
El Salvador	6.19	0.72	11.6	2.29	1.64	0.61	0.05
Eswatini	1.07	0.27	25.6	1.14	0.01	0.96	0.17
Ethiopia	88.04	27.65	31.4	194.41	57.69	92.00	44.69
Gambia	2.02	0.21	10.4	5.80	2.11	3.51	0.11
Georgia	3.79	0.30	7.9	5.14	1.91	0.13	3.09
Ghana	24.79	1.60	6.5	11.74	7.91	2.94	0.89
Guatemala	14.65	2.34	15.9	30.37	24.56	1.45	4.36
Guinea	10.22	1.96	19.2	8.45	3.24	3.05	2.15
Guinea-Bissau	1.53	0.35	23.2	4.21	1.21	1.89	1.04
Haiti	9.95	5.14	51.6	39.36	28.18	7.97	3.21
Honduras	8.30	1.27	15.3	19.44	16.60	0.84	2.01
India	1231.97	220.18	17.9	17.55	16.21	0.87	0.45
Indonesia	242.07	30.22	12.5	8.08	4.09	3.88	0.09
Jordan	7.38	0.68	9.2	8.67	7.64	0.80	0.17
Kenya	42.12	9.79	23.2	29.29	13.13	12.33	3.80
Kyrgyzstan	5.49	0.45	8.1	3.65	0.24	0.27	3.10
Lao PDR	6.25	1.32	21.1	3.71	0.22	1.41	2.08
Lesotho	2.01	0.26	13.1	2.56	0.01	2.20	0.34
Liberia	3.86	1.47	38.1	21.69	13.56	5.14	3.00
Madagascar	21.20	7.31	34.5	33.96	25.69	2.68	5.58
Malawi	14.60	3.50	24.0	36.88	19.92	9.84	7.13
Mali	15.06	1.10	7.3	23.02	8.38	9.73	4.76
Mauritania	3.51	0.33	9.3	15.79	4.69	7.14	3.80
Mongolia	2.74	0.59	21.6	5.14	3.15	1.99	0.00
Morocco	32.44	1.58	4.9	1.57	0.00	1.42	0.00
Mozambique	23.63	7.67	32.5	39.70	26.93	5.46	7.17

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Myanmar	50.72	9.39	18.5	13.18	0.01	5.46	7.71
Nepal	26.69	3.07	11.5	11.12	1.18	4.97	4.98
Nicaragua	5.83	1.16	20.0	16.39	11.93	1.76	2.69
Niger	16.61	1.98	11.9	47.27	15.69	12.68	18.66
Nigeria	159.11	10.82	6.8	1.93	0.21	1.41	0.26
Pakistan	179.58	36.68	20.4	22.66	12.85	4.29	5.18
Philippines	94.11	13.25	14.1	15.30	12.85	1.25	1.17
Rwanda	10.06	3.76	37.4	9.17	6.83	1.45	0.89
Senegal	12.74	1.87	14.7	13.15	6.36	4.70	1.95
Sierra Leone	6.42	1.84	28.6	16.70	9.49	4.34	2.80
Sri Lanka	20.24	2.84	14.0	8.95	2.63	5.79	0.48
Tanzania	44.60	15.46	34.7	14.29	6.40	4.66	3.11
Timor-Leste	1.09	0.30	27.4	7.39	3.06	1.33	3.01
Togo	6.44	1.35	21.0	3.02	0.00	2.56	0.38
Tunisia	10.63	0.53	5.0	0.17	0.00	0.00	0.00
Uganda	32.63	10.71	32.8	31.65	20.93	8.81	1.73
Ukraine	45.98	1.15	2.5	0.30	0.00	0.27	0.00
Uzbekistan	28.60	2.70	9.4	0.17	0.08	0.00	0.08
Vietnam	88.09	12.55	14.2	1.66	1.24	0.25	0.17
Yemen	23.22	6.62	28.5	27.87	5.22	7.16	4.54
Zambia	13.72	6.85	49.9	9.71	5.42	1.53	2.75
Zimbabwe	12.80	6.17	48.2	25.32	5.25	13.03	7.04

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Appendix B

Figure 15. *Undernourishment Rate by Country 2005-2015 (Group 1/4)*

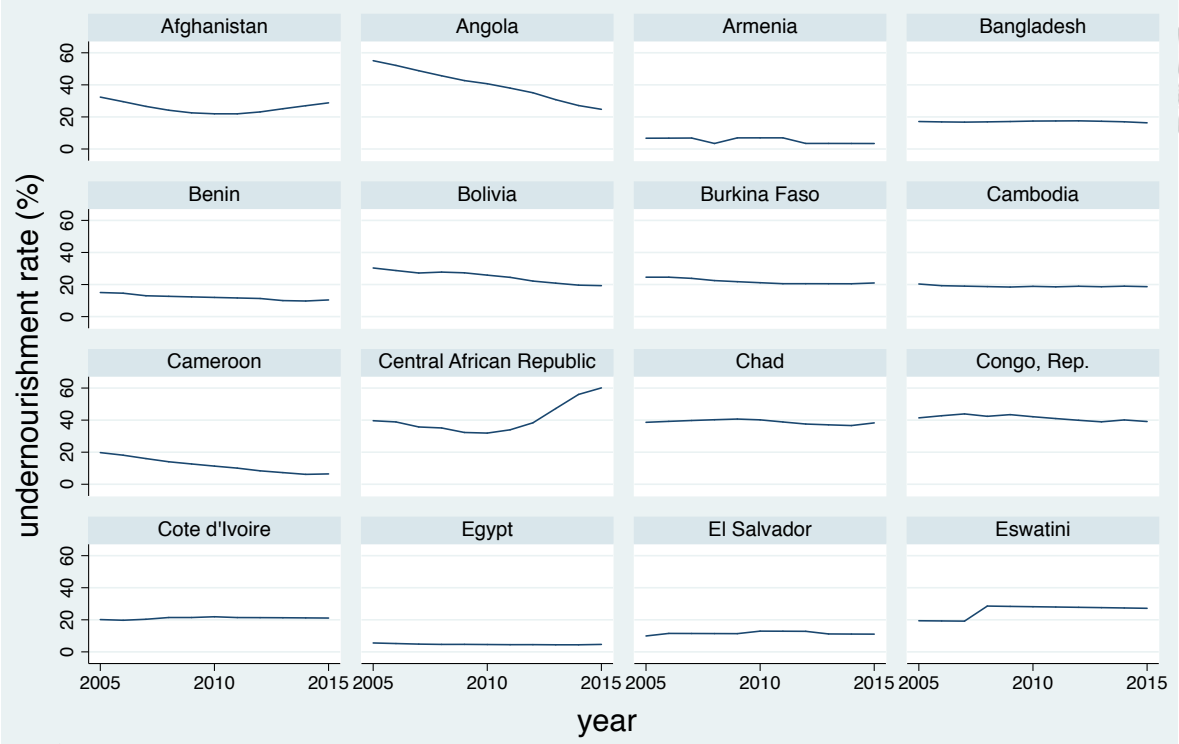

Figure 16. *Undernourishment Rate by Country 2005-2015 (Group 2/4)*

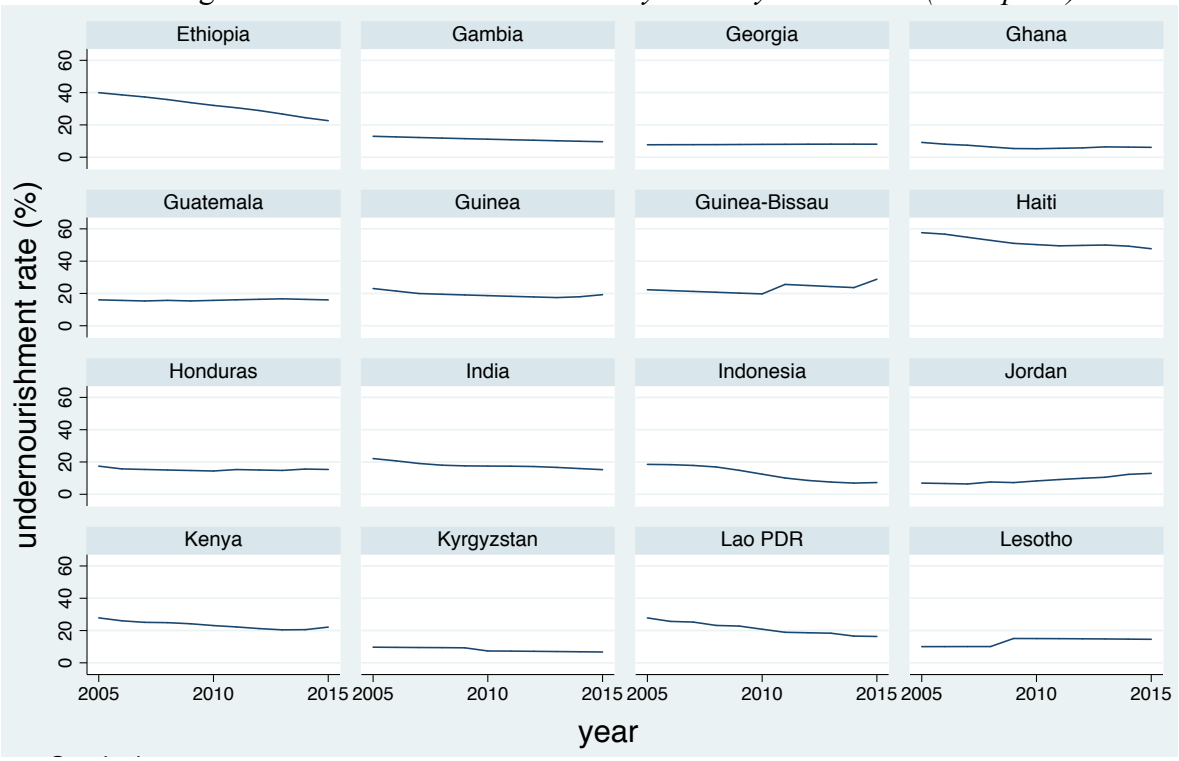

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Figure 17. *Undernourishment Rate by Country 2005-2015 (Group 3/4)*

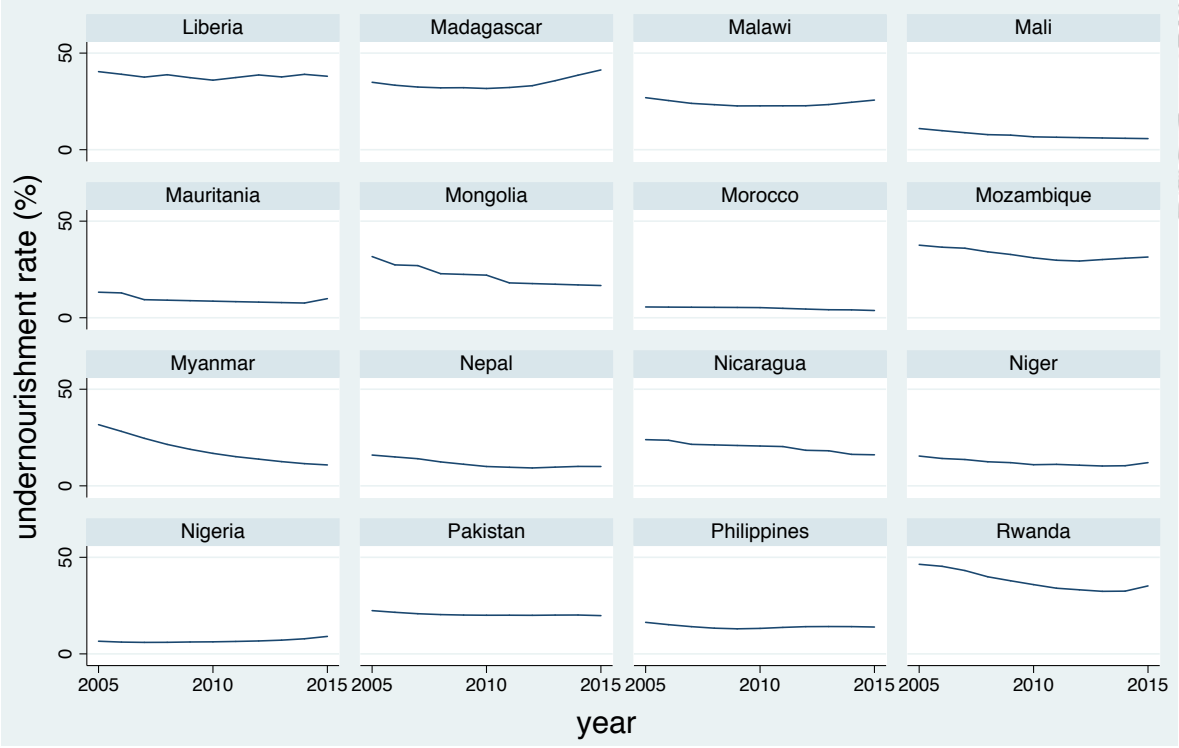
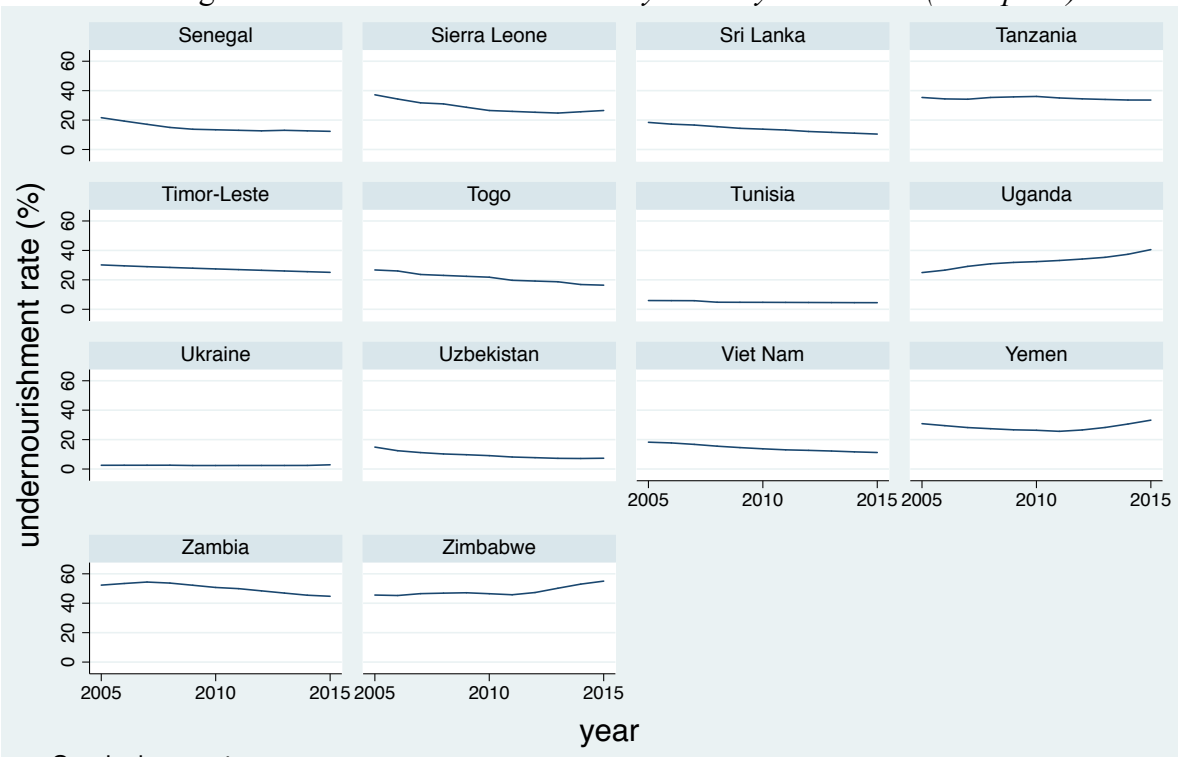


Figure 18. *Undernourishment Rate by Country 2005-2015 (Group 4/4)*



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