# Food Security and Infant Mortality* (Very Preliminary)

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**Abstract**

This paper investigates the widely held belief that donor-driven food aid does not achieve the primary objective of food aid, which is to improve health conditions. We exploit plausibly exogenous variation in the amount of U.S. food aid received by Sub-Sahara African, Latin American and Caribbean countries caused by weather induced production shocks in the U.S. for causal identification during the period 1970-2006. The first stage results show that the elasticity of food aid shipments with respect to U.S. production is approximately 1.5. The second stage results show that increasing the amount of U.S. food aid by one standard deviation, on average decreases infant mortality by approximately 13 deaths per one thousand live births, which in our sample, is approximately the reduction in average infant mortality between 1982 and 1996. This is nine times larger in magnitude than the estimated OLS correlation, which is most likely biased downwards due to reverse causality and omitted variables bias. In addition, we find that government accountability and bureaucratic capacity are important determinants of the effectiveness of aid. In contrast, we find no evidence that transportation infrastructure matters.

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# 1 Introduction

For the past five decades, alleviating hunger through food aid has been a central part of development efforts worldwide. The *Human Development Report* published by the United Nations Development Program in 1994 names the lack of *food security*, defined as the inadequate availablility of food supplies, as one of the main threats to safety from chronic threats such as hunger, disease and repression in developing countries. According to the standards set by the United Nations, approximately 30% of the world's population suffers from malnutrition.[1] The primary method for improving food security has been the provision of food aid.

In recent years, doubt has consistently increased over whether food aid has accomplished its main development objective – to decrease hunger and improve nutrition and health status of needy populations in poor countries. Few doubt the humanitarian and economic benefits of emergency relief aid (Lavy, 1992). However, the effectiveness of over 90% of food aid, which is largely driven by donor motives, has been increasingly criticized in both policy and academic circles. The most serious charge is that donor-based food aid does not reach needy populations and hence does not achieve the goal of alleviating hunger in developing countries. This could be because donor-driven aid does not correspond to the contemporaneous needs of countries. Alternatively, like other types of aid, the lack of political will, administative capacity or poor transportation infrastructure in the recipient countries may hinder the delivery of aid to need populations who are often in distant outlying rural areas. Another criticism of donor-driven food aid is that it is often delivered in a form that is not compatible with domestic tastes. For example, over 90% of U.S. aid is comprised of wheat, whereas the main traditional staples in recipient countries are coarse grains or rice. Therefore, the lack of the appropriate cooking technology or taste p may diminish the benefits of this aid.

This study addresses this important question by estimating the impact of donor-based food aid on infant mortality in Sub-Saharan African, Latin American, and Caribbean countries during between 1970 and 2006. Despite the seriousness of food security problems, there exists no rigorous empirical analysis on the effect of donor-based food aid on nutrition or health outcomes. According to experts on food policy programs,the evaluation of food assistance programs is "woefully incomplete, excessively focused on univariate analysis and on individual case studies"(Pillai, 2000; Barret, 2006).[2]

The main difficulty facing studies of the effect of food aid, or of foreign aid more generally, is reverse causality and omitted variable bias. Aid is typically delivered to impoverished regions with low levels of agricultural production and economic growth. The population living in such regions will typically also have poorer health. A cross sectional correlation between food aid receipts and low measures of development may therefore capture the effect of the outcomes on aid provision rather than the effect of aid on the outcomes of interest. Similarly, both the receipt of aid and low levels of economic development may be outcomes of poor institutions. In this case, the correlation will be

[1]See World Development Indicators. For example, the standards are set to be 2,350 Kcal/55 g protein/day per capita for an adult.

[2]See Pillai (2000) for a review of evaluations of food assistance programs.

confounded by omitted variable bias. Past studies have attempted to address this problem by controlling for potentially relevant factors. In a study of food aid in Ethiopia, Abdulai, Barret and Hoddinott (2005) find that adding the controls mitigates the negative relationship between aid and local food production seen in the simple bivariate correlation.[3] But their fixed effects estimates are very likely to be still biased downwards due to time varying omitted factors. Therefore, to estimate the true impact of food aid, one needs to find a source of variation in food aid that is plausibly exogenous to political, economic, and climate conditions of recipient countries.

The principal contribution of this paper is to improve upon past studies by exploiting plausibly exogenous variation in food aid receipts caused by weather induced production shocks in the U.S., a country that has historically contributed over half of global food aid. In order to subsidize domestic farmers, the U.S. government purchases "surplus" wheat during times of positive production shocks. A large part of this is sent as food aid to the governments of poor countries (Diven, 1999; Neumayer, 2005; Barret, 2006). Using meteorological data, we show that changes in U.S. production is largely explained by weather shocks in the U.S. Therefore, production shocks in the U.S. should not be correlated with circumstances in recipient countries. Hence, we can use U.S. production shocks as instrumental variables and estimate the causal effect of food aid. Our strategy relies on the assumption that donor country production shocks did not also affect other factors such as multilateral food aid. We can check this by examining whether Official Development Assistance (ODA) funds are correlated with U.S. production shocks.

Using data from several public data sources, we construct a country level panel from 1960 to 2005. We focus our study on countries in Sub-Saharan Africa (SSA), Latin America and the Caribbean (LAC), where infant mortality rates are among the highest in the world, and where the U.S. has historically provided large amounts of food aid. OLS estimates show that food aid has no effect on infant mortality rates in recipient countries. Our first stage results show that for developing countries in SSA and LAC, a 1% increase in U.S. wheat production increases wheat aid receipts by approximately 1.5%. To test the assess the validity of our strategy, we estimate the effect of future U.S. production shocks on current food aid and the effect of current U.S. production shocks on past aid receipts. In both cases, we find no correlation. Moreover, we also find that U.S. production shocks are not correlated with ODA. These results are consistent with our identification assumptions. The second stage estimates show that increasing aid by one standard deviation will decrease infant mortality by approximately 13 deaths per 1,000 live births in countries where the average infant mortality rate is approximately 88 per 1,000 live births. This reduction is equivalent to the reduction in average infant mortality in SSA and LAC countries over fifteen years (1982-1996) (see Figure 3). Consistent with the belief that OLS estimates of the correlation biases away from finding that food aid is beneficial, the 2SLS estimate is significantly larger in magnitude as the OLS estimates.

The main outcome of interest for this study is infant mortality because it is one of the most consistently measured health indicators across developing countries. Studies have found that the malnutrition which increases infant mortality will also increase long-term health risks of survivors, as expressed by factors such as height (Bozzoli, Deaton

[3]Lensink and Morrissey (2006) have similar findings in a cross-country study on foreign aid.

and Quintana-Domeque, 2008). Therefore, beyond its literal meaning, infant mortality can also be broadly interpreted as an indicator of the living conditions for survivors. The findings of this study which show that food aid reduces infant mortality rates hence implies that food aid could potentially also improve health and economic conditions for survivors later in life.[4] Moreover, studies such as Murphy and Topel (2003) have directly demonstrated that the aggregate economic gains from mortality rate reductions can be enormous.

In addition to the main results, we explore factors that could increase or hinder the effectiveness of food aid; namely, the availability of transportation infrastructure, bureaucratic capacity, government political accountability, government corruption and conflict. We find that the bureaucratic capacity and political accountability of the government greatly enhances the benefits of food aid. The evidence suggests that government corruption and conflict hinders the effectiveness of food aid. Interestingly, there is no evidence that transportation infrastructure, measured as the length of roads or the length of paved roads, affects the benefits of food aid.

The study makes several contributions. First it contributes to the limited existing evidence on assesing the effectiveness of food aid. To the best of our knowledge, ours is the first to directly estimate the causal effect of food aid on mortality. Existing studies, which do not attempt to establish causality, provide conflicting assesments on the effects of food aid. On the one hand, studies have argued that food aid alleviate hunger and increase domestic production of food (Levihnson and McMillan, 2007; Quisumbing, 2003; Yamano, Alderman and Christiaensen, 2005). On the other hand, food aid, by increasing the domestic supply of food, could reduce prices, which in turn could decrease the income of farmers (Pedersen, 1996; Kirwan and McMillan, 2007).[5] Our empirical strategy is not suitable for evaluating the long-term effects of food aid. However, we are able to provide a conclusive answer regarding the effect on health, which is arguably the most urgent problem at hand.

Second, our findings add to the literature in political economy by demonstrating that food aid is more effective when the government is more accountable to the population that it governs and when administrative capacity is high. Specifically, our finidngs add to the literature on the quality of institutions in determining the effect of foreign aid (Svensson, 2003), and a growing number of recent studies which emphasize the importance of administrative capabilities on economic and health outcomes(Greif, 2008; Besley and Persson, 2009; Meng, Qian and Yared, 2009).[6] More generally, there is a growing body of work that associates health outcomes with political factors in developing coun-

[4] For example, Case, Fertig and Paxson (2005), and van den Berg, Lindeboom and Portrait (2006) and studies citied within find that early childhood living conditions are associated with better health and economic outcomes later in life. Studies on the long run effects of in-utero health have also shown that in-utero healh is an important factor to outcomes later in life. (For example, see Almond, 2006).

[5] In the long-run, the resulting decrease in incentives to produce may deteriorate the infrastructure for production and increase the reliance on food imports. See Barret (2002) for a review of the descriptive evidence on the benefits and pitfalls of food aid.

[6] For example, Svensson (2003) studies the roles of democracy and aid on economic growth. Also see Burnside and Dollar (2000), Cillier and Dehn (2001), Collier and Dollar (2002), Islam (2003) and Chauvet and Guillaumont (2003).

tries or in historical contexts for now developed countries (Besley and Kudamatsu, 2006; Chattopadhyay and Duflo, 2004; Miller, 2008).[7] In particular, our study is closely related to Kudamatsu's (2009) study of the effect of democratic political institutions on infant mortality in Sub-Saharan Africa. He provides evidence that democractic governments decrease infant mortality more than non-democratic regimes by improving public health service delivery. Our results are consistent with this and suggest that one important vehicle for improving public health may be better delivery of food aid.

Finally, our finding that transportation infrastructure plays no role in the effectiveness of food aid adds to recent evidence showing the limited benefits of physical infrastructure in developing countries (Duflo and Pande, 2007; Banerjee, Duflo and Qian, 2009).

This paper is organized as follows. Section 2 presents the background and empirical strategy, Section 3 describes the data, Section 4 presents the results and Section 5 offers conclusions.

# 2 Background

## 2.1 Infant Mortality

The most common direct cause of infant mortality is dehydration from diarrhea (Arifeen et al., 2001). The use of Oral Rehydration Fluids (water mixed with sugar and salt) has greatly reduced this phenomenon. In developing countries, common direct causes also include pneumonia and malnutrition (Murray and Lopez, 1996). Clearly, these direct causes can be outcomes of neglect on the part of a child's care giver. Therefore, increasing the health of adults will also benefit the children that they care for. An increase in food can improve infant mortality directly by increasing the amount of food available to the infant. It will also improve adult health which can result in better care for the child and improve the quality and availability of a mother's breast milk. This will, in turn, also improve the nutritional intake of infants.[8]

Infant mortality is one of the best indicators of heath and nutrition in developing countries. Relative to other indicators, it is easier to measure consistently across different countries. It has also been shown to be a good indicator of health later in life of children who do not die. Studies usch as Bozzoli, Deaton and Quintana-Domeque (2008) find that infant mortality is correlated with reduced height of surviving children. Furthermore, malnutrition not only increases infant mortality, but also increases long-term health risks for survivors. These risks express themselves in adult height, as well as in late-life disease. Therefore, in addition to its literal interpretation, high infant mortality rates can also be broadly interpreted as poor living conditions during early life, which has been associated with a wide range of health problems later in life by studies such as Case et al. (2005), Van den Berg, Lindeboom and Portrait (2006).

[7] For other studies, see, for example Mpuku (1997), Przeworki et al. (2000).

[8] See World Population Prospects published by the United Nations Department of Economic and Social Affairs (2008).

## 2.2 Food Aid

Food aid has historically been a major element of development assitance. It is geared to support longer-term dvelopment and it has been the primary aid response to countries and people in crisis. International insitituional arrangements for food aid, such as the World Food Program (WFP), were first established during the 1950s. By the 1970s, food aid represented approximately a quarter of Official Development Assistance (ODA). The main goal was to convert "surplus" food production from the North into a useful resource in the South. However, criticism that this conversion has not been successfully caused food aid to decline to under 4% of total ODA by the 1990s. That said, bilateral food aid remains an important source of food for developing countries, especially for countries in Sub-Saharan Africa, Latin America and the Carribean. The U.S. is the largest donor of bilateral food aid.

What we commonly refer to as food aid is comprised of three categories. First, there is *program aid*. These are subsidized deliveries of food to a central government that subsequently sells the food and uses the proceeds for whatever purpose (not necessarily food assistance). Program food aid provides budgetary and balance of payments relief for recipient governments. While this, in principle, increases the flexibility of recipient country governments by allowing them to finance programs with the highest social returns, it also creates an opportunity for corruption. The government need not spend the money on programs that would benefit the population. Second, is *project food aid*. It provides support to field-based projects in areas of chronic need through deliveries of food (usually free) to a government or NGO that either uses it directly (e.g., Food for Work, school feeding) or monetizes it, using the proceeds for project activities. The third category, emergency and humanitarian relief, consists of free deliveries of food to government and non-government agencies responding to crisis due to natural disaster or conflict. While the final category of food aid receives the most press coverage, it is by far the smallest in terms of quantity. In this paper, we will call the first two types of aid, which are not driven by emergency needs of recipient countries, "donor-based" food aid.

Donor-based aid is broadly based on need in the sense that rich countries do not receive aid. However, on a year-to-year basis, it is mostly motivated by donor interests, such as agricultural subsidies to domestic producers. In the United States, Canada, EU countries, and Australia, the government purchases surplus production as a form of price support for the agricultural sector. This food is then transferred as food aid to developing countries either in bilateral agreements or by agencies that coordinate multilateral food support (Hoddinott, Cohen and Bos, 2004; Barret, 2005; Diven, 1999).

This study focuses on the effects of bilateral food aid from the U.S., which has its roots in 1954 with Public Law 480 (PL480). The U.S. has always been the largest donor in the world, accounting for approximately 57% of global food aid in 1990 and 64% in 2000. It is followed by the EU countries, which together account for less than 20%. The other major donors are Japan, Australia and Canada, each contributing less than 3%. The main recipients of food aid are countries in Latin America, Africa and Asia. The United Nation's World Food Programm (WFP) accounts for the rest of food aid.

## 3 Empirical Strategy

The OLS relationship for the effect of food aid and infant mortality can be characterized as the following.

$$mortality_{it} = \beta \ln foodaid_{it} + \mathbf{X}_{it}\Gamma + \lambda_i time_t + \delta_i + \varepsilon_{it} \quad (1)$$

According to equation (1), the mortality rate in a recipient country $i$ in year $t$ is a function of: the natural logarithm of the amount of aid of food that is received by country $i$ in year $t$, $\ln foodaid_{it}$; a vector of time and recipient-country varying controls such as the number of conflicts or weather conditions, $\mathbf{X}_{it}$; recipient-country fixed effects, $\delta_i$; and recipient-country specific linear time trends, denoted $\lambda_i time_t$. Because most of the variation in food aid is driven by time-varying production shocks in the U.S., we cannot control for year fixed effects. All reported standard errors are clustered at the year level. If food aid decreases infant mortality, then we expect that $\hat{\beta}_{OLS} < 0$. Note that our sample includes only countries that recieve some food aid. Therefore, we don't lose observations by taking the natural logarithm of food aid.

The main problems for interpreting $\beta_{OLS}$ as causal are reverse causality and omitted variables bias. For example, since poorer regions with low levels of production typically receive more aid, the interpretation of $\beta_{OLS}$ will also reflect this reverse-casual relationship. Omitted variables present another problem. Outcomes such as domestic production and aid receipts may both be outcomes of other factors such as low quality institutions. To address this, we instrument for aid receipts with weather induced production shocks in the U.S. As we discussed in the section on background, while only poor countries receive aid, year to year variation in aid amount is largely driven by the interests of the U.S. in subsidizing domestic wheat producers. This is shown in Table 2, which presents the estimated correlation of annual U.S. wheat and rice production with average monthly temperature and precipitation in wheat and rice producing regions of the U.S. The R-Square from this non-parametric estimation shows that over 70% of production can be explained by natural conditions. Our identification assumption is that U.S. production shocks affect infant mortality in food aid recipient countries only through changes in food aid.

The first stage equation can be written as the following.

$$\ln foodaid_{it} = \theta\, US\ \ Prod_t + \mathbf{X}_{it}\Phi + \lambda_i time_t + \delta_i + \nu_{it} \quad (2)$$

The natural logarithm of food aid received by country $i$ from the U.S. in year $t$ is a function of: the amount of U.S. food production in year $t$, $US\ \ Prod$; a vector of time and recipient country varying controls, $\mathbf{X}_{it}$; recipient country fixed effects, $\delta_{it}$; and country specific time trends, $\lambda_i time_t$. Standard errors are clustered at the year level. If U.S. production drives U.S. food aid, then we expect $\hat{\theta} > 0$.

This strategy relies on the assumption that U.S. production shocks does not affect mortality through channels other than U.S. food aid. One concern is the possibility that the U.S. also uses its surplus food production to fund multilateral aid programs such as the ODA. If the ODA provides aid in forms other than food aid, then this will cause our estimate be confounded. We can check this possibility directly by estimating the first stage equation with ODA as the dependent variable. To further test the robustness of our first stage, we conduct a placebo test of the relationship between future production on current aid and current production on past aid. If U.S. production shocks mechanically increases aid due to PL480, then current aid should not be correlated with future shocks.

Note that our strategy captures the short run effects food aid on infant mortality. It cannot address long run questions such as the effect of food aid availability on decreasing production incentives in recipient countries or the incentives of recipient country governments to develop agriculture. The estimated effects of food aid on contemporaneous food imports and food production in recipient countries are shown in Appendix Tables A1 and A2. We do not discuss them for brevity.

# 4 Data

We construct a country level panel using data from several public sources. We restrict the sample to countries that have received food aid during the period 1970-2006. This includes 85 developing countries. When we restrict the sample to SSA and LAC countries for the main estimates, our final sample consists of 52 countries over 1970-2006. The duration of the sample is limited by data on food aid, which is only reported beginning in 1970.

Table 1 presents the descriptive statistics for SSA and LAC countries. Infant mortality is on average 88 per 1,000 births according to the the CME (Child Mortality Estimation) Info database, which is based on interagency research by the United Nations Children's Fund (UNICEF), the World Health Organization (WHO, the World Bank, and the United Nations Populations Division. To the best of our knowledge, this is the highest quality data on infant mortality available for a broad cross section of countries over a long time horizon. It is available for the years 1960-2007. However, due to the limitation of food aid data, we only use the 1970-2006 sample for this study. Infant mortality rate is the probability of dying below age one, expressed as a rate per 1,000 live births).

The main difficulty in measurement arises in populations that lack accurate registration of births and deaths. This is especially problematic in Sub-Saharan African countries with high HIV prevalance and high infant mortality rates. In populations severely affected by HIV/AIDS, HIV+ children will be more likely to die than other children, and will also be less likely to be reported since their mothers will have been more likely to die also. Therefore, mortality estimates will thus be biased downwards. Because estimates of mortality rates for these populations are almost entirely derived from reports of mothers about the survival of their children, the magnitude of the bias will depend on the extent to which the elevated mortality of HIV+ children is not reported because of the deaths of their mothers. To address this problem, the CME data corrects for HIV for seventeen countries with an adult HIV prevalence rate exceeding 5% at any point in the epidemic period, including Botswana, Cameroon, Central Africa Republic, Côte d'Ivoire, Gabon, Kenya, Lesotho, Malawi, Mozambique, Namibia, Rwanda, South Africa, Swaziland, Uganda, United Republic of Tanzania, Zambia, Zimbabwe.[9]

[9]The Technical Advisory Group (TAG) of the IGME developed a method to adjust HIV/AIDS related

Another difficulty is *birth transference*, which refers to the inaccurate reporting of birth dates of children. From other surveys conducted by United Nations agencies such as the Demographic and Health Surveys (DHS), interviewers appear to be particularly anxious to avoid asking the health questions about deceased children. This reporting bias most commonly manifests as the reported birthdate being earlier than actual birthdates. In DHS surveys, this birth transference is more pronounced for deceased than for surviving children. When this occurs it results in mortality rate being under-estimated for the most recent period. Adjustment for birth transference is done before the adjustment of HIV/AIDS related deaths for data from the surveys with serious birth transference issues. However, the methods for correction are not reported.

In addition to the corrections made to survey data each year as we describe above, the historical series we use from the CME has also been corrected retrospectively. The incorporation of new evidence into the time series in the estimation process has resulted in substantial changes in child mortality levels and trends for some countries (for example, Ghana, Sierra Leone), compared to the values reported in the past.

It is important to note that since these measurement errors of our dependent variable are unlikely to vary with U.S. production shocks, they should not bias the coefficients of the 2SLS estimates (although they may decrease precision).

The WDI also reports similar mortality rates, but only every 5 years. Therefore, there are fewer observations than for the CMe measure. They are collected and corrected contemporaneously as the CME data. However, they are not further corrected retrospectively. Our empirical analysis will use the CME measure as the main measure. The results using WDI can provide a broad consistency check on the data and give a sense of how much retrospective correction matters to this study. The WDI also reports mortality rates for children under five years of age. This includes infant mortality. It is approximately 127 per 1,000 births.

Aid data is reported by the *Food and Agriculture Organization* (FAO) of the United Nations. We only report aid from the U.S., which makes up more than half of total food aid. Table 1 shows that wheat is the most important component of food aid. On average, a country receives 53,518 MT of wheat from the U.S. annually. This is almost 70% of all food aid in terms of weight. The next most important crop are coarse grains, followed by rice and bulgur wheat. The FAO defines coarse grains as maize, rye, oats, barley, millet and sorghum (Paolino and Tseng, 1980).

Production data is also reported by the FAO. Table 1 shows that the in terms of weight, wheat production in the U.S. is more than seven times larger than the second most important crop, rice. Production levels in recipient countries are significantly lower,

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mortality for each survey data observation during HIV/AIDS epidemic, by adopting a set of simple assumptions about the distribution of births to HIV+ women by the duration of their infection, vertical transmission rates, survival times of both mothers and children from the time of the birth, and much else besides. After adjusting the survey data for HIV/AIDS related mortality for the epidemic period, a regression curve is then fitted to all available data points (observations before the HIV/AIDS epidemic period and HIV/AIDS adjusted data points during the epidemic) to produce the final estimates. For the most recent period lacking empirical data, extrapolating from non-HIV/AIDS curve (which is obtained by subtracting the UNAIDS estimates of HIV/AIDS deaths from the fitted curve), and then adding back the UNAIDS estimates of HIV/AIDS deaths, have been applied to generate the final estimates.

where wheat ranks as the third most important crop in terms of production weight, after coarse grains and rice. Note that in terms of weight, food aid is approximately 5% of the domestic production of recipient countries.

GDP growth is very low in the countries of our sample. On average, annual GDP growth is approximately 0.5%.

Figure 1 plots, for each year, annual U.S. wheat production and the average amount of wheat aid received by the countries in our sample. The plot shows that changes in wheat aid over time roughly follows U.S. wheat production trends. Figure 2 shows a similar plot for U.S. rice production and rice aid. The $y$-axis is scaled to be comparable to those in Figure 1. This figure shows that much less rice is produced and given as aid, and there is no obvious correlation between production and aid. This is consistent with the fact that PL480 follows from subsidies targeted towards wheat farmers.

The measure of food aid we use in the main empirical analysis includes rice and wheat. This is because rice and wheat are produced in similar regions in the U.S. and need similar climate and geographic conditions. Therefore, when we predict production based on geographic conditions, we cannot separate rice and wheat production. But these figures together with the agriculture policies in the U.S. makes clear that all the results are being driven by wheat.

Figure 3 plots average infant mortality over time. It shows that during the period of this study, infant mortality declined from almost 120 per 1,000 births to approximately 75 per 1,000 births. Note that infant mortality can change dramatically from year to year.

# 5 Results

## 5.1 First Stage and Reduced Form Estimates

Table 3 shows the first stage estimates. Columns (1)–(5) show the first stage estimates by region: Sub-Saharan Africa (SSA), Latin America and the Caribbean (LAC), East Asia and Pacific, Other and Europe and Central Asia. Columns (1) and (2) show that the U.S. production shocks are most correlated with food aid in SSA and LAC countries. Therefore, for the rest of this study, we will focus on these two groups of countries.

Column (6) shows the estimate on food aid for SSA and LAC countries when lagged GDP growth is controlled for. The estimates show that the elasticity between U.S. production and food aid is approximately 1.7 and statistically significant at the 1%, and that countries that are growing faster receive less aid. Because GDP growth rates are roughly linear over time for each country, we cannot control for it in addition to country-specific time trends. Therefore, in the main estimations, we only control for country-specific time trends. Columns (7) and (8) show that the estimated elasticity between U.S. production and food aid is similar with these additional controls and still statistically significant at the 1% level.

Column (9) shows that current U.S. production is not correlated with past food aid receipts. The estimate is an order of magnitude smaller than the main estimates and statistically insignificant. Column (10) shows that future production shocks are uncorrelated with current food aid. Column (11) shows that the elasticity of U.S. foreign aid with respect to U.S. production shocks is nearly identical to the elasticity of U.S. food aid and production shocks. This is not surprising, since economic aid, which is mostly comprised of food aid, accounts for over 93% of U.S. foreign aid. The high correlation between food aid and total foreign aid means that we cannot control for total U.S. aid in the main specifications. Column (12) shows that multilateral aid as measured in ODA is uncorrelated with U.S. production shocks. These results are consistent with the identification assumption that U.S. production shocks do not affect infant mortality through channels other than U.S. food aid.

Table 4 presents the reduced form estimates of the effect of U.S. production shocks on infant mortality. Columns (1)–(3) show the effect for our main outcome measure, infant mortality, as reported by the WHO. As before, we first show the estimate controlling for lagged GDP growth and a year time trend (see column 1). Then, we control for country-specific time trends (column 2), and the number of conflicts (column 3). The estimates are similar across the three specifications. Since annual U.S. production is on average 1799.56 MT with a standard deviation of 15.07 MT, these estimates imply that a one standard deviation increase in U.S. production will lower infant mortality by almost one death per 10,000 live births. The estimate is statistically significant at the 1% level. In columns (4)–(9), we repeat the estimation with infant and under 5 child mortality reported by the WDI. These measures are only reported every five years and the estimates should not be interpreted literally. However, they also show that U.S. production shocks decrease mortality in SSA and LAC countries. This supports the main estimates. Columns (10)–(11) show that the estimated effects are significantly larger in SSA countries relative to LAC countries. They are both statistically significant at the 1% level.

## 5.2 OLS and 2SLS Estimates

Table 5 Panel A shows the OLS estimates of the correlation between U.S. food aid receipts and the three measures of infant mortality. Since the natural logarithm of U.S. crop aid is on average 8.87 with a standard deviation of 2.14, the estimates imply that a one standard deviation increase in food aid is correlated with a decrease in mortality of approximately 1.4 per 1,000 deaths. The estimates are similar for the different measures, and for the two regions considered. They are statistically significant at the 1% level for the two infant mortality measures in columns (1)–(8).

Panel B shows the 2SLS estimates. As with the OLS estimates, they are roughly similar across the different mortality measures. Columns (1)-(2) and show that a one standard deviation increase in food aid will decrease infant mortality by approximately 13 deaths per 1,000 births. The estimates are statistically significant at the 1% level. Columns (3)-(6) show that the estimated effect of food aid is similar between SSA and LAC countries.

## 5.3 Determinants of Aid Delivery

In this section, we investigate whether factors such as political institutions and administrative capacity affect the benefits of food aid by estimating the interaction effect of food aid and each individual factor on our main infant mortality measure. For factors that are time varying such as a accountability, the number of conflicts and whether there is a big war, the specification controls for the main effect of each variable in addition to the interaction effect between the variable and food aid (or U.S. production for the reduced form). The main effects are not reported for brevity.

The reduced form estimates are shown in Table 6. First, we examine the role of roads which could facilitate delivery of food to needy populations or decrease the cost of hungry populations migrating to areas where food aid is given. We have two measures of transportation infrastructure: the length of roads and the lengths of paved roads. Note that because we control for country fixed effects, the road length measures are effectively normalized by country characteristics that are roughly time-invariant such as land area or population. Columns (1)-(2) show that additional roads and paved roads do not enhance the benefits of U.S. production shocks.

Next, we examine the role of bureaucratic capacity. Food aid, like all government programs, should be more effective in countries where governments have high administrative capacity. Following Besley and Persson (2009), we measure bureaucratic capacity as government income tax revenues as a percentage of GDP. Their measure is constructed using data on GDP and income tax revenues compiled by the IMF. We create a dummy variable to indicate if a country is above the median of the sample and we estimate the interaction effect between this dummy variable and U.S. production shocks. Columns (3) show that countries with above median administrative capacity are those that receive most of the benefits of U.S. production shocks. The estimate is statistically significant at the 1% level.

In column (4), we investigate whether governments that are accountable to their constituencies are more likely to use food aid in a way that benefits the population. We measure accountability as a dummy variable that equals one if a country has a Polity 2 score in year $t$ greater than zero. The Polity 2 score measures the level of autocracy of the executive. The dummy variable indicating if it is above zero is a common measure for if a government is "democratic" and therefore accountable to the population that it governs. Column (4) shows that democratic countries experience almost twice as large of a reduction in infant mortality from U.S. production increases as non-democratic countries. The estimate is statistically significant at the 1% level.

Column (5) examines the effect of government corruption on the effectiveness of food aid. The World Bank Index for corruption control is only available for 1996-2006. We use the mean of the score over this period as a time invariant measure for each country for the sample period of 1970-2006. Column (5) shows that countries with above median levels of government corruption experience approximately 30% less benefits from U.S. production shocks.

Finally, we investigate whether food aid is less effective in countries where there is conflict or political instability. Conflict is measured in numbers of conflict episodes annually and with a dummy variable for whether there is a "big war" in year $t$ that kills more than 1,000 individuals. Columns (6)–(7) show that not surprisingly, U.S. production shocks only benefit countries with no conflicts and no big wars. Column (8) shows that the benefits are almost twice as large in countries with above median political stability as measured by the World Bank Political Stability Index.

Table 7 shows the OLS and 2SLS estimates. We focus the discussion on the 2SLS estimates reported in Panel B. As suggested by the reduced form estimates in Table 6, road length does not increase the benefits of food aid (columns (1) and (2)). Column (3) shows that countries with above median administrative capacity experience over three times the benefits of food aid relative to countries with below median administrative capacity. Column (4) suggests that democratic accountability also enhances the benefits of food aid. However, the estimate is only statistically significant at the 15% level. Similarly, while the estimated interaction effects of food aid with corruption, conflict and political stability have signs that are consistent with the reduced form estimates in Table 6, the 2SLS estimates are not statistically significant. Therefore, they can only be interpreted as suggestive.

# 6 Conclusion

This study addresses a straight-forward and important question: to what extent does donor-driven food aid fulfill the primary objective of food aid – improving health and nutrition? Using infant mortality rates to measure health and nutrition, we find that increasing food aid significantly decrease mortality. Moreover, our preliminary results show that the effectiveness of food aid can be greatly hindered by the lack of political will or administrative capacity of the recipient government. The next step for this study is to conduct a cost benefit analysis and compare the cost-effectiveness of food aid to other programs aimed at alleviating hunger or improving health.

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Figure 1: U.S. Wheat Production and Aid for SSA and LAC Countries

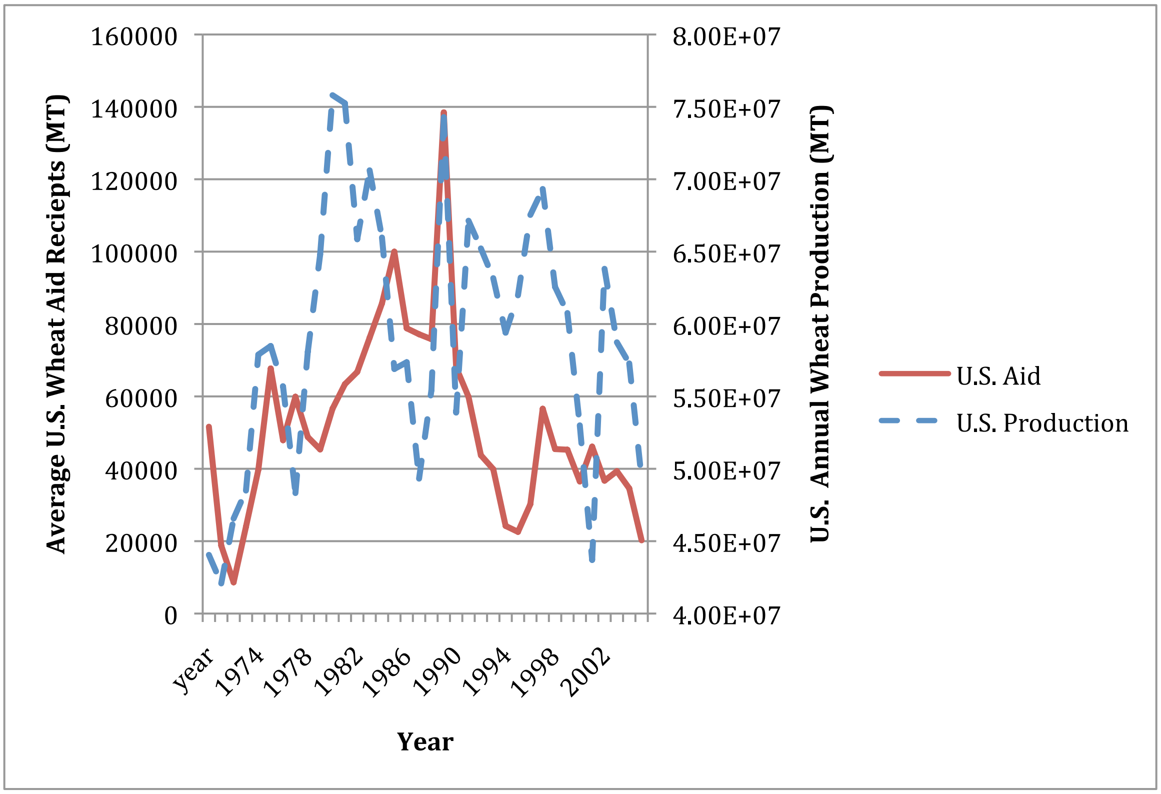


Figure2: U.S. Rice Production and Aid for SSA and LAC Countries

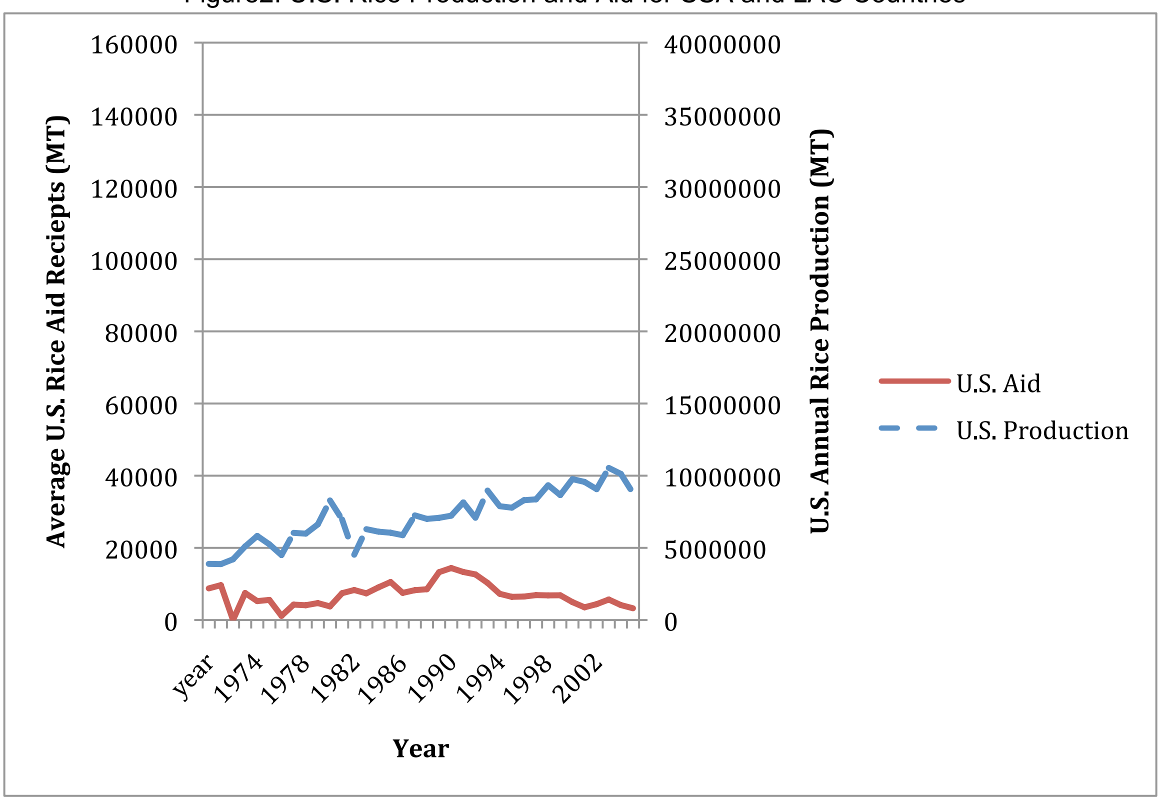

Figure 3: Average Infant Mortality Rates in SSA and LAC Countries 1971-2006

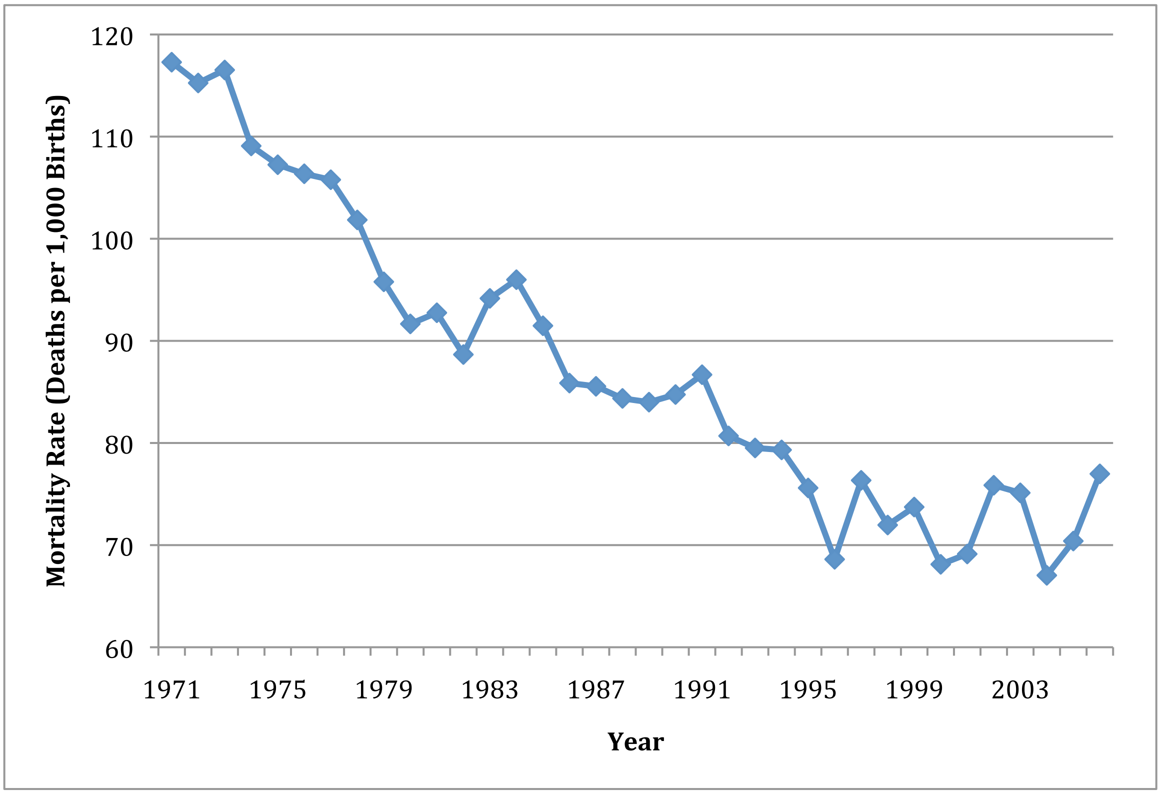

Table 1: Descriptive Statistics

| Variable | Obs | Mean | Std. Dev. |
|---|---|---|---|
| Infant Mortality (WHO) | 1389 | 88.46 | 41.02 |
| Infant Mortality (WDI) | 176 | 82.60 | 42.17 |
| Under 5 Child Mortality (WDI) | 176 | 127.53 | 74.89 |
| Wheat Aid | 1156 | 53518.38 | 187556.00 |
| Rice Aid | 1085 | 6922.82 | 19590.21 |
| CoarseGrain Aid | 1068 | 17084.61 | 37457.57 |
| Bulgur Aid | 704 | 2488.05 | 6076.03 |
| U.S. Wheat Production | 1389 | 59100000.00 | 8998205.00 |
| U.S. Rice Production | 1389 | 7002460.00 | 1782286.00 |
| U.S. Buckwheat Production | 1389 | 62189.34 | 29190.68 |
| Recipient Wheat Production | 1389 | 149651.80 | 663646.20 |
| Recipient Rice Production | 1389 | 472444.50 | 1263703.00 |
| Recipient Buckwheat Production | 1389 | 458.62 | 4062.31 |
| Recipient Coarse Grains production | 1389 | 978662.30 | 2372483.00 |
| Recipient GDP Annual Growth | 1145 | 0.0047 | 0.08 |

## Table 2: The Correlation Between Weather and U.S. Production

| | Dependent Variables: Ln U.S. Production | | | | |
|---|---|---|---|---|---|
| | (1A) | (2A) | | (1B) | (2B) |
| | Ln Wheat | Ln Rice | | Ln Wheat | Ln Rice |
| Temp Jan | -0.0215 | -0.00368 | Rain Jan | -0.000958 | 0.000104 |
| | (0.0147) | (0.0179) | | (0.00227) | (0.00161) |
| Temp Feb | 0.0322 | -0.00157 | Rain Feb | 0.00259 | -5.11e-05 |
| | (0.0171) | (0.0237) | | (0.00234) | (0.00250) |
| Temp March | -0.00438 | -0.0238 | Rain March | 0.000348 | 0.00120 |
| | (0.0236) | (0.0463) | | (0.00184) | (0.00262) |
| Temp April | -0.0647 | 0.0153 | Rain April | 0.000180 | 8.81e-05 |
| | (0.0398) | (0.0536) | | (0.00273) | (0.00262) |
| Temp May | 0.0411 | 0.00420 | Rain May | 0.000633 | 0.000155 |
| | (0.0373) | (0.0402) | | (0.00185) | (0.00213) |
| Temp June | -0.0613 | -0.00719 | Rain June | -0.000123 | -1.44e-05 |
| | (0.0503) | (0.0811) | | (0.00267) | (0.00263) |
| Temp July | 0.167 | 0.0399 | Rain July | 0.00616 | 0.000345 |
| | (0.0702) | (0.106) | | (0.00264) | (0.00284) |
| Temp Aug | -0.0342 | -0.0692 | Rain Aug | 0.000409 | 0.000273 |
| | (0.0511) | (0.0920) | | (0.00223) | (0.00194) |
| Temp Sept | -0.0158 | -0.0225 | Rain Sept | -0.00512 | -0.00202 |
| | (0.0309) | (0.0717) | | (0.00187) | (0.00177) |
| Temp Oct | -0.00548 | -0.00232 | Rain Oct | 0.00240 | -0.000915 |
| | (0.0306) | (0.0447) | | (0.00179) | (0.00235) |
| Temp Nov | 0.0128 | 0.00646 | Rain Nov | -0.000777 | -0.00105 |
| | (0.0260) | (0.0386) | | (0.00304) | (0.00183) |
| Temp Dec | -0.0108 | 0.00557 | Rain Dec | -0.00227 | -0.00122 |
| | (0.0233) | (0.0287) | | (0.00206) | (0.00174) |
| | | | Observations | 36 | 36 |
| | | | R-squared | 0.801 | 0.909 |

Regressions also control for a year time trend.

Table 3: The Effect of U.S. Production Shocks on U.S. Food Aid

| | Dependent Variables: Ln Aid Receipts | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ln U.S. Crop Aid | | | | | | | | Lagged Ln U.S. Crop Aid | Ln U.S. Crop Aid | Ln U.S Total Aid (USD 96) | Ln ODA (USD 96) |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| | SSA | LAC | EAP | OTHER | ECA | SSA+LAC | SSA+LAC | SSA+LAC | SSA+LAC | SSA+LAC | SSA+LAC | Ln ODA |
| **Mean Dependent Variable** | **8.46** | **9.26** | **10.45** | **10.79** | **10.29** | | **8.78** | | **8.80** | **8.78** | **2.64** | **3.98** |
| Ln US Crop Prod | 1.531 | 1.062 | -1.014 | -1.291 | 0.727 | 1.720 | 1.582 | 1.506 | 0.277 | 1.379 | 1.367 | 0.320 |
| | (0.554) | (0.672) | (1.249) | (0.541) | (1.314) | (0.616) | (0.498) | (0.549) | (0.724) | (0.683) | (0.647) | (0.203) |
| Lagged GDP Growth | | | | | | -1.421 | | | | | | |
| | | | | | | (0.708) | | | | | | |
| Ln US Crop Prod 1 Yr Later | | | | | | | | | | 0.235 | 0.532 | 0.254 |
| | | | | | | | | | | (0.834) | (0.583) | (0.267) |
| Ln US Crop Prod 2 Yrs Later | | | | | | | | | | 0.0198 | 0.176 | 0.381 |
| | | | | | | | | | | (0.821) | (0.667) | (0.206) |
| Controls | | | | | | | | | | | | |
| Year Trend | N | N | N | N | N | Y | N | N | N | N | N | N |
| Country Specific Year Trend | Y | Y | Y | Y | Y | N | Y | Y | Y | Y | Y | Y |
| Number of Conflicts | Y | Y | Y | Y | Y | N | N | Y | Y | Y | Y | Y |
| Observations | 616 | 443 | 75 | 243 | 84 | 1145 | 1389 | 1165 | 1057 | 1165 | 974 | 1058 |
| R-squared | 0.619 | 0.528 | 0.407 | 0.686 | 0.397 | 0.548 | 0.610 | 0.600 | 0.610 | 0.601 | 0.784 | 0.817 |

All regressions control for country fixed effects. Standard errors are clustered at the year level.

Table 4: The Effect of U.S. Production Shocks on Infant Mortality in SSA and LAC Countries

| | Dependent Variables: Mortalit Rate (Deaths per 1,000 Births) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Infant Mortality | | | WDI Infant Mortality | | | WDI Child Mortality | | | Infant Mortality | |
| | SSA+LAC | | | | | | | | | SSA | LAC |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| **Mean of Dependent Variable** | | **88.46** | | | **82.6** | | | **127.53** | | **82.6** | |
| Ln US Crop Prod | -9.169 | -10.25 | -9.103 | -19.46 | -23.09 | -17.07 | -33.99 | -43.62 | -31.66 | -9.084 | -6.031 |
| | (3.679) | (2.576) | (2.490) | (13.20) | (11.24) | (7.575) | (23.02) | (21.38) | (13.27) | (2.390) | (2.070) |
| Controls | | | | | | | | | | | |
| Lagged Annual GDP Growth | Y | N | N | Y | N | N | Y | N | N | N | N |
| Year Trend | Y | N | N | Y | N | N | Y | N | N | N | N |
| Country Specific Year Trends | N | Y | Y | N | Y | Y | N | Y | Y | Y | Y |
| Number of Conflicts | N | N | Y | N | N | Y | N | N | Y | N | N |
| Observations | 1145 | 1389 | 1165 | 158 | 176 | 136 | 158 | 176 | 136 | 616 | 443 |
| R-squared | 0.949 | 0.988 | 0.990 | 0.971 | 0.993 | 0.996 | 0.976 | 0.994 | 0.997 | 0.987 | 0.988 |

All regressions control for country fixed effects.
Standard errors are clustered at the year level.
Sample contains countries in SSA and LAC.

Table 5: The Effect of Food Aid on Infant Mortality in SSA and LAC Countries

| | Dependent Variables: Mortality Rate (Deaths per 1,000 Live Births) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Infant Mortality | | | | | | WDI Infant Mortality | | WDI Child Mortality | |
| | (1) SSA + LAC | (2) SSA + LAC | (3) SSA | (4) SSA | (5) LAC | (6) LAC | (7) SSA + LAC | (8) SSA + LAC | (9) SSA + LAC | (10) SSA + LAC |
| **Mean of Dep. Variable** | **88.46** | | | | | | **82.6** | | **127.53** | |
| A. OLS | | | | | | | | | | |
| Ln U.S. Crop Aid | -0.611 | -0.685 | -0.607 | -0.642 | -0.592 | -0.479 | -0.675 | -1.227 | -0.923 | -1.730 |
| | (0.123) | (0.108) | (0.161) | (0.157) | (0.128) | (0.120) | (0.922) | (0.495) | (1.611) | (0.895) |
| Controls Number of Conflicts | N | Y | N | Y | N | Y | N | Y | N | Y |
| Observations | 1389 | 1165 | 683 | 616 | 460 | 443 | 176 | 136 | 176 | 136 |
| R-squared | 0.988 | 0.990 | 0.987 | 0.986 | 0.987 | 0.988 | 0.993 | 0.996 | 0.994 | 0.996 |
| B. 2SLS | | | | | | | | | | |
| Ln U.S. Crop Aid | -6.478 | -6.045 | -5.551 | -5.932 | -4.902 | -5.679 | -4.490 | -3.165 | -8.483 | -5.869 |
| | (1.264) | (1.370) | (1.305) | (1.513) | (1.765) | (3.269) | (3.441) | (1.434) | (6.533) | (2.514) |
| Controls Number of Conflicts | N | Y | N | Y | N | Y | N | Y | N | Y |
| Observations | 1389 | 1165 | 683 | 616 | 460 | 443 | 176 | 136 | 176 | 136 |
| R-squared | 0.950 | 0.958 | 0.963 | 0.957 | 0.940 | 0.922 | 0.987 | 0.995 | 0.987 | 0.995 |

All regressions control for country fixed effects and country specific time trends. Standard errors are clustered at the year level.

Table 6: The Heterogeneous Effects of U.S. Production Shocks on Infant Mortality in SSA and LAC Countries

| | Dependent Variable: Infant Mortality Rate | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Physical Infrastructure | | Bureaucratic Capacity | Government Accountability | Gov Corruption | Conflict and Political Stability | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| **Mean of Dependent Variables** | | | | **88.46** | | | | |
| Ln U.S. Crop Prod | -3.549 | -5.498 | -2.659 | -7.741 | -11.80 | -7.253 | -8.497 | -7.300 |
| | (6.788) | (7.121) | (1.651) | (2.263) | (2.624) | (3.103) | (2.143) | (2.818) |
| Ln U.S. Prod x Ln Road (Km) | -0.493 | | | | | | | |
| | (0.605) | | | | | | | |
| Ln U.S. Prod x Ln Paved Road (Km) | | -0.227 | | | | | | |
| | | (0.524) | | | | | | |
| Ln U.S. Prod x Inc Tax Rev>0.075 | | | -11.89 | | | | | |
| | | | (2.743) | | | | | |
| Ln U.S. Prod x Polity2>=0 | | | | -5.000 | | | | |
| | | | | (2.303) | | | | |
| Ln U.S. Prod x WB Corrupt<0.38 | | | | | 3.933 | | | |
| | | | | | (1.175) | | | |
| Ln U.S. Prod x UCDP Conflict Number | | | | | | 6.292 | | |
| | | | | | | (2.621) | | |
| Ln U.S. Prod x Big War | | | | | | | 9.769 | |
| | | | | | | | (2.778) | |
| Ln U.S. Prod x WB Stability>-0.4 | | | | | | | | -5.047 |
| | | | | | | | | (1.421) |
| Observations | 1143 | 1143 | 1389 | 1389 | 1389 | 1020 | 1004 | 1389 |
| R-squared | 0.991 | 0.991 | 0.989 | 0.989 | 0.988 | 0.991 | 0.992 | 0.989 |

All regressions control for country fixed effects and country specific year trends.
Regressions in columns (5), (6), (9) and (10) also control for the main effects.
Standard errors are clustered at the year level.
Sample contains SSA and LAC countries.

## Table 7: The Heterogeneous Effects of Food Aid on Infant Mortality in SSA and LAC Countries

| | Dependent Variable: Infant Mortality Rate | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Physical Infrastructure | | Bureaucratic Capacity | Government Accountability | Gov Corruption | Conflict and Political Stability | | |
| | (1) | (2) | (3) | (4) | (8) | (9) | (10) | (11) |
| **Mean of Dependent Variable** | | | | **88.46** | | | | |
| **A. OLS** | | | | | | | | |
| Ln U.S. Crop Prod | -2.069 | -0.726 | -0.397 | -0.559 | -0.508 | -0.761 | -0.500 | -0.218 |
| | (0.728) | (0.973) | (0.142) | (0.155) | (0.145) | (0.101) | (0.103) | (0.194) |
| Ln U.S. Prod x Ln Road (Km) | 0.149 | | | | | | | |
| | (0.0748) | | | | | | | |
| Ln U.S. Prod x Ln Paved Road (Km) | | 0.00993 | | | | | | |
| | | (0.0757) | | | | | | |
| Ln U.S. Prod x Inc Tax Rev>0.075 | | | -0.335 | | | | | |
| | | | (0.190) | | | | | |
| Ln U.S. Prod x Polity2>=0 | | | | -0.143 | | | | |
| | | | | (0.243) | | | | |
| Ln U.S. Prod x WB Corrupt<0.38 | | | | | -0.276 | | | |
| | | | | | (0.179) | | | |
| Ln U.S. Prod x UCDP Conflict Number | | | | | | 0.343 | | |
| | | | | | | (0.197) | | |
| Ln U.S. Prod x Big War | | | | | | | -0.318 | |
| | | | | | | | (0.295) | |
| Ln U.S. Prod x WB Stability>-0.4 | | | | | | | | -0.664 |
| | | | | | | | | (0.197) |
| Observations | 1143 | 1143 | 1389 | 1389 | 1389 | 1165 | 1004 | 1389 |
| R-squared | 0.991 | 0.991 | 0.988 | 0.988 | 0.988 | 0.990 | 0.992 | 0.988 |
| **B. 2SLS** | | | | | | | | |
| Ln U.S. Crop Prod | -53.90 | -352.5 | -1.811 | -2.651 | -7.107 | -6.350 | -6.033 | -5.826 |
| | (30.39) | (2173) | (1.013) | (1.814) | (1.614) | (1.485) | (1.715) | (1.797) |
| Ln U.S. Prod x Ln Road (Km) | 5.250 | | | | | | | |
| | (3.245) | | | | | | | |
| Ln U.S. Prod x Ln Paved Road (Km) | | 27.95 | | | | | | |
| | | (174.7) | | | | | | |
| Ln U.S. Prod x Inc Tax Rev>0.075 | | | -7.024 | | | | | |
| | | | (2.259) | | | | | |
| Ln U.S. Prod x Polity2>=0 | | | | -6.444 | | | | |
| | | | | (4.367) | | | | |
| Ln U.S. Prod x WB Corrupt<0.38 | | | | | 1.730 | | | |
| | | | | | (1.640) | | | |
| Ln U.S. Prod x UCDP Conflict Number | | | | | | 4.431 | | |
| | | | | | | (5.338) | | |
| Ln U.S. Prod x Big War | | | | | | | 1.024 | |
| | | | | | | | (4.360) | |
| Ln U.S. Prod x WB Stability>-0.4 | | | | | | | | -0.971 |
| | | | | | | | | (2.024) |
| Observations | 1143 | 1143 | 1389 | 1389 | 1389 | 1165 | 1004 | 1389 |

All regressions control for country fixed effects and country specific year trends. Regressions in columns (5), (6), (9) and (10) also control for the main effects. Standard errors are clustered at the year level. Sample contains SSA and LAC countries.

## APPENDIX Table A1: The Effect of Food Aid on Contemporaneous Food Production in SSA and LAC Countries

| | Dependent Variables: Recipient Country Food Production | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Wheat | | | Rice | | | Coarse Grains | | | Buckwheat | | | Ln Meat Production | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) |
| | OLS | RF | 2SLS | OLS | RF | 2SLS | OLS | RF | 2SLS | OLS | RF | 2SLS | OLS | RF | 2SLS |
| Ln U.S. Crop Aid | -0.0169 | | 0.0501 | 0.0348 | | 0.163 | 0.00345 | | -0.0715 | 0.00269 | | -0.00571 | -0.00753 | | -0.00765 |
| | (0.00714) | | (0.0502) | (0.00837) | | (0.0670) | (0.00663) | | (0.0831) | (0.00456) | | (0.0153) | (0.00238) | | (0.0185) |
| Ln US Crop Prod | | 0.0754 | | | 0.246 | | | -0.108 | | | -0.00877 | | | -0.0115 | |
| | | (0.0816) | | | (0.103) | | | (0.107) | | | (0.0227) | | | (0.0286) | |
| Observations | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 |
| R-squared | 0.994 | 0.994 | 0.994 | 0.986 | 0.986 | 0.984 | 0.991 | 0.991 | 0.989 | 0.989 | 0.989 | 0.989 | 0.995 | 0.995 | 0.995 |

All regressions control for country fixed effects and country-specific linear time trends.

Standard errors are clustered at the year level.

## Table A2: The Effect of Food Aid on Contemporaneous Net Food Imports by Type

| | Dependent Variables: Ln Production | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Wheat | | | Rice | | | Coarse Grains | | | Meat | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| | OLS | RF | 2SLS | OLS | RF | 2SLS | OLS | RF | 2SLS | OLS | RF | 2SLS |
| Ln U.S. Crop Aid | 3.42e-05 | | 0.00131 | 3.77e-05 | | 0.000355 | -1.33e-06 | | 3.72e-05 | 1.48e-05 | | 0.000220 |
| | (5.34e-05) | | (0.000513) | (7.45e-06) | | (0.000119) | (3.33e-06) | | (1.79e-05) | (2.00e-05) | | (0.000129) |
| Ln US Crop Prod | | 0.00197 | | | 0.000534 | | | 5.61e-05 | | | 0.000331 | |
| | | (0.000316) | | | (0.000111) | | | (2.43e-05) | | | (0.000181) | |
| Observations | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 |
| R-squared | 0.741 | 0.750 | 0.340 | 0.516 | 0.523 | | 0.479 | 0.481 | 0.384 | 0.804 | 0.804 | 0.784 |

| | Dairy | | | Fish | | | Value Added Grains | | | Other Foods | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OLS | RF | 2SLS | OLS | RF | 2SLS | OLS | RF | 2SLS | OLS | RF | 2SLS |
| Ln U.S. Crop Aid | 3.45e-05 | | 0.000414 | 8.89e-05 | | -0.000764 | 8.20e-06 | | 0.000166 | 0.000540 | | -0.00468 |
| | (1.40e-05) | | (0.000153) | (5.16e-05) | | (0.000532) | (5.14e-06) | | (9.04e-05) | (0.000181) | | (0.00212) |
| Ln US Crop Prod | | 0.000624 | | | -0.00115 | | | 0.000250 | | | -0.00704 | |
| | | (0.000134) | | | (0.000734) | | | (8.16e-05) | | | (0.00238) | |
| Observations | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 | 1165 |
| R-squared | 0.660 | 0.670 | 0.063 | 0.596 | 0.597 | 0.361 | 0.693 | 0.697 | 0.524 | 0.932 | 0.933 | 0.846 |

All regressions control for country specific time trends and country fixed effects.

Standard errors are clustered at the year level.

Note: Imports include food aid. Since most food aid is in the form of wheat and rice, this will be reflected in those estimates.