



## Examining the link between food prices and food insecurity: A multi-level analysis of maize price and birthweight in Kenya



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### ABSTRACT

In developing countries where many poor people rely on rainfed, locally produced food for the majority of their caloric intake, shifts in climate and weather patterns can dramatically reduce agricultural productivity. The reduction in agricultural productivity reduces overall food availability and ultimately impacts food accessibility, putting millions of people at risk for malnutrition. In this project we focus on Kenya where roughly a third of households are food insecure. We examine the relationship of the price of maize and low birth weight to help quantify the impact of local food prices on one outcome of household food insecurity. Using spatially referenced data from recent Kenyan Demographic and Health Survey datasets, price data, livelihood information, and a remotely sensed-based measure of local growing season productivity, we develop a dataset linking pregnancies occurring from 2001 to 2008 to the spatially and temporally relevant maize price data. We construct several regression models to examine the impact of local maize prices and remotely sensed based estimates of crop production on infant birth weight – specifically low birth weight. The results of the models highlight the importance of including community crop production to evaluate maize price impacts on low birth weight outcomes. Also, because of the positive correlation between pre-pregnancy maize prices and birth weight, the results suggest that some households may benefit from high prices or that high prices may impact the number of conceptions. More generally, our work demonstrates that multilevel models that account for community-level variation are important for disentangling these complex relationships and can contribute to the discussion of how to design more effective food policies.

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### Introduction

“Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (World Food Summit, 1996). Episodes of household food insecurity occur when access to food decreases (e.g. cost increases while income or entitlements do not), when food availability decreases (e.g. crop production decreases) or when there are constraints to people’s proper use of calories (e.g. due to illness or lack of nutritional knowledge).

In developing countries where many poor people rely on rainfed, locally produced food for the majority of their caloric intake, shifts in climate and weather patterns can dramatically reduce agricultural productivity. This reduction in productivity reduces

overall food availability, increases local food prices due to rising demand and diminished supply. This ultimately impacts food accessibility, putting millions of people at risk for malnutrition (Sen, 1990). Given this frequently adopted model of food security, policy professionals and aid programs monitor the local pricing of staple crops as an indicator of impending food crises. In an effort to improve scientific understanding of food insecurity and evaluate the usefulness of pricing data as an indicator of food insecurity, we examine the link between price and household health outcomes related to food insecurity – specifically the weight of an infant at birth.

In this project we focus on Kenya where roughly 1/3 of households are food insecure (Bloss et al., 2004; FAO, 2009) and dependence on rainfed agriculture to produce affordable food is high. Given the potential for crop losses owing to frequent and increasing drought conditions (Williams and Funk, 2010), interest in food prices as a measure of access to food or indications of potential food stress is growing. Considering the Kenyan climate conditions

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and within the framework of the dominant food insecurity theoretical models (as highlighted above), we anticipate that episodes of household food insecurity may increase, leading to an increase in low birth weight (LBW) babies.

Here we examine the relationship between food prices and household food insecurity. The price of maize, a major Kenyan food staple, serves as an indication of fluctuations in food access, while LBW represents household food insecurity. We combine data from four separate data types/sources to conduct this analysis – spatially referenced parental and infant information from the most recent Kenyan Demographic and Health Surveys (DHS), monthly maize prices, livelihood classifications, and a local measure of growing season productivity. Each pregnancy recorded in the DHS that resulted in a live birth (and where birth weight was measured) is temporally and spatially linked to maize price and environmental conditions relevant to the most recent growing season. Using this linked dataset we can determine how and whether local maize prices, an indicator of food accessibility, is linked to LBW.

## Background

### *Low birth weight*

When babies are born weighing less than 2500 g, the international standard for low birth weight (LBW), their mortality rates are higher than those of their normal birth weight counterparts (Walker et al., 2007). If an LBW baby does survive, her future is grimmer than that of a normal birth weight baby. Educational rates and income levels are lower among children who are born with LBW and if a mother was herself characterized as LBW then she is more likely to produce LBW children (especially girls) (Victoria et al., 2008). LBW babies are therefore less likely to grow into healthy and economically productive members of society.

The weight of an infant at birth is the result of a multitude of interrelated biological (e.g. maternal height) and socio-environmental (e.g. socioeconomic status, health care, maternal age, time since previous birth) factors (Mwabu, 2008; Abu-Saad and Frasier, 2010; also see Kramer, 1987 for an extensive discussion). Among the most prominent of the environmental factors, is maternal nutrition (Kramer, 1987; Keen et al., 2003; Wu et al., 2004; Cetin et al., 2010). Studies of interventions related to maternal nutrition have produced a variety of results identifying the impacts of different types of vitamins, minerals and eating habits on the birth weight of a newborn. Intervention efforts to improve birth outcomes, including LBW, have historically focused on the third trimester as the period where maternal nutrition is of prime importance. More recent studies (of humans and animals) have highlighted the importance of the earlier stages of pregnancy and even pre-pregnancy, on birth outcomes (Moore et al., 2004; Cucó et al., 2006; Rao et al. 2001; Abu-Saad and Frasier, 2010). And while results of successful interventions are not always consistent across human studies, the positive influence of maternal nutrition on the birth weight of an infant in animal studies is undeniable (Wu et al., 2004).

One component of maternal nutrition relevant in a food insecure context is appropriate caloric intake and weight gain, which are directly linked to food availability and accessibility. Therefore, while LBW is an indicator of future health of the child it is also represents nutritional deficiencies of the mother (Young, 2001). In highly food insecure communities – where adequate food supply is limited or food is costly (see the UNICEF framework, 1990) – the potential for women to intake an adequate amount of nutritional food is unlikely, and could possibly increasing the risk of a woman delivering an LBW baby (Young, 2001). We therefore theorize that women who have the least access to food or experience

reduced access to food (price increases would reduce access) would not gain the proper amount of weight or consume the needed calories for healthy in-utero growth, resulting in a LBW infant. Based on previous studies, the impacts of reduced food access at any point in pregnancy and possibly even during the pre-pregnancy period could have a negative impact on birth weight.

### *Linking LBW and food insecurity in Kenya*

For this analysis, we rely on the Food and Agriculture Organization's (FAO) model of household food insecurity. As reflected in the definition above, this model ties food security to four primary factors– access, availability, utilization and stability (UNICEF, 1990; Devereux, 2001a; FAO, 2012). These determinants (with some variation) of food insecurity have been thoroughly examined in the literature with the “access” component generally determined to be of particular importance (Sen, 1981; Sen, 1997; Smith et al., 2000 and Devereux, 2001b). Price of food serves as one measure of access.

In developing countries poor people generally spend about 75% of their income on food (Darnton-Hill and Cogill, 2010). As food prices go up they are able to purchase less food. At first, a reduction in the diversity of food occurs followed by a reduction in the amount of basic food staples and water (Darnton-Hill and Cogill, 2010). Increases in the incidence of LBW as a result of increased food prices have been seen in history across the globe. Darnton-Hill and Cogill (2010) describe the findings of several studies: a food/economic crisis in Indonesia is correlated with an increase in negative health effects on babies who were conceived during the period (Block et al., 2004); an increase of LBW babies following an increase in the price of staple foods in the Congo (Martin-Prével et al., 2000); small negative effects on birth weight resulting from food rationing during the Dutch famine in the mid-20th century which were then followed by a future of negative health consequences where exposure to rationing during the third trimester (the last 3 months of pregnancy) was found to be of particularly importance (Stein and Susser, 1975).

We build on these prior studies and examine the impact of the price of maize, a staple of many Kenyans, on LBW. In Kenya one of the most common and least expensive food products is maize (Freeman et al., 2004; Grobler-Tanner, 2006). Maize provides at least 40% of the calorie requirements for around 96% of the Kenyan population (Byerlee and Eicher, 1997) and the poorest people may consume as much as 70% of their calories from a combination of maize and beans (Greer and Thornbeck, 1985). Depending on where in Kenya they are located, some households primarily grow their own maize while others rely on purchased maize from local markets (Freeman et al., 2004). Poor households can spend a quarter of their income on maize purchases which may increase given an increase in maize price.

If people cannot afford maize or their own maize crops do not grow then there may be little that is accessible to them and they may begin to show indications of reduced caloric intake – malnutrition. Because of the importance of maize in the diet of the Kenyan poor, the widespread use of maize prices by the FAO and the international community as an indication of potential food emergencies, as well as the availability of maize data, we focus specifically on the local prices of maize in several areas of Kenya. We theorize that if the cost of maize increases (indicating reduced access to a staple product) many of the poorest people will be deprived of a vital source of nutrition and will show signs of malnutrition.

However, while perhaps less researched, some households may also benefit from maize price increases if they are able to sell excess maize. Some reports have noted that maize sales constitute as much as 44% of a household's income (see Kimenju and Tschirley, 2008). Given, the complexity of the situation in Kenya, however, household income may increase with price increases

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