Aus dem Institut für Ernährungswirtschaft und Verbrauchslehre
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An Econometric Analysis of Policy Measures for Improving Food Security and Welfare in Developing Countries

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Kiel, im März 2012 Christian Kuhlgatz

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Chapter 1

Introduction and Summary

1.1 Introduction

Governments throughout the developing world employ policies for increasing food security and welfare. Despite these efforts, many people remain food insecure, as neither they nor public safety nets are consistently able to afford food that meets their nutrient requirements. The food price hikes in 2007-8 considerably exacerbated the situation, as civil unrests over high food prices and a significantly rising number of undernourished people indicate (FAO/WFP 2010). Given the renewed international interest for measures to fight hunger and malnutrition (see FAO, 2008) and the far-reaching consequences of nutrient-related health impairments, the goal of this dissertation is to contribute to the understanding of policies that aim to increase food security and welfare for developing countries.

According to the definition of the 1996 World Food Summit, food security exists "when all people, at all times, have access to sufficient safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life". Three variables are therefore central to attain food security: 1. food availability on local markets, 2. food access, i.e. individuals have enough income and other resources to obtain sufficient food, and 3. food utilization, i.e. the proper handling of food and nutrient knowledge (Sen, 1981; USAID, 1992). The second chapter introduces a microeconomic food security model, in order to provide a conceptual framework for examining the different ways policy measures can influence food security. This model contributes to the previous understanding of food insecurity by explicitly modeling the effect of the budget constraint on nutrient supply and the associated health consequences. It provides a theoretical starting point for a discussion of the range of commonly implemented food security strategies in developing countries.

The presence of covariate shocks on the food and income situation of whole regions calls for food security strategies that facilitate international trade. This is particularly true, as private

storage capacities are limited in developing economies, and state-managed buffer stocks have mostly failed to effectively smooth food price volatility. Short run responses to food crises frequently include measures that raise the availability of food on local markets, such as state interventions, trade supportive measures and international food aid. Longer term policies consider the support of local income generation possibilities in order to enhance welfare and drive people out of poverty. Given the importance of export-led growth strategies in the developing world, the third chapter uses household data from the nationally representative Ghana Living Standard Survey of 2005-6 to empirically investigate the effect of export agriculture on the purchasing power and poverty of farm households. Innovative econometric strategies are used to obtain unbiased estimates of the welfare impact of different export cropping specialization degrees. Furthermore, the determinants of export crop cultivation are analyzed in order to indicate effective possibilities to promote export cropping.

While policies that enhance local purchasing power and facilitate commercial food flows are vital for the prevention of food insecurity, there are critical situations in which only internationally financed food aid can prevent malnourishment and starvation. Because nutrient deficiencies result in severe health impairments when not treated in a critical window of opportunity, an effective targeting of food aid resources is crucial. The fourth chapter therefore analyzes the responsiveness of cereal food aid from the six largest donor countries to recipient countries' needs. Given that a coordinated aid response is needed to effectively manage crisis situations, this chapter contributes to previous studies by employing an empirical approach that captures contemporary coordination efforts in the aid flows of the analyzed donors. The fifth chapter takes a different view at food aid allocation, as it uses newly available data on delivered nutrients, and therefore more directly measures the responsiveness to physiological needs. The analysis focuses on aid flows from the largest food aid donor, the USA, of the period 1993-2007. Emergency, project and program food aid are separately examined, as these different food aid instruments are employed to pursue different goals and use different intranational targeting mechanisms. In contrast to previous studies on global food aid allocation, this chapter employs an econometric method that accounts for unobserved heterogeneity among recipient countries.

Table 1.1 provides an overview of the dissertation by categorizing the chapters into their different methodological approaches and illustrating their contribution to the discussed research areas. In the following section, each chapter is thoroughly summarized.

Table 1.1. Classification of chapters: approaches and contribution to food security dimensions

	Empirical analysis		*Theory*
	Welfare impact	*Aid targeting*	
Food availability		Chapters 4 & 5	Chapter 2
Food access	Chapter 3		Chapter 2
Nutrient requirements		Chapter 5	Chapter 2

Chapter 2: Food Security Policy – Developing Countries
Chapter 3: Determinants and Welfare Impacts of Export Crop Cultivation – Empirical Evidence from Ghana
Chapter 4: Food Aid Allocation Policies: Coordination and Responsiveness to Recipient Country Needs
Chapter 5: Food Aid and Malnutrition in Developing Countries: Evidence from U.S. Food Aid allocation

1.2 Summary

1.2.1 Food Security Policy – Developing Countries

In the second chapter, policy measures are investigated that are commonly employed by developing countries in order to improve food security. Given the complexity of the food security concept, a microeconomic food security model is developed that shows how various policy instruments affect different dimensions of food security. A version of Becker's (1965) model is employed, with the modifications suggested by Barrett (2002). This model is extended by the incorporation of physiological needs for nutrients, which are modeled as product characteristics as in Lancaster (1971). In particular, individuals are assumed to maximize utility given a budget constraint, whereby utility is obtained from product characteristics and from the individuals' health status. Product characteristics influence utility either directly or indirectly through their impact on the individual's physical health. Nutrient-related health impairments occur when individuals do not choose consumption bundles that contain enough nutrients to meet their physiological requirements. This can be caused either by lacking nutritional knowledge or by budgetary constraints. Given that food security is an *ex ante* concept, it is in the above model captured as the individual's perceived risk of getting nutrient-related health impairments. In line with Barrett (2002), three types of health damages are distinguished: temporary impairments, permanent damages and, finally, death. This distinction is helpful, as irreversible health impairments have severe future consequences for future well-

being and human capital accumulation, which probably also affect the individual's behavior.

The exact modeling of the effects of ingested food ingredients on specific health dimensions allows further insights on the choice of food for households that are food insecure. Firstly, if an individual cannot afford food bundles that simultaneously provide enough amounts of various nutrients, the consumption decision transforms into a trade-off between the different health dimensions related to those nutrients. Secondly, individuals may accept becoming malnourished in order to improve the nutrition of family members or to derive utility from non-nutrition product characteristics. The fact that food crises often affect whole regions, which can hamper the regional economic development due to irreversible health damages, provides a strong argument for implementing food security policies. The food security model allows categorizing the different food security policies that governments of developing countries pursue.

Following this framework, the subsequent section provides a review on the range of commonly applied domestic food security policies. Since food constitutes a substantial share in expenditures of poor households, developing countries use diverse measures to increase food and nutrient access. Direct food market policies include price and trade (de)regulation policies, state engagement in storage and trade, public safety nets that aim to enhance food access and measures to optimize food utilization by means of food fortification or dietary education programs. While there has been a shift from direct state interventions to agricultural market liberalization, the recent food price crisis has shown the reoccurrence of diverse food trade restriction policies.

On the other hand, there are more indirect policies, which attempt to improve the economic environment in underdeveloped region. The goal of such policies is to enhance agricultural productivity, increase purchasing power and reduce the significance of health shocks. These policies include public investments in infrastructure and agricultural research and development (R & D), the support of the financial sector and the provision of health services. Evidence shows that public spending on agricultural R & D and on infrastructure generally yields the highest returns in terms of poverty reduction (e.g. Fan et al., 2008). In the survey part of the study, each of the abovementioned policies is briefly discussed, and, where available, evidence on effectiveness and efficiency is presented.

1.2.2 Determinants and Welfare Impacts of Export Crop Cultivation – Empirical Evidence from Ghana

Driven by large fiscal deficits, many governments of developing countries have made a shift to policies promoting exports of the primary sector. The International Monetary Fund and World Bank supported these policies, based on the rationale of the comparative advantage of developing countries in these products. On the micro-level, economic theory suggests that firms entering the export markets gain in productivity, as they can learn from international best practice, obtain technical assistance from the buyers or realize scale economies through participation in large export markets (Grossman and Helpman, 1991). On the other hand, firms face considerable competition in export markets, which they can probably harder predict, and developing countries that concentrate on few export goods are at particular risk of being dependent on external shocks (Sheperd, 2010). Even when most farmers do not directly enter foreign markets, their potentially beneficial (or adverse) effects are likely to be transmitted through the value chain down to the export crop producers.

The impact of export participation has been mostly analyzed for firms of the manufacturing sector. This chapter contributes to the scanty literature on farmers' benefits from export cropping by investigating the determinants and the welfare impacts of export crop cultivation on Ghanaian farm households. Ghana's large agricultural sector and its pioneering role in export-led growth policies make its agricultural sector particularly worth investigating. Export crop cultivators are supported by the Ghanaian government in various ways, for example by direct intermediation between farmers and international cocoa buyers, securing high quality standards, investments in R & D, or strengthening the co-operative movements. The analyzed data stem from the Ghanaian Living Standard Survey 5, and are representative for the years 2005-6.

To avoid biased results due to possible self-selection of farmers into export crop cultivation, the full information likelihood approach is employed to analyze the determinants of export cropping. This analysis identifies the main barriers and driving forces to export cropping, and therefore helps finding ways to implement export oriented policies at the micro level. The results indicate that engagement in export cropping is significantly influenced by access to land and financial resources. The significance of state trading enterprises and co-operatives shows that policies that strengthen intermediation in input and output markets of the export crop sector are promising ways to increase the country's agricultural exports.

The welfare impacts of export cropping are examined by employing methods that account for self-selection. The *propensity score matching* (PSM) approach proposed by Rosenbaum and Rubin (1983) is used to compare welfare outcomes of farmers who cultivate export crops with farmers who produce solely for domestic markets. Since export crop cultivators considerably differ in the intensity of export crop production, this study furthermore employs the *generalized propensity score* (GPS), which is proposed by Hirano and Imbens (2004) in cases of a continuous treatment variable. The GPS balances differences in farm characteristics at different export cropping intensity levels, and therefore allows the estimation of the dose response function, which relates the welfare outcomes to different export cropping intensities.

The PSM approach shows that the welfare of farmers increases when engaging in export cropping. The significant but quite modest impact on poverty and expenditures may stem from the fact that the relationship between export cropping intensity and the welfare outcomes is nonlinear. This is illustrated by the dose response functions, which generally show little welfare differences at low to medium export cropping intensities, but steep improvements at the highest specialization levels. For example, a farmer with little export crop production can, on average, double the per capita expenditures of her household by shifting to 100% specialization in export cropping. The impact on poverty is nonlinear and more ambiguous. For all welfare analyses, common support was imposed, and balancing tests showed that the employed propensity scores are able to balance differences in observable farm characteristics.

1.2.3 Food Aid Allocation Policies: Coordination and Responsiveness to Recipient Country Needs

Food aid has long been a controversial measure for closing the gap between available food and food consumption needs within a region. Despite concerns of inefficacy, there are critical situations where local markets and safety nets cannot supply sufficient food, in which food aid is the only type of aid that can prevent malnutrition (Barrett and Maxwell 2005). Given the severe consequences of ill-timed food aid shipments, the targeting of food aid donors is of particular interest. Furthermore, it is important to coordinate food aid from different donor sources in order to effectively target food shortages in the recipient countries. Although there is a range of studies that analyzed the allocation determinants of donor countries (e.g. Gabbert and Weikard, 2000; Jayne et al., 2001; Barrett and Heisey, 2002; Neumayer, 2005), none of these studies have examined the coordination of food resources from different donors. This is in contrast to the considerable efforts made by the World Food Programme (WFP) and international non-governmental organizations (NGOs) to manage food aid from different sources.

This study fills this gap in the empirical literature, and moreover accounts for several methodological concerns in previous studies. Particularly, the determinants of cereal food aid flows of the six main food aid donors (USA, Canada, European Commission, EU member states, Japan, Australia) of the period 1972-2004 are investigated. As a methodological refinement, a multivariate Tobit model is employed, in which the aid shipments of each donor equation are simultaneously estimated. This approach allows for a nonzero correlation between each donors' error term, and indicates whether and in what direction donors' food aid flows are coordinated. In addition, a censored least absolute deviation (CLAD) model is employed in order to estimate the aggregated food aid response of donors. The semiparametric CLAD approach has never been used in the food aid context, and adds econometric flexibility compared to the conventional Tobit model, as it is robust to conditional heteroscedasticity and provides consistent estimates for a wide range of error distributions (Powell 1984).

In line with Barrett and Heisey (2002), food availability is approximated by local food production, and a distinction is made between the responsiveness to food production levels (progressivity effect) and the responsiveness to food production shocks (stabilizing effect). Furthermore, as donors probably only respond to production shortfalls of a particular magnitude, the stabilizing effect is measured by a variable that only captures negative shocks greater than a donor-specific threshold. This threshold is found by a modified version of the empirical search strategy proposed by Young and Abbott (2008). Furthermore, poverty, natural disasters and violent conflicts are incorporated due to their potential impact on food access of households within a country. Given that the omission of donor interest variables can considerably bias the estimates of food aid responsiveness (McGillivray, 2003), indicators of geopolitical interests are included in the regressions.

The estimation results indicate that there is strong evidence of donor coordination in food aid allocation. The finding of positive and significant correlation coefficients suggests that mechanisms like the consolidated appeals process as well as aid managing organizations such as the WFP and NGOs channel food resources from different donor sources to similar needy countries. The empirical results further show that globally aggregated food aid as well as food aid from each donor is significantly targeted at poorer countries and, to a more modest degree, at countries facing temporary food production shortfalls. It therefore seems that food availability and particularly food access is taken into account by food aid donors. In line with previous studies on food aid allocation (e.g. Barrett and Heisey, 2002), there is strong persistence in food aid flows. Food aid responses to natural disasters and violent conflict are common but

more modest and uneven across donors.

1.2.4 Food Aid and Malnutrition in Developing Countries: Evidence from U.S. Food Aid Allocation

In the wake of the food price crisis 2007/8, renewed attention has been drawn on international measures to fight hunger and malnutrition. Nutrient deficiencies are major causes of morbidity and mortality throughout the developing world (Black et al., 2008). Against this backdrop, food security policies have to consider the fact that the supplied food must contain sufficient amounts of every vital nutrient in order to prevent the target population from becoming food insecure. In the case of food aid however, most previous studies focused on cereal food aid shipments (e.g. Barrett and Heisey, 2002). The focus on cereal aid flows is owed to the fact that most of donors' food aid flows still consist of cereal products, and that international agreements such as the Food Aid Convention (FAC) are mostly defined in cereal equivalents. Although energy-rich cereals may be used as a proxy for dietary energy allocation, this is only a rough approximation, as cereal products differ in their energy content and non-cereal products can also contain considerable amounts of energy.

This study contributes to the literature of food aid allocation in two ways. Firstly, it is the first analysis that examines aid flows of particular nutrients. This proceeding is nearer to the physiological requirements of the vulnerable population than the examination of cereal aid shipments, and indicates how need-oriented food aid has been in tackling nutrient-related diseases. Secondly, previous empirical approaches are refined by accounting for the panel structure of the data. In specific, a dynamic correlated random effect (CRE) Tobit model is estimated, which allows for correlation between the unobserved heterogeneity and the covariates. For this, a version of the approach of Mundlak (1978) is employed, who suggests conditioning on the country means of each time varying independent variable. Given that the analyzed data range over a period of 15 years, the country mean is likely to inadequately capture correlation with country-specific unobserved heterogeneity. Thus, the CRE Tobit model applied in this analysis is conditioned on the country means of three sub-periods for each time varying variable. In order to avoid the initial conditions problem that inhibits empirical models with random effects and state dependence, we follow the suggestion of Wooldridge (2005) for CRE Tobit models and condition on the first observed value of the dependent variable.

Country-level aid flows of the post cold war period 1993-2007 are analyzed. Four severely deficient nutrients are considered in this study: dietary energy, iron, vitamin A and zinc. We

analyze food aid flows of the USA, as this is the by far largest food aid donor and the USA still controls the composition of nearly all food aid flows, even when channeled through the WFP or NGOs (Clay 2003; Barrett and Maxwell, 2005). The analysis separately investigates program, project and emergency food aid, as each of these food aid types have different goals and targeting mechanisms. Several need and donor-interest indicators are employed that were proposed in previous studies on food aid allocation. In addition, demographic indicators that capture a region's vulnerability towards health impairments, indicators of nutrient availability in local diets, and a variable of media attention are introduced.

The empirical results show that US food aid has been generally targeted at populations with high nutritional demand and tight budgetary constraints. Zinc and vitamin A, which require action in a particularly critical window of opportunity, are somewhat more responsive to need situations than other nutrients. Significant differences in the allocation patter ns between emergency, project and program food aid suggest that the US adjusts its different food aid tools to different demand situations. There is strong evidence of aid persistence, which is -at the macro level- most probably caused by administrative momentum (Diven, 2001). There is a general irresponsiveness towards temporary shocks. Food prices adversely affect emergency food aid, which clearly indicates significant managerial problems in aid budget planning (Barrett and Maxwell, 2005). Donor interests affect the allocation of nutrients in project and program food aid, while nutrients in emergency food aid are biased by media attention. Sensitivity analyses show that the results are quite robust to different econometric strategies of modeling time and unobserved heterogeneity.

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Chapter 2

Food Security Policy – Developing Countries

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2.1 Introduction

Recent food price hikes and the global economic crisis left their marks, as the number of hungry and malnourished people increased worldwide, particularly in developing countries. Evidence shows that about 902 million people in the developing world were malnourished in 2008, reflecting an increase of about 65 million since 2000-2002 (FAO, 2009). The impact of the declines in household income from the global economic downturn has been compounded by the relatively high food prices in many developing countries, resulting in further increases in the number of undernourished households in these countries. Preliminary estimates for 2009 indicate that the cutbacks in food expenditures have resulted in the number of undernourished rising above 1 billion people in developing countries (FAO, 2009). This development makes it increasingly difficult to achieve the first millennium development goal (MDG) of halving the number of hungry people by 2015. Fanzo et al. (2010) identify lack of political will at both global and national levels as the major cause of the growing divergence from this important MDG. Although food insecurity had attracted little attention in the media and political agendas of developed countries during the last decades, the situation changed in 2008, as riots over higher food prices occurred throughout the developing world (Falcon and Naylor, 2005; Fanzo et al., 2010). The rising numbers of food insecure persons and the clearly established linkages between food security, national security and global security have contributed to renewing international interest in food security policies of developing countries.[1]

Food security involves ensuring both an adequate supply of food and access of the population to that supply, mostly through generating adequate levels of effective demand via income growth or transfers. Food security in developing countries therefore tend to be influenced by both micro and macro factors, that include adoption of new technologies, support for institutions available to farmers, food price policy, as well as monetary, fiscal, and exchange rate policies that affect overall economic growth and income distribution. The policies that are normally associated with food security usually involve structural changes in relative prices, the general economic environment, as well as other measures such as targeted food subsidies,

[1] Global security is affected in cases where civil unrests threaten regimes within highly insecure regions, and thereby further destabilize the whole region and weaken political allies. An additional threat to global security is that increasing food insecurity and global inequality may raise terrorist motivation (Falcon and Naylor, 2005).

improving technologies and institutions available to farmers and consumers (Weber et al., 1988).[2]

Policy makers are often confronted with the dilemma of higher food prices to induce increased food production and the food security of low-income consumers, as higher prices impose a heavy cost on this group of consumers. A variety of short- and long-term policy options have been used by governments to promote food security in the developing world. Some measures affect food availability on local markets, others the individuals' entitlements to obtain food, while others tend to influence food utilization, i.e. how much nutrients an individual obtains from a given supply of food.

This chapter reviews the concept of food security and the various approaches developing countries have used to promote food security in their countries. A simple microeconomic model of food security is developed and used to discuss the operational issues on food security strategies. As argued by Mellor (1978), an employment program, or an income–transfer program for the poor to improve their food security status, will be inefficient in assisting them unless provision is made for an enlarged supply of basic food commodities. Thus, policies geared at improving food security should include both income-generation and food production measures. The discussion in this chapter therefore involves both direct and indirect policy interventions that are used to ensure food security in developing countries.

The chapter is organized as follows. The next section presents a simple microeconomic model of food security that explains individuals' demand for food ingredients, as well as the different channels through which they become food insecure. Sections three and four examine the food security policies of developing countries, as they relate to the theoretical model derived in section two. Specifically, section three discusses the food market intervention policies, while section four focuses on the indirect food security measures normally employed to attain a sustainable social and economic environment over the long term. The final section sums up the main conclusions.

2.2 Microeconomic food security model

Food security exists when all people, at all times, have access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO,

[2] Sen (1999) points out that hunger relates not only to food production and agricultural expansion, but also to the functioning of the entire economy and the operation of the political and social arrangements that can, directly or indirectly, influence people's ability to acquire food and to achieve health and nourishment.

2003). Thus, both diet quality and quantity are important components of food security. Diet quality measures the ability of foods to supply protein of high biologic value and adequate supplies of micronutrients such as minerals, trace elements and vitamins, whereas diet quantity refers to the availability and consumption of total food energy. In general, where the quantity of food is reduced, then so is the intake of micronutrients (Abdulai and Aubert, 2004). Access to non-food inputs such as clean water, sanitation and health care has recently been included in the broader definition of food security (FAO, 2009).

The complexity of the food security concept makes it difficult for an effective analysis of a policy's effectiveness. Notwithstanding this task, an attempt is made in a simple microeconomic food security model to show how various policy instruments affect the different dimensions of food security. The model is a version of Becker's (1965) model with the modifications proposed by Barrett (2002). To the extent that food security involves both hunger and malnutrition, we incorporate the ingredients of the Lancaster's (1971) product characteristics approach to capture individuals' preferences for product attributes. As noted by Barrett (2002), five key elements that a useful food security model needs to incorporate include: (i) the physiological needs of individuals, (ii) irreversibilities like death and permanent impairments, (iii) behavioral dynamics, (iv) uncertainty and risk, and (v) complementarities and trade-offs between food and other variables such as care-giving and education. These elements are incorporated in the model below.

2.2.1 Model definition

The most important elements of the model are that individuals are assumed to maximize utility derived from the consumption of goods and services (***c***) and health status (***h***). Total consumed product characteristics (***x***) are obtained through the consumption of ***c***. Product characteristics include ingested metabolizable ingredients (***d***), which affect the individual's health status (***h***), and characteristics that are directly valued by the individual (***e***), such as taste, texture and social acceptance**.** Individuals face a time constraint in producing goods and services within a production function. The health status of an individual is determined by a health production function. Given these assumptions, each individual is assumed to maximize a time separable utility function of the form

$$U_t = E_t \sum_{\tau=t}^{T} \gamma^{\tau-t}\, U\left(\boldsymbol{e}_\tau, \boldsymbol{h}_\tau, \boldsymbol{m}_\tau\right) \qquad \gamma \in [0,1] \tag{2.1}$$

where E_t is the expectations operator given the information set at time t, γ is the subjective discount factor, T is the number of periods and $\boldsymbol{m}$ is leisure. Utility is nonnegative and strictly increasing in the individual's health status ($\boldsymbol{h}$), which is a vector of non-negative health dimensions such as physical and cognitive capabilities. In addition, utility is generated by the consumption of product attributes that the individual values ($\boldsymbol{e}$), and by investing time in leisure. As indicated above, each individual faces the following constraints in maximizing the utility function.

$$\boldsymbol{x}_t = A\boldsymbol{c}_t \tag{2.2}$$

$$\boldsymbol{h}_{t+1} = \Theta\left(\boldsymbol{h}_t, \boldsymbol{d}_t, \boldsymbol{l}_t, \boldsymbol{z}_t, \boldsymbol{\varphi}^h\right) \tag{2.3}$$

$$\boldsymbol{p}^c\left(\boldsymbol{c}_t + \boldsymbol{s}_t\right) = \boldsymbol{p}_t^y\, \boldsymbol{y}_t + \boldsymbol{b}_t + \boldsymbol{g}_t \tag{2.4}$$

$$\boldsymbol{b}_t = \Psi(\boldsymbol{a}_t) \tag{2.5}$$

$$\boldsymbol{a}_{t+1} = \delta\, \boldsymbol{a}_t + \boldsymbol{s}_t + \boldsymbol{\varphi}^a \qquad \delta \in [0,1] \tag{2.6}$$

$$\Omega\left(\boldsymbol{y}_t, \boldsymbol{l}_t, \boldsymbol{h}_t, \boldsymbol{a}_t \mid \boldsymbol{\varphi}^p\right) = 0 \tag{2.7}$$

$$\boldsymbol{l}_t + \boldsymbol{m}_t = \boldsymbol{L} \tag{2.8}$$

$$\boldsymbol{c}_t, \boldsymbol{l}_t, \boldsymbol{m}_t, \boldsymbol{a}_t \geq 0 \tag{2.9}$$

Overall consumed product characteristics ($\boldsymbol{x}$) are obtained through the consumption of commodities and services ($\boldsymbol{c}$) according to the linear consumption production technology denoted as matrix A in equation (2.2).[3] A health production function is formulated in equation (2.3), where the main determinants of health are chemical ingredients of ingested food, labor activity ($\boldsymbol{l}$), other variables influencing health ($\boldsymbol{z}$) and health shocks ($\boldsymbol{\varphi}^h$).

The budget constraint formulated in equation (2.4) shows the relationship between the value of goods purchased for consumption and stocks and household total income, where $\boldsymbol{s}$ represents a vector of stockpiled goods, $\boldsymbol{c}$ is as defined earlier, $\boldsymbol{p}^c$ is a vector of prices of consumption goods; $\boldsymbol{p}^y$ represents the vector of prices for the household's own produce, including

[3] For simplicity, we assume that food is linearly interrelated with metabolizable nutrients (as does Lancaster, 1971).

wage labor, and production inputs (vector $\boldsymbol{y}$ of netputs). This full income relation ensures that the value of consumption does not exceed the sum of net income, the value of borrowings ($\boldsymbol{b}$) and the value of non-labor income ($\boldsymbol{g}$), such as rents and transfers received by the individual. A borrowing constraint is formulated in equation (2.5), so that the amount of borrowed money $\boldsymbol{b}$ cannot exceed the willingness to lend that is captured by the function $\Psi(\cdot)$, which increases in asset stocks ($\boldsymbol{a}$). Equation (2.6) represents the law of motion for asset stocks, with δ as the depreciation factor and current stock building quantities and asset shocks ($\boldsymbol{\varphi}^a$) as explanatory variables. In equation (2.7), the production technology is captured as the function $\Omega(\cdot)$, which is determined by netput quantities, labor activity, health status, asset stocks and production shocks ($\boldsymbol{\varphi}^p$). Household human resources constraint is expressed in equation (2.8), where the total time endowment $\boldsymbol{L}$ is allocated between leisure $\boldsymbol{m}$ and hours of work for pay $\boldsymbol{l}$. Nonnegativity constraints for labor activity, consumption quantities and assets are formulated in equation (2.9).

2.2.2 Food security: nutrient provision and food safety

Modeling product characteristics has two advantages. First, miscellaneous positive and negative effects of food ingredients on human organism are exactly captured. This allows a more realistic description of complex human metabolism. For example, the effects of vitamin A deficiency (food attribute) on sight (health dimension), can be explicitly modeled, and clearly differ from the effects of iodine deficiency (food attribute), which causes – amongst others – impairment of intelligence (health dimension).[4] The incorporation of health dimensions takes into account the fact that impairments in different parts of the human body are likely to affect labor productivity differently in equation (2.7), and may also be differently valued by the individual.

Second, food insecurity can be modeled in greater detail by analyzing the extent to which health dimensions are impaired by nutrient deficiency (or unhealthy food ingredients). Formally, for every health dimension k in vector $\boldsymbol{h}$, there are three possible degrees of nutrition levels ($\boldsymbol{NS}$), captured as thresholds for every element in $\boldsymbol{d}$:

[4] Detailed impacts of vitamin A and iodine deficiencies on health status are documented in WHO (1982) and Hetzel (1983), respectively.

1) 'healthy nutrient threshold' $\boldsymbol{NS}^{1}_{k,t}\left(\boldsymbol{l}_t, \boldsymbol{z}_t, \boldsymbol{\varphi}^h\right)$: the minimum nutrient requirement (upper limit for unhealthy ingredients and overconsumption) to maintain proper functioning of the health dimension,
2) 'non-permanent impairment nutrient threshold' $\boldsymbol{NS}^{2}_{k,t}\left(\boldsymbol{l}_t, \boldsymbol{z}_t, \boldsymbol{\varphi}^h\right)$: the minimum nutrient requirement to prevent permanent impairment, and
3) 'survival nutrient threshold' $\boldsymbol{NS}^{3}_{k,t}\left(\boldsymbol{l}_t, \boldsymbol{z}_t, \boldsymbol{\varphi}^h\right)$: the minimum nutrient requirement for survival.

Nutrient requirements increase in current labor activity level ($\boldsymbol{l}_t$), and change with other health influencing factors ($\boldsymbol{z}_t$) such as age, gender, pregnancy status and stature. Furthermore, negative health shocks ($\boldsymbol{\varphi}^h$), involving illnesses such as diarrhea and measles or worm infections, lead to less nutrient absorption and higher nutrient requirements (WHO, 1982). Thus, lack of nutrients that support the immune system, e.g. vitamin A, may trigger a vicious cycle by causing higher vulnerability to illnesses, which in turn raises required nutrient intake. This approach is also able to explicitly model hunger, which is defined as the 'physiological sensation associated with insufficient food intake' (American Dietetic Association, 1990). Along an individual's health dimension 'energy requirement', a decline below the $\boldsymbol{NS}^{1}_{t}$ threshold implies lack of caloric intake, resulting in the negatively perceived health output hunger.

For the human organism as a whole, formal degrees of healthy ($\boldsymbol{NS}^{1}_{t}$), non-impairment ($\boldsymbol{NS}^{2}_{t}$) and survival ($\boldsymbol{NS}^{3}_{t}$) nutrient states are determined by nutrient thresholds of those health dimensions that impose the tightest constraints on food ingredients (highest minimum nutrient requirements / lowest upper limit for unhealthy ingredients). If at some time t^D any element in the vector of ingested food $\boldsymbol{d}$ falls below the required $\boldsymbol{NS}^{3}_{t}$ level, at least one vital function of the organism breaks down and the individual dies, which is formally expressed as $\boldsymbol{h} = 0, \ \forall\, t > t^D$.

The analysis of nutrient requirements and food ingredients given above has been rather deterministic. However, food security as an *ex-ante* concept of exposure to undernutrition or malnutrition requires the incorporation of decisions under uncertainty. These include health shocks, shocks to asset stocks ($\boldsymbol{\varphi}^a$), production shocks ($\boldsymbol{\varphi}^p$) as well as uncertainty regarding prices and transfers. In addition, imprecise knowledge on nutrient requirements and food ingredients are likely to drive risk-averse individuals even further away from consumption bundles in proximity to nutrition state thresholds.

Risk is incorporated in the model by assuming that individuals make consumption decisions conditional on a subjective joint density function $\Phi(\cdot)$ over exogenous variables (Barrett, 2002). Given this density function and control variables $\boldsymbol{x}_t$, $\boldsymbol{s}_t$ and $\boldsymbol{l}_t$, food security can be defined as the marginal probability at time t to exceed any of the three nutrition states in time $t + s$ (where $s \geq 0$):

1) 'healthy food security':

$$\boldsymbol{FS}_t^1 = \Pr\left(\boldsymbol{d}_{t+s} \geq \boldsymbol{NS}_{t+s}^1 \ \forall\, \boldsymbol{d} \in N \wedge \boldsymbol{d}_{t+s} \leq \boldsymbol{NS}_{t+s}^1 \ \forall\, \boldsymbol{d} \in UN\right)$$

2) 'non-permanent impairment food security':

$$\boldsymbol{FS}_t^2 = \Pr\left(\boldsymbol{d}_{t+s} \geq \boldsymbol{NS}_{t+s}^2 \ \forall\, \boldsymbol{d} \in N \wedge \boldsymbol{d}_{t+s} \leq \boldsymbol{NS}_{t+s}^2 \ \forall\, \boldsymbol{d} \in UN\right)$$

3) 'survival food security':

$$\boldsymbol{FS}_t^3 = \Pr\left(\boldsymbol{d}_{t+s} \geq \boldsymbol{NS}_{t+s}^3 \ \forall\, \boldsymbol{d} \in N \wedge \boldsymbol{d}_{t+s} \leq \boldsymbol{NS}_{t+s}^3 \ \forall\, \boldsymbol{d} \in UN\right)$$

where N is the set of nutrients and UN is the set of unhealthy ingredients. To distinguish 'food secure' from 'food insecure' individuals, a threshold that allows a classification according to the three food security probabilities outlined above, needs to be defined. In case of the current period ($s = 0$), food security degrees are binary variables that are directly or indirectly observable. Given the formal model of hunger above, it can be easily seen that the aim of decreasing hunger is positively correlated to that of increasing food security, but only as far as an individual's energy requirement represents one of the constrained health dimension.

Even if nutrients themselves do not give any direct utility, they indirectly influence food consumption decisions due to their effects on physical wellbeing. In cases where individuals cannot afford consumption bundles that simultaneously provide enough amounts of different nutrients (e.g. iron and vitamin A), the consumption decision definitely transforms into a trade-off between the various health conditions related to those nutrients (e.g. physical and cognitive incapability due to iron deficiency versus inability to see due to vitamin A deficiency).[5] Given that the individual is aware of this mechanism, consumption decision is likely to be influenced by the personal valuation of the affected health dimensions (eq. 2.1) and their expected contribution to the individual's labor productivity (eq. 2.7).

In some settings, temporary nutrient deficiencies may be accepted by individuals, in order to help other family members improve their nutrition, thus ensuring future income generation opportunities, or just for deriving utility from non-nutrition characteristics. As evident from

[5] The impacts of iron deficiency on cognitive function and work capacity are reviewed in Pollitt (1993) and Haas & Brownlie IV (2001), respectively.

table 2.1, nutrition deficiency – e.g. iodine and vitamin A – is widespread in both developing and developed countries. Remarkable differences between the regions, for example, exceptionally low malnutrition rates in America, a high prevalence of inadequate iodine nutrition in Eastern Mediterranean and a prevalent vitamin A deficiency in preschool-age children of South-East Asia and Africa, justify different food policy approaches to improve food security in the different regions.

Table 2.1. Malnutrition in different world regions

	Inadequate iodine nutrition: number of affected persons (proportion)[a]	Vitamin A deficiency : number of affected persons (proportion)[b]	
		Preschool-age children	Pregnant women
Africa	312.9 Mio. (41.5%)	56.4 Mio. (44.4%)	4.18 Mio. (13.5%)
Americas	98.6 Mio. (11%)	8.68 Mio. (15.6%)	0.23 Mio. (2%)
South-East Asia	503.6 Mio. (30%)	91.5 Mio. (49.9%)	6.69 Mio. (17.3%)
Europe	459.7 Mio. (52%)	5.81 Mio. (19.7%)	0.72 Mio. (11.6%)
Eastern Mediterran	259.3 Mio. (47.2%)	13.2 Mio. (20.4%)	2.42 Mio. (16.1%)
Western Pacific	374.7 Mio. (21.2%)	14.3 Mio. (12.9%)	4.9 Mio. (21.5%)
Total	2008.8 Mio. (30.6%)	190 Mio. (33.3%)	19.1 Mio. (15.3%)

a: Estimates for iodine nutrition are based on surveys from 1994 – 2006.

b: Vitamin A deficiency indicator is a serum retinol threshold of <0.70 μmol/l. WHO estimates for vitamin A deficiency are based on surveys from 1995-2005.

Source: de Benoist et al. (2008), WHO (2009)

2.2.3 Analyzing food security policies

The microeconomic model presented above illustrates the various dimensions of food security as expressed by the three components of nutrition availability, nutrition access and food utilization, and can be employed to show how government policies affect the food security status of individuals.

Nutrition availability may be improved by the supply of sufficient food stuffs at the local markets to ensure that food meant for consumption and storage (i.e., food in $\boldsymbol{c}_t$ and $\boldsymbol{s}_t$) are not in limited supplies. Major food security policies in this area generally include, besides ensuring higher productivity and output levels, improving market integration through infrastructure, private trade supportive policies, state trading as well as public buffer stocks (Abdulai, 2000). Governments in developing countries therefore invest in Research and Development

(R & D), farm infrastructure (irrigation and soil-conservation technologies) and extension services, early warning systems or subsidize farm inputs to shift the individual's production function $\Omega(\bullet)$ for food upwards or decrease food supply fluctuations ($\boldsymbol{\varphi}^p$). Public investment programs in storage facilities such as rat-proof granaries that reduce asset shocks ($\boldsymbol{\varphi}^a$) and depreciation (δ) are direct policies that tend to influence private assets. An indirect, but significant policy for preventing negative asset shocks is the provision of institutions for a stabile legal environment. This is particularly important because the occurrence of food insecurity itself may negatively affect regional security, since food insecure households are more likely to act against the law in order to improve their access to food (Falcon and Naylor, 2005). Privately stored food ($\boldsymbol{a}_t$), which can be employed to overcome food shortfalls, also contributes to the household's (future) nutrition availability.

Given that nutrient availability remains a chronic problem in developing countries and crisis prone regions, the issue of improving food availability continues to attract attention in these countries. This is in contrast to the discussion of food security in the developed world, where food production and availability are generally at higher levels, markets are well integrated and the institutions are stable over time, contributing to lower levels of food insecurity. Moreover, measures for improving farm productivity are not that relevant for achieving food security in developed countries, given that relatively small proportions of the populace are engaged in farming. As argued by Coates et al. (2006), food insecurity in developed countries mostly arises from shortcomings in food access, which partly explains why relatively more attention is given to examining and explaining this complex concept in research work related to the food sector (see also Wilde, 2010).

Nutrition access is solely derived from eq. 2.4, i.e. food buyers are dependent on food prices as well as food availability, and by any of the right hand side elements that determine their purchasing power. Government policies related to food availability ($\boldsymbol{c}_t$ and $\boldsymbol{s}_t$), have been discussed above. Policies that help in lowering and/or stabilizing consumers' food prices ($\boldsymbol{p}^c$) and/or stabilizing producers' food prices ($\boldsymbol{p}^y$) have been generally employed to improve nutrition access in developing countries. In particular, improving the non-farm earnings of individuals is a way of enhancing their 'entitlement' over an adequate amount of food (Sen, 1999).[6] Policies that have been generally used to address non-farm earnings possibilities in-

[6] According to Sen (1999), a family's entitlement depends on, among other things, distinct influences such as ownership over productive resources as well as wealth that commands a price in the market, production possibilities and their use, as well as the ability to sell and buy goods and the determination of relative prices of dif-

clude education policies to enhance the human capital of individuals, promoting credit institutions to improve access to credit, as well as policies that foster market integration through trade incentives and better infrastructure, which both provide extended rural-urban linkages and spatial income diversification (Abdulai and Delgado, 1999).

Public work programs are employed to stabilize income shocks, while supplementary feeding programs normally target vulnerable groups (e.g. pregnant women, children) that need special diets (with the targeting criterion in $\boldsymbol{z}_t$). Market failures in financial markets have also been addressed to enhance borrowing conditions ($\boldsymbol{b}_t$) and provide better insurance and hedging possibilities that help stabilize income ($\boldsymbol{\varphi}^p$). Commodity and cash transfers ($\boldsymbol{g}_t$) are measures that are mainly used in the framework of food safety nets, emergency food aid, schooling services and input starter packs, as well as providing incentives for schooling or health services.

Finally, food utilization is incorporated through the consumption technology A in eq. 2.2 and through $\boldsymbol{\varphi}^h$ in eq. 2.3, which includes health shocks that reduce the nutrient absorption capability of an individual's organism. The former can be influenced by policies altering the overall food quality, e.g. through micronutrient fortification and better access to clean water, or by individual nutrition education programs on food preparation. The latter is commonly handled by enhancing the sanitation conditions, health education programs and better access to medical treatment (e.g. placement of and access to medical facilities, trade and distribution of medicine).

2.3 Food market policies in developing countries

Given that food constitutes a substantial share of the expenditure of both rural and urban population, developing countries tend to employ diverse policy measures to influence agricultural prices.[7] These policies, which normally have direct impacts on food prices and food availability, are discussed below.

2.3.1 Price and trade regulation policies

In this section, we briefly discuss the main price and trade regulation policies that are commonly used in developing countries with the goal of improving food security.

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ferent products.

[7] On average, households in low-income countries spent 53 percent of their expenditures on food in 1996, the corresponding figures for middle-income and high-income countries were 35 and 17 percent, respectively (Seale et al., 2003).

The rationale behind government administered consumer prices for staple food (issue prices) is either to improve food access through lower market prices for consumers, or to stabilize consumption in times of upward price shocks by imposing price ceilings. The majority of developing countries have historically maintained low food prices to help urban consumers and to foster industrialization through lower wages. In pursuing these objectives, two paths of food price subsidies have generally been followed. These include universal price subsidies that benefit net food buyers and limited access subsidies, where rationed quantities are granted at concessional prices. Universal price subsidies have generally been criticized as inefficient, since all individuals profit from general food subsidies. The greater share of rationed food grains has generally been distributed to the politically vocal and well organized groups, which include the urban population, government employees and industrial workers.[8] While these beneficiaries have normally supported the cheap price policies, escalating fiscal expenditures for food subsidies and occasional political pressure from multinational donors have compelled most developing countries to liberalize food markets over time.

Discrimination of the agricultural sector through non-compensated cheap food price policies has been continuously criticized because of its negative impact on farm households' welfare and farm investments, thus harming current and future food security of most rural households (e.g. in Schultz, 1964). To encourage domestic food supply and improve local food availability, some governments of development countries have offered producers higher than market prices, determined producer price floors or subsidized farm inputs. Higher procurement prices have the ability to lift food insecure farmers above the food security threshold, while price floors are designed to prevent farmers just above the food security threshold from falling into insecurity through declines in farm incomes. In particular, Asian countries with rice as the main staple food have effectively employed price stabilization policy as a food security tool (Timmer and Dawe, 2007).

An issue that usually accompanies procurement price increases is the extent to which these higher prices are passed on to domestic consumers. If no sufficient compensation is given to consumers, rising food expenditures tend to impair the food security of net food-buyers such as the urban population and rural workers not engaged in food production. This negative impact may be low in the case of foods that have small relevance to dietary requirements and contribute less to households' expenditure. For example, while Kenyan consumers have had

[8] For example, India's public distribution system has been found to considerable favor population in urban districts (Gulati et al., 1996).

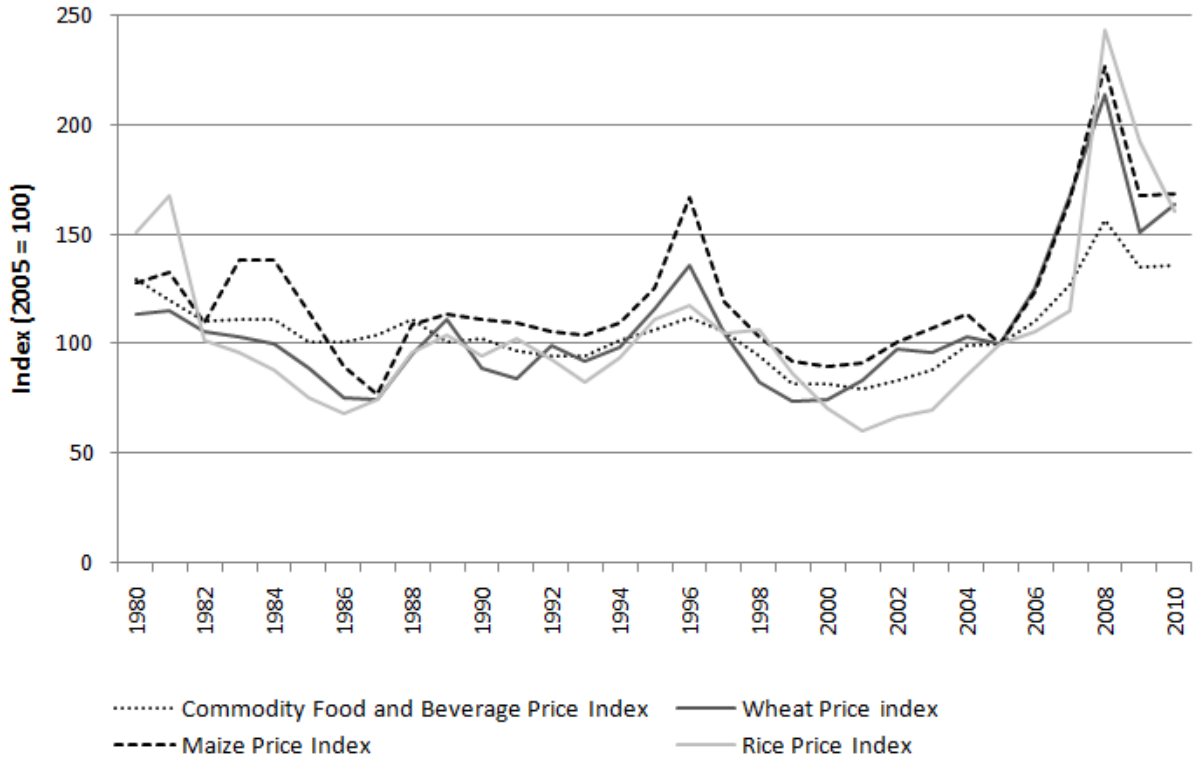
to face higher retail prices for sugar, price increases in staple foods, such as rice in Asia or wheat in northern Africa and the Middle East, have commonly not been fully passed on to consumers.

Efficient price stabilization policies should normally incorporate factors that affect a country's specific price and production risks, e.g. if it is landlocked or prone to draughts and floods. Given that decision-makers are usually subjected to rent-seeking activities of special interest groups, it is not surprising that the procurement and issue prices that are chosen tend to be sub-optimal (Dixit and Josling, 1997; Rashid et al., 2007).

Trade restriction regimes have commonly been employed in the form of quotas and tariffs. Import and export trade restrictions for the food sector have historically been implemented to reduce dependency on foreign imports. Current import restrictions such as quotas and tariffs generally offer net-food importing countries the opportunity to respond to world market price fluctuations.

For example, developing countries recently had to deal with the sharp increases in world food prices, particularly for cereal staple foods (see figure 2.1). These price increases resulted in food crises in some regions, as the number of undernourished persons increased significantly (see table 2.2). The trend of a declining proportion of undernourished people in the developing world has been reversed in the late 2000s. In Latin America and the Caribbean, where absolute numbers of undernourished persons had previously been reduced, the number of malnourished people increased significantly. Declining global food prices in 2009 could not prevent a further increase in the number of undernourished, which indicates that the massive income losses from due to the global economic recession (FAO, 2009). These estimates only capture part of the food insecure population, since food insecurity also includes people that are not currently suffering from malnourishment, but are at risk of falling below the NS thresholds in future periods (Barrett, 2002).

Figure 2.1. Food Price Indices (1980 – 2010)



Source: IMF (2009)

Table 2.2. Prevalence of undernourished people by region

	millions of undernourished (percentage share in total population)				
	1990-92	2000-02	2004-2006	2008 [a]	2009 [a]
Asia & Pacific	585.7 (20)	552.1 (16)	566.2 (16)	581.0 (16)	642 (18)
Latin America & Caribbean	52.6 (12)	49.4 (9)	45.3 (8)	46.7 (8)	53 (9)
Near East & North Africa	19.1 (6)	31.6 (8)	33.8 (8)	37.2 (8)	42 (9)
Sub-Saharan Africa	168.8 (34)	205.5 (32)	212.3 (30)	237.0 (31)	265 (34)
Developing World	826.2 (20)	838.0 (17)	857.7 (16)	902.0 (17)	1002 (18)

a: Figures on proportion of undernourished in 2008 and 2009 are calculated using data from FAO (2009) and UN (2009). FAO estimates for 2009 are preliminary.

Source: FAO (2009)

The food price increases resulted in some countries re-examining their liberalized agricultural trade policies, and intervening by imposing food price controls and trade restriction policies. For instance, Argentina, China, India, Russia and Thailand restricted food exports in the wake of the price increases, while food importing countries reduced their tariffs and taxes on food

and agricultural input imports to improve domestic food supply (Wodon and Zaman, 2008). Timmer and Dawe (2007) argue that such measures helped in stabilizing domestic rice prices in Bangladesh and as such circumvented high levels of inefficient public procurement.

Some authors have argued that tightening export restrictions tends to discourage local food production and also intensifies the burden on the food-importing countries. For example, von Braun (2008) points out that the elimination of export bans could reduce international grain price fluctuation and reduce price levels by 30 percent.

2.3.2 State engagement in storage and trade

This section discusses the specific consequences arising from state and parastatal agencies that are legal monopolies or act as competitors in stock holding, national food trade and/or international food trade.

Government engagement in holding strategic food reserves may be justified on food security grounds, and probably market failures in domestic private stockholding. Two strategic objectives of public buffer stocks can be derived from these justifications: (i) to reduce year-to-year domestic harvest fluctuations, in which government stocks are mostly substitutes for international trade flows, and (ii) to smoothen consumption in the presence of significant seasonality in agricultural markets (Siamwalla, 1988). Available evidence reveals that public buffer stocks are in most cases more expensive than procuring food from international markets. If prices of public grain reserves are stickier than prices on the open markets, public storage authorities have to cope with large consumer switches between publicly provided food and food from the open market (Krishna and Chibber, 1983). Thus, measures to prevent supply gaps at all times require inefficiently large precautionary food inventories, with large opportunity costs.

Although grain price fluctuations have not increased since the 1970s and the traditionally thin international rice market has considerably expanded and become more stable since the 1990s, the significant impact of few key players, such as China, USA and EU on the world market have raised new doubts on the reliability of international trade (Calpe, 2004; Byerlee et al., 2006). During liberalization periods, public buffer stocks have in some countries proved to be hardly dispensable. To be effective, modern public grain reserves generally require a well informed, as well as professional management with good analytical capacities. The empirical evidence suggests that mismanagement and decisions based on wrong production estimates have lead to catastrophic outcomes in the past (e.g. Charman and Hodge, 2007). Although advanced information technology may provide more efficient tools for data handling, public

buffer stock authorities need to deal with decreased information spill-overs they obtained from the former public and now privatized state trading enterprises. In markets where private stockholders do not have significant market power, a probably more efficient way to achieve consumption smoothing during the marketing season is to subsidize private grain storage (Siamwalla, 1988).

The objectives of state enterprises (STEs) usually include pursuing cheap food policies, supporting farm gate prices, stabilizing domestic prices through food transport between regions, subsidizing lower income groups and in some cases providing farms with needed inputs. Direct participation of the state in agricultural markets is mostly a means to support and complement administered pricing policies. The operation of STEs can be economically justified in the presence of market failures. Rashid et al. (2007) discuss four commonly accepted types of market failures in this context; (i) weak infrastructure and limited flow of information, (ii) risk mitigation for technology diffusion, (iii) thinness and volatility of international markets, and (iv) inability to participate in international markets, e.g. due to low foreign exchange reserves. They demonstrate for six Asian countries (Bangladesh, India, Indonesia, Pakistan, Philipines, and Vietnam), that all of these justifications of STEs have become less persuasive over time. This stems from the fact that other implemented policy measures, such as public work programmes for building road infrastructure, investments in agricultural research and prospective macro policies, as well as exogenous developments, such as reduced price volatility in international rice markets and advances in information technology, have substantially reduced the market failures that costly STEs were initially meant to circumvent. In contrast, private traders have become more and more effective in coping with food crises.

STEs have commonly operated at significantly higher unit costs than the private sector (e.g. Rashid et al., 2007). This inefficiency partly stems from services to remote areas that may not be adequately covered by private traders and hence may have to rely on safety net support in a privatization scenario. A major political incentive to further operate STEs is the flexibility to promptly enact political mandates without parliamentary scrutiny (Dixit and Josling, 1997). With this quick and direct government response tool, governments have however been tempted to solve food crises with unforeseen and immense food transport activities. Such STE actions, as well as abruptly adjusted preferential arrangements for STEs have the potential to seriously discourage private traders from participating in food trade. For example, the reduction of food import tariffs for STEs during the food crises in 2004 in Madagascar resulted in a

dramatic breakdown of commercial food imports, which substantially worsened the food supply situation at local markets (Dorosh, 2008).

On the other hand, domestic food distribution systems have shown to be prone to fundamental design errors. For instance, the shift in India's Public Distribution System from universal food rations to targeted food rations has reduced the access of poor households to public food rations, probably because private ration shop owners store fewer public food rations due to less expected demand (Kochar, 2005).

2.3.3 Agricultural market liberalization

Given the drawbacks mentioned in the above sections and the disappointing results of expensive regulation policies on food security in the 1960s and 1970s, many developing countries have made efforts to liberalize their agricultural markets. Support for trade liberalization is based on conventional welfare analysis, which shows that price controls undermine the functioning of prices as indicators of scarcity and, thus, results in welfare losses. Regulatory limits on trade, privately held stocks and food processing furthermore discourage private investments and prevent private actors from pursuing their optimal strategies.

However, Timmer and Dawe (2007) point out that price stabilization policy can help ensure food security when access to credits and insurances is incomplete. Myers (2006) also asserts that when the theoretical welfare model is extended by allowing for discontinuous jumps in the utility function at low nutrition levels, welfare gains can be obtained through stabilization price policies. These gains can be of considerable magnitude, especially for the poor with nutrition intake close to the food security threshold. Nevertheless, the inability of these policies to overcome the fundamental problems of market failures, their obstruction of efficient private entrepreneurs' engagement and excessive rent-seeking behavior have usually made them an increasingly expensive instrument.

Kherallah et al. (2000) show that the market reforms undertaken by developing countries have largely contributed to food security in these countries, although some of them found themselves stuck in the transition process. For example, private traders in Bangladesh were able to stabilize food markets after the government had fully liberalized the markets for the major crops in the early 1990s (del Ninno et al., 2007). However, considerable threat to food security was observed in cases where producer subsidies were withdrawn without efforts to diversify incomes of affected producers, and particularly in remote areas where market forces could not fill the gap left by the state trading organizations. This has been the case in Malawi at the end of the 1980s, where the abolishment of agricultural input subsidies and the closure of

many markets of the state marketing board in Malawi resulted in a national food crisis (Harrigan, 2008). On realizing the emergencies that emerge through liberalization, governments have commonly stopped or reversed further transition, so that regulation and government agencies still play a significant role in agricultural markets in many developing countries.

2.3.4 Public safety nets for food access

With public actions in food markets on the retreat, the role of the state is increasingly seen as the provider of public insurance, i.e. safety nets for food access and health, and public goods, such as physical infrastructure. This section focuses on public insurance schemes through safety nets. The shift towards approaches that aim at helping households meet their individual nutrition demand also marks a significant shift from supply side policies to food access policies. Two common instruments for public insurance in developing countries are supplementary feeding and public works programs. Supplementary feeding programs have been widely used in developing countries with significant focus on infants, children and pregnant or lactating mothers as target groups. They are commonly operated in cooperation with NGOs, and a large share of the employed food comes from international sources, like food aid (Barrett, 2002). Intervention designs range from controlled feeding at health facilities, over home visiting physicians that supervise nutrient intake to take-home rations.

In a comprehensive meta-analysis, Dewey and Adu-Afarwuah (2008) investigate the effects of a multitude of complementary feeding interventions for children on diverse health outcomes in developing countries. To avoid bias in comparing treatment and control groups, the authors mostly included interventions with randomized treatment assignment, or non-randomized interventions with a low risk of confounding effects. They found that child growth can be considerably improved when programs are employed in a well-controlled environment. Findings on child morbidity have mainly been inconsistent; in three out of ten studies, the morbidity rates even increased in the intervention group. Possible explanations for such adverse effects are reductions in breastfeeding in the intervention groups or unhygienic preparation and storage of supplements at home (Dewey and Adu-Afarwuah, 2008). The results of feeding interventions on children's behavioral development are mixed, with two out of four studies reporting significant improvements in the infants' ability to walk by 12 months. Feeding interventions mostly enhanced the children's micronutrient status for iron and vitamin A. These findings suggest that feeding interventions can be effective, but this largely depends on how the local context, particularly household behavior, is taken into ac-

count. To be effective, large scale feeding intervention programs thus need a carefully thought-out design, which may involve considerable costs in implementing.

Given the general insufficiencies of physical infrastructure and fluctuating rates of unemployment and underemployment in developing countries, labor-intensive public work programs have been increasingly considered as a promising instrument with little opportunity costs (Dev, 1995). For example, the government of Ethiopia has committed to spend 80 percent of their food assistance resources on food for work projects (FDRE, 1996). Public work schemes have been used in South Asia since ancient times to ensure food entitlements, and have proved to be relatively successful (Dev, 1995; Clay, 1986).

Two food security related purposes are pursued through the establishment of public work programs. The first, short-run purpose is to smooth food consumption by providing a cash or in-kind wage. The particular domain of public work provision is during the slack season and in the face of covariate shocks like droughts and floods, where market demand for unskilled labor usually brakes down (Barrett, 2007). When rightly timed, these programs have the ability to overcome market failures in the financial market. The second is the construction and maintenance of assets that foster future economic growth. The created assets usually include road and social infrastructure, reforestation or on-farm improvements such as irrigation, water and soil conservation. Most of these assets have public good characteristics, and are therefore not sufficiently provided by market forces to meet the social optimum. The rationale for building on-farm assets is to overcome market failures that hinder farmers from investing. The choice of what to construct is not trivial, and many top-down planning approaches that did not incorporate local advisors, have often resulted in poorly developed infrastructure (Holden et al., 2006).

An indirect effect of public work on food access is its potential to drive up market wages because of (i) its characteristic as a reservation wage, and (ii) productivity gains through the built assets that increase labor demand (Abdulai et al., 2005). The design of public work programs is knowledge-intensive and requires proper adjustments to the local economic environment. This requires setting a wage rate high enough to ensure adequate nutrition for the participants, but low enough to minimize inclusion errors (attracting food secure people) and crowding out workers of regular jobs. It is, however, significant to mention that if the increase in demand for food accompanying the additional employment of low-income people is not met by an increased food supply, the employment-based increase in real income will be substantially reduced by higher prices (Mellor, 1978).

2.3.5 Measures to optimize food utilization

Some developing countries have employed food fortification measures with micronutrients such as iodine, vitamin A, iron and zinc, to optimize food utilization. The advantage of these measures is that they can improve nutrition status without necessarily altering food access. While in most cases nutrient requirements can be met with foodstuff accessible on local markets, it has been found that the enrichment with iron is often the only option to meet the requirements of infants, given the high costs of iron-rich food (Dewey and Adu-Afarwuah, 2008).

Common approaches in developing countries are the fortification of salt with iodine, wheat flour with iron, vitamin B_1 and B_2 and niacin, milk and margarine with vitamin A and D, and sugar with vitamin A. Fortified food is also often provided in supplementary feeding programs, like the nutrient supplementation of the large scale Mexican Progresa program (Rivera et al., 2004). In general, micronutrient fortification has proven to be a cost effective instrument that has the ability to reach large shares of the population at very low costs, as shown by iodized salt that costs about five cents per person and year (Barrett, 2002).

Nutrition education programs are an alternative method to micronutrient fortification, and attempt to achieve a more balanced nutrient intake by improving food consumption patterns. This is an especially promising approach when aimed at persons that are responsible for the preparation of food for other household members. In their systematic review on developing countries, Dewey and Adu-Afarwuah (2008) concluded that the impact of nutrition education interventions for mothers had rather modest impacts on child weight and growth. Child morbidity was not affected in two studies, but an efficacy trial in Brazil reported significant decreases in diarrhea and respiratory infections.

2.4 Policies influencing the economic environment

In addition to the direct policy interventions discussed above, governments normally employ a wide array of measures to influence food production and availability in order to enhance food security in their countries. These measures are discussed below.

2.4.1 Public investments in the agricultural sector

The need for public investments in agricultural development stems from the atomistic nature of the sector, whereby small-scale farmers lack the means to undertake long-term investments. Public investments in land-augmenting infrastructure such as irrigation, rural electrici-

ty and transport networks and in supply-shifting factors such as agricultural research and extension services can enhance the incentive content of prices facing farmers (Rao, 1989; Abdulai and Huffman, 2000). Available evidence shows that public investments in agriculture – along with infrastructure spending – generally yield the highest returns in terms of poverty reduction and economic growth (Minten and Barrett, 2008; Fan and Zhang, 2008; Fan et al., 2008). Despite this potential, public expenditures for the sector have declined over the last decades (see table 2.3).

Table 2.3. Public agriculture expenditures as percentage of agricultural GDP

	1980	1990	2000	2002
Africa	7.4 (*2.29*)	5.44 (*1.37*)	5.71 (*1.2*)	6.72 (*1.47*)
Asia	9.44 (*2.96*)	8.51 (*1.71*)	9.54 (*1.35*)	10.57 (*1.23*)
Latin America	19.51 (*1.66*)	6.79 (*0.78*)	11.1 (*0.64*)	11.57 (*0.6*)
Total	10.76 (*2.23*)	8.04 (*1.24*)	9.34 (*1.03*)	10.32 (*1.09*)

Values in parentheses are unweighted shares that are reported because the weighted averages commonly calculated at regional and global levels may bias towards large countries.

Source: Fan et al. (2008), using data from International Monetary Fund, *Government Financial Statistics Yearbook*

With public agricultural expenditures per agricultural GDP ratios of below 10 percent, support for the agricultural sector appear to lack far behind that of developed countries, which have ratios of over 20 percent (Fan et al., 2008). The difference is even greater for public spending in agricultural R & D, which was 0.37 percent for low-income countries, 0.67 percent for middle-income countries and 2.35 percent for high-income countries (Asenso-Okyere and Davis, 2009). Only China, India and Brazil appear to have extensive research programs in all R & D areas, including gene manipulation technology (Pingali and Raney, 2005). In the face of the food crisis, African countries have begun to reiterate their commitment, agreed upon in the Comprehensive African Agricultural Development Plan (CAADP), to increase their public investment in agriculture to an annual 10 percent share of their national budgets (on average below 5 percent in the years 2000 and 2002).

The view that public investments in agricultural infrastructure are induced by price increases was heavily criticized by Rao (1989). He argued that evidence pertaining to public investments in land-augmenting or supply-shifting factors do not support the argument that agricultural prices play a powerful role in promoting or retarding agricultural growth. Similar to ar-

guments advanced by the World Bank (2007), Rao (1989) concludes that the low political power of the rural population and the discriminatory trade and macroeconomic policies of developing countries are among the reasons that account for the chronic underfunding of agricultural R & D.

Although extension services have proven to be effective, as shown by the median rate of return of 58 percent, they have been increasingly scaled down by many developing countries (Alston et al., 2000). Instruments that have been employed to enhance access to farm inputs include universal input price subsidies, concessional credit arrangements with STEs, nonrecurring subsidized input packages and targeted distribution of inputs after natural disasters. An example of a universal free distribution of farm inputs is the Malawian Starter Pack intervention, which emerged as a response to growing soil degradation, and successfully addressed food insecurity of the rural poor (Harrigan, 2008).[9] As is the case for food, such input price subsidies are not targeted towards the food insecure and tend to become a persistent expenditure item, once introduced. These measures therefore need to be carefully targeted to limit leakages.

2.4.2 Financial sector in rural and peri-urban regions

Throughout the developing world, poor households lack access to formal financial markets. While informal insurance and credit arrangements can at least partly fill this gap for idiosyncratic shocks, this is typically not the case when covariate risks affect the whole community.[10] What follows are depletion, erosion and dis-saving of physical and human capital as well as the destructive exploitation of the environment.

Due to their inability to save money, obtain loans or buy insurance, poor households find it difficult to cope with income shocks, which tend to affect their food security status in different ways. First, the household can afford less food, and may therefore fall into food insecurity. Second, as a response to the risky environment, the household can make precautionary savings. This *ex ante* measure to mitigate shocks prevents individuals from investing in income generating activities, thus reducing their ability to improve their future food security status (Zeller et al., 1997). Third, liquidity constraints favor engagement in economic activities with

[9] Later, the Starter Pack intervention was scaled down to a targeted anti-poverty program, which, however, could not adequately handle an upcoming food crisis (Harrigan, 2008).

[10] Problems in informal market include significant market power of the best informed credit lenders, credit rationing due to high default rates and the importance of social networks for credit access, which discriminates against those with few contacts and ethnic minorities (Zeller et al., 1997; Barrett, 2007).

immediate profits, which usually yield low returns, and hinders adoption of new technologies (Barrett, 2007; Abdulai and Huffman, 2005; Abdulai et al., 2008).

To enhance the functioning of financial markets, developing countries have implemented government lending projects that involve state-owned banks providing loans at subsidized interest rates. The results of these approaches have rather been disappointing. Reasons for these disappointing outcomes include corruption and administrative targeting that excluded large parts of poor households (Armendáriz de Aghion and Morduch, 2005). Some governments of developing countries have played an indirect but significant role in the revolution of microfinance, with a focus on micro credits and micro savings. For example, the Grameen Bank started as a special project from the state-owned Bangladesh Bank, and has received loans at concessional rates from the Bangladesh Bank. State-owned banks in Indonesia (Bank Rakyat Indonesia) and Thailand (Bank of Agriculture and Agricultural Cooperatives) have also established innovative microfinance programs with a wide range of small-scale customers.

2.4.3 Transportation and communication infrastructure

Improved infrastructure in developing countries affects food security in a number of ways. These include (i) reduction in search and transportation costs of market participants (ii) increase in agricultural productivity as a result of better access to inputs, credits, services and information, (iii) improved access to health services, (iv) improvement in human capital as a result of better access to education and health services, (v) better job opportunities. In spite of the empirical evidence on the positive impact of transportation and communication infrastructure on economic and agricultural growth, public expenditures devoted to infrastructure remain quite low in developing countries (Easterly and Levine, 1997; Antle, 1983; World Bank, 2004).

At the macro level, Torero et al. (2006) have found a significant positive effect of telecommunications penetration in developing countries on economic growth. An analysis of the garment industry of China, India, Pakistan and Bangladesh based on firm-level survey data also revealed that better phone services can increase income through higher wage rates, firm profitability, and growth (Dollar et al., 2005). Gabre-Madhin (2001) analyzed the Ethiopian grain market and argues that, given considerable information deficiencies among traders and brokers, the use of information technology can considerably increase interspatial trade flows. Meanwhile, the Ethiopian government supported the 2008 established Ethiopian Commodity Exchange that uses radio, television, cellular phone technology and electronic price display

boards to countrywide spread agricultural commodity prices. In addition, information asymmetries arising from poor measurement of traded items and lack of trustworthiness have been approached with warehouse receipt systems, where food commodities are properly weighed and stored.

2.4.4 Healthcare, sanitation and water access

Given that many parts of the developing world still face serious problems in the health sector, such as unequal access to medical treatment, lack of sanitation facilities, scarce and contaminated water, many governments have engaged in providing public health services to reduce the risk of infection and cope with health shocks (Gwatkin et al., 2007). It is encouraging to note that, at the macro level, public spending on health care in developing and transition countries have been effective in improving health of the poor population (Gupta et al., 2003). Thus, public spending has in the sum been additive to private and informal health provisions, as well as international health projects. In detail, sanitation, hygiene, water supply and water quality interventions have mostly been found to be effective in fighting diseases and mortality (Esrey et al., 1991; Fewtrell et al., 2005).

In addition to providing public health services, developing countries have also engaged in providing water and sanitation infrastructure. This is, because increased water supply through these public goods can improve an individual's food security by ensuring better hygienic conditions and also freeing time that is otherwise used for water collection (Esrey et al., 1991; Hutton and Haller, 2004). While building water pipes is the most costly intervention for improving water supply, it provides daily access to treated water (Hutton and Haller, 2004). Water provided by other interventions, such as building wells or spring protection, is on the contrary vulnerable to becoming contaminated when transported or stored at home. Given that measures to improve microbial safety immediately before consumption is very effective in reducing diarrheal infection, water treatment at the point of use are proposed as effective measures in fighting water-borne illnesses (Fewtrell et al., 2005).

2.5 Conclusions

In this chapter, we have argued that food security remains a major concern in the developing countries, and that national governments have employed various policies to address food security concerns of their citizens. Given the broad definition of food security, these policies usually involve direct interventions involving structural changes in relative prices and targeted food subsidies, as well as indirect measures like improving agricultural infrastructure and the

general economic environment, and providing farmers with new farm technologies to increase food production. To the extent that ensuring food security also involves measures that stimulate adequate levels of effective demand through 'entitlements', governments have also employed income diversification strategies and cash-transfers to achieve food security goals. However, these income-support measures for the poor are only efficient when provision is made for an enlarged supply of basic food commodities. This underlines the significance of investing in agricultural sector to boost food production.

The discussion in this chapter has shown that over time the food policies of developing countries have largely moved from direct state interventions that attempted to circumvent food market failures to a more liberalized market approach, where the state entrusts private entities with the task of adequate provision of food, but still invests in safety nets and public goods to overcome market failures. With the reduction of state activities, significant linkages between governments and private enterprises, NGOs, multilateral organizations, research institutions and donor countries have been established to improve food security in developing countries. The discussion in the chapter also clearly revealed that despite the evidence that public investments in agriculture – along with infrastructure spending – generally yield the highest returns in terms of poverty reduction and economic growth, public expenditures for the sector have declined over the last decades. Governments therefore need to increase public investments in agriculture to promote productivity and overall economic growth.

The voluminous literature on food security in developing countries referred to in this chapter shows the efforts several policy analysts have put into research to examine policy options and their impacts on food security. However, a number of important questions still remain unaddressed. For example, in analyzing the effects of stabilization schemes on food prices, an important issue that crops up is determining the adjustments that do the least damage to economic growth and equitable distribution of income in the society. As pointed out by Timmer (1989), addressing such issues normally require general equilibrium analyses, with dynamic investment functions linked to the impact on expectations of instability in food prices, in credit markets and in the budgetary behavior of government. Most food security analyses remain partial and highly intuitive. Despite this limitation, there is a general consensus that our understanding of the food security policies of developing countries has been significantly enhanced by the carefully conducted theoretical and empirical analyses over the last two decades.

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Chapter 3

Determinants and Welfare Impacts of Export Crop Cultivation – Empirical Evidence from Ghana

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Abstract

This paper investigates determinants and welfare impacts of farms households' engagement in export cropping, using cross-sectional data from Ghana in 2005-6. To avoid biased results due to possible self-selection, we employ the full information likelihood approach to analyse the determinants, and the generalised propensity score approach to examine welfare impacts of export cropping. The results indicate that engagement in export cropping is significantly influenced by access to land and credit facilities. A consideration of the extent of export cropping shows a non-linear relationship, with expenditures rising and poverty declining at higher levels of export specialisation.

Keywords: Export crops, Farm households, Household welfare, Poverty, Ghana

3.1 Introduction

During the last three decades, many governments of developing countries have made a remarkable shift from subsidizing industrialization to policies promoting exports of the primary sector. Usually driven by large fiscal deficits and supported by the International Monetary Fund and the World Bank, economic reform programs were implemented with the main aims of reducing the countries' debts and improving their trade position in the global economy. Key elements of the economic reforms included the devaluation of local currencies and a correction of distorted price policies that were mostly discriminatory against agricultural commodities (Krueger et al., 1988). Economic theory suggests that producers in developing countries benefit from productivity gains by participating in international trade (Grossman and Helpman, 1991). The rationale behind this is that exporting firms may learn international best practice through their contact with foreign markets, obtain valuable technical assistance from the buyers or realize scale economies through participating in large markets. Export companies often have to invest in local infrastructure and crop research, and need to provide concessional inputs and extension services to their suppliers in order to ensure an efficient value chain that meets the high standards of buyers' markets. These provisions allow farmers to also benefit from export markets. Another potential benefit of export-oriented agriculture is that farmers may easily escape the effect of the 'agricultural treadmill', as they produce for international markets with large demand. This is in contrast to farmers producing for the domestic market, where they face smaller markets (von Braun, 1995).

In spite of these potential benefits, a number of criticisms have been advanced against export promotion by some authors. In particular, they argue that export-oriented agriculture make developing countries dependent on raw products whose terms of trade tend to deteriorate over time (Prebisch, 1950). Furthermore, the usually high concentration of developing countries in very few export commodities makes them particularly vulnerable to external shocks (Noorbakhsh and Paloni 1998). At the farm level, a reallocation of resources from subsistence agriculture or food crops to export crops may decrease the farmers' risk bearing capability and reduce their ability to predict the quantity and quality requirements of market demand. In the case of the Ghanaian cocoa sector however, adverse effects of international price variability for the farmers have traditionally been mitigated by determining an annually fixed producer price.

The benefits from export promotion have been mostly tested for firms of the manufacturing sector (e.g., Söderbom and Teal, 2000; Isgut, 2001). Despite agriculture's large contribution to

export revenues for many developing countries, particularly sub-Saharan Africa, there is surprisingly scanty empirical evidence on the determinants of participation in export cropping and the impact of participation on household welfare (Balat and Porto, 2006; Coello, 2009). The study by Balat and Porto (2006) on Malawi and that of Coello (2009) on Vietnam reported positive impacts of export cropping on household welfare, using the propensity score approach to account for selectivity bias. However, both studies classify the extent of export cropping as a discrete choice variable. This proceeding may hide significant differences within their arbitrary treatment classes and therefore result in misleading conclusions.

This paper contributes to the scanty empirical literature on farmers' benefits from export cropping by analyzing the determinants of participation in export cropping and the impacts of export crop revenues on household welfare, using farm data from Ghana (the Ghana Living Standards Survey). Specifically, we employ a Full Information Maximum Likelihood (FIML) procedure to estimate both the probability of participating and the extent of participation in export cropping. We then use the usual propensity score method to examine the impact of participation on household welfare, and then the generalized propensity score method to examine the impact of extent of participation on household welfare. Both the FIML procedure and the propensity score approaches are used to account for selection bias that occurs when households self-select into participation. Besides household *per capita* expenditures, we also use different types of poverty measures as welfare indicators in the impact assessment analysis. To the extent that the current study accounts for selection bias in the extent of participation estimation, it improves on previous studies that failed to account for selectivity. In addition, to the best of our knowledge, this is the first study to treat export specialization as a continuous variable, rather than a discrete choice as in previous studies.

Ghana's large agricultural sector and its pioneering role in export-led growth policies in sub-Saharan Africa, makes its agricultural export sector particularly worth investigating. Ghana, as most African countries, is still heavily dependent on agricultural production. About 56% of the labor force is employed in the agricultural sector, and the sector accounts for 34% of the country's GDP (CIA, 2010). Cocoa is currently the second most important export commodity and typically contributes a third of the country's export revenues.

Our empirical results generally indicate a positive relationship between export cropping and household welfare. An interesting finding is the non-linear relationship between the intensity of export cropping and the welfare measures we employ in the analysis. Specifically, there appears to be no impact of export cropping on per capita household expenditure at low levels

of participation, while a positive impact appears at higher levels of export crop participation. Similarly, household poverty levels are not affected at low levels of participation, but higher participation levels tend to reduce poverty.

The paper is structured as follows. The following section presents a brief overview of the potential gains from export cropping in Ghanaian agricultural export sector. Section 3.3 outlines the conceptual framework employed in the empirical analysis. In section 3.4, the Ghana Living Standards Survey 5 dataset used in the analysis and the variables included in our models are described. Section 3.5 presents the results of our empirical investigation, and the final section concludes.

3.2 Potential gains from export cropping in the Ghanaian agricultural sector

The rationale behind the assumption of benefits for export firms stems mostly from the direct contact with trading partners abroad and the assistance obtained from upstream firms. While there are large estates particularly in the rubber and pineapple market, where producers directly export their produce, the majority of farmers have no direct contact to the buyers' market. Beneficial effects of export markets are likely to be transmitted through the value chain from the exporting companies and co-operatives to farm households. There are several ways in which knowledge in and profitability of export markets can benefit farmers. For example, Pray and Umali-Deininger (1998) found that large export markets stimulate research and development (R & D) of exporting firms and marketing boards. Such R & D makes the technology adopting farms more productive, thus allowing them a higher standard of living. As trade theory suggests, export firms make up a relatively small proportion in overall firms, which may allow them to set up larger R & D programs than firms on the domestic market that have fewer financial capabilities (Melitz, 2003). Particularly in Africa, large amounts of multinational company research funds go to plantation projects, which indicate their affinity to export crops (Pray and Umali-Deininger, 1998). In Ghana, the state owned marketing board COCOBOD has its own R & D programs for improved varieties and farming practices for cocoa and coffee.

Furthermore, exporting firms facing large and profitable international markets also may have additional incentives to assist farmers with concessional inputs and credits, and increase investments in rural infrastructure. For example, as Ghana's cocoa has reputation for its high quality, COCOBOD makes significant efforts to provide extension services for reducing co-

coa of inferior quality. The mandatory quality checks on cocoa markets conducted by COCOBOD ensures that farmers adjust their production methods in order to comply with quality standards of the buyers' markets. Because cocoa prices are annually determined, price competition for cocoa buyers is virtually prohibited and farmers can profit from an increased competition at the service level (Laven, 2007). State determined cocoa prices also decouple farmers from the generally high volatility in international cocoa prices within the price-fixed period.

In contrast to the cocoa market, other agricultural export sectors have been mostly liberalized and private export and processing firms provide similar services to farmers. Here for example, the Ghanaian Rubber Estate Limited supports upstream rubber farmers by building feeder roads, providing credits and extension services. Agricultural exporters face considerable competition due to other exporting countries, which can significantly affect the farmers. For example, pineapple production dropped in the mid-2000s because of a sudden shift in European consumers' preferences towards the MD2 pineapple variety, which was developed in Costa Rica by the transnational company Fresh Del Monte Produce. The Ghanaian agribusiness could not adequately adjust to the new demand situation, as MD2 pineapples have high requirements regarding investments and supply chain management (Fold and Gough, 2008). The presence of niche export markets, such as organic and ready-cut forms of pineapples, however still allows pineapple processors to provide profitable opportunities to small-scale farmers.

While the dominant role of the state in export marketing has traditionally hindered the co-operative movement, a shift in Ghanaian farm policy from the 1990s on supported the development of farm based organizations. This favorable business environment and supportive initiatives of World Bank, aid agencies and NGOs have stimulated the growth of farm co-operatives particularly in the export sector (Salifu et al., 2010).[11] As the demand of export markets is hard to predict for small-scale farmers, such co-operatives link the local producers' supply to the buyers' demand abroad. For example, co-operatives in the pineapple sector co-ordinate the farmers' output to fulfill buyers' requirements for consistent provision of bulk amounts of pineapples, and ensure the compliance of their produce with European standards. The largest co-operative of Ghana, Kuapa Kokoo (45,000 members in 2007) was formed as a

[11] The number of registered agricultural co-operatives has risen from 872 in 2002, to 1,463 in 2005 to 3,069 in 2008 (Salifu et al., 2010). In the GLSS 5 data from 2005-06, about 22% of the export crop farmers and 2% of non-export crop farmers were active in co-operatives.

Licensed Buying Company shortly after the partial liberalization of internal cocoa marketing. This farmer union has made fair trade agreements with foreign buying firms and also invested in a chocolate factory in the UK, which allows for direct spillovers from foreign markets and eases trade coordination. Kuapa Kokoo finances public goods such as sanitation facilities and schools in cocoa growing regions, which provide benefits for the local export crop farmers.

3.3 Conceptual framework

In this section we present the theoretical framework and empirical specification used in the analysis.

3.3.1 Theoretical model

We employ a simple model that captures the outlined potential gains (or drawbacks) from export farming as benefits (or losses) in the utility function of farm household members.[12] Basically, we assume that farmers make the decision on to whether to participate in export cropping and then the extent to which they participate in export cropping. We consider a risk-neutral farm household that maximizes utility dependent on net returns, Π, subject to competitive input and output markets and a single-output technology that is quasi-concave in the vector of variable inputs, I. This may be expressed as

$$\max_I U(\Pi) = \max_I U(PQ(I, Z) - T'I) \tag{3.1}$$

where U denotes utility, P represents product price and Q is the output level, which depends on the vector of input quantities I and on farm and household characteristics Z. Costs are represented as the multiplication of the vector of used inputs I with their corresponding input prices T'. Given that participation in export cropping (ex) changes the farm's output supply and input demand patterns, export cropping will affect the net returns' function of the farm household. The net returns can then be expressed as a function of output price, household endowments, input prices and export cropping in the following relationship:

$$\Pi = \Pi(P, T, ex, Z) \tag{3.2}$$

[12] Common models for learning effects from export participation (e.g. Melitz, 2003) assume product heterogeneity and entry of firms in the foreign markets, which do not apply to Ghanaian farms and their mostly unprocessed export products.

Following the above assumptions, it may be assumed that, in deciding whether to participate in export cropping, the household weighs up the expected net benefits from participation represented as $U_{ex}^{*}(\Pi)$ and the expected net benefits from non-participation (indicating production of food crops) represented as $U_{d}^{*}(\Pi)$, with participation occurring if the net benefits from participation exceeds those of non-participation, i.e. if $U_{ex}^{*}(\Pi) > U_{d}^{*}(\Pi)$. The parameters of this net benefits maximizing decision are not observable, but may be represented by a latent variable, such that $U(\Pi) = 1$, if $U_{ex}^{*}(\Pi) > U_{d}^{*}(\Pi)$ and $U(\Pi) = 0$, if $U_{ex}^{*}(\Pi) \leq U_{d}^{*}(\Pi)$. If we drop other subscripts for expositional purposes, the utility of participation can be related to a vector of farm and household characteristics, Z_i as follows

$$U(\Pi) = \alpha' Z_i + \mu_i \tag{3.3}$$

where α is a vector of parameters, i is an index for household, and μ is an error term with zero mean and a variance of σ_{μ}^{2}. Equation (3.3) and $U_{i}^{*}(\Pi)$ may also be expressed as

$$\Pr(U(\Pi) = 1) = \Pr\left(U_{ex}^{*}(\Pi) > U_{d}^{*}(\Pi)\right) = Pr(\mu_i > -\alpha' Z_i) = 1 - \Phi(-\alpha' Z_i) \tag{3.4}$$

where Φ represents the cumulative distribution function for μ, which is assumed to be normally distributed in the present application. Given that planting export crops has a positive impact on utility, the farmer will extend the input usage for these crops until the expected marginal returns from export cropping equals the expected marginal returns from cultivating non-export or food crops, i.e.

$$\frac{\partial E(\Pi)_{ex}}{\partial I_j} = \frac{\partial E(\Pi)_{d}}{\partial I_j} \tag{3.5}$$

where j is an element of input vector I. Input fixity or rationing, and various forms of imperfect markets such as incomplete information may however hinder farms from reaching their optimum level of export crop cultivation (Sadoulet and de Janvry, 1995). Thus, the farmers' chosen level of export intensity may not indicate their potential optimum. Other factors such as traditional values or the planting of tree crops for gaining property rights may be contributing to the less than optimal cropping intensities. The conceptual framework developed in this section is employed below in the empirical analysis on determinants of participation- and welfare impacts of participation in export cropping.

3.3.2. Estimation of the determinants of export cropping

Given our focus on the extent of export crop cultivation in the empirical analysis, we define export cropping intensity as export revenue share, and denote it as t_i, while Z_i represents farm and household characteristics as in equation (3.4). Export cropping intensity can then be related to these characteristics in a regression such as:

$$t_i = Z_i\beta + \varepsilon_i \ , \qquad \varepsilon \sim \mathrm{N}(0, \sigma) \tag{3.6}$$

where ε_i is the error term. The export revenue share t_i can only be observed for farms that have actually chosen to participate in export cropping, i.e. $U(\Pi) = 1$.

Since farms with specific advantages (e.g. in production efficiency or information acquisition) are more likely to participate in export markets, the choice of participation becomes endogenous. In this case, ordinary least square (OLS) estimates of the parameters in equation (3.6) will suffer from sample selection bias. Thus, the error terms of equations (3.3) and (3.6) are correlated, i.e. $\rho = \mathrm{corr}(\varepsilon, \mu) \neq 0$. Under such conditions, a Heckman selection model can be employed to correct for the selection bias. This approach essentially includes the estimation of selection into export cropping with a Probit model, and then using the estimated probability to participate in order to obtain unbiased estimates of extent of participation' equation (3.6). Instead of applying the common two-step approach proposed in Heckman (1976), we employ full information maximum likelihood (FIML) estimation, as this method allows for the incorporation of survey weights. In FIML a bivariate normal distribution of the error terms is assumed, so that the correlation between the error terms (ρ) can be derived by simultaneously estimating the selection and extent equations.[13] In order to be identified, the selection model requires that a variable can be found that strongly affects the chance of export participation but not the export intensity. We will discuss this issue in the presentation of the result. For ease of interpretability, we also report average marginal effect of each independent variable on the probability of export crop participation.

3.3.3 Welfare impacts of participation in export cropping

The problem of self selection also affects the analysis on impact of participation on household

[13] In contrast to the two-step procedure, FIML corrects for selectivity without adding the inverse Mills ratio to the explainable variables of the extent equation. To be consistent with most economic studies that employ the two-step method, the selectivity effect is summarized by calculating $\lambda=(\rho\sigma)$, which is equivalent to the coefficient of the inverse Mills ratio.

welfare. A common solution to this problem are matching approaches, in which individuals of the treatment group (participation in export cropping) are paired with individuals of the control group (non-participation in export cropping) that are similar in their observable characteristics. The theoretical underpinning is based on the counterfactual average treatment effect, which is defined as

$$\Delta_{\mathrm{i}} = Y_i^{ex} - Y_i^{d} \tag{3.7}$$

where Y_i^{ex} and Y_i^{d} represent the welfare outcome of household i if it cultivates export crops and if it does not cultivate export crops, respectively. This causal effect of export cropping cannot be calculated, as it is not observable how a farmer would have performed, in the case of non-participation in export cropping (Rosenbaum and Rubin, 1983).[14] Given that selection into treatment is based on observable characteristics, Rosenbaum and Rubin (1983) show that individuals of different treatment groups but with similar characteristics can be compared as if treatment was randomly assigned. Their approach involves estimating the propensity score $p(Z_i)$, which is defined as the conditional probability of being selected into the treatment group, given pre-treatment characteristics Z_i.[15] An underlying assumption of the propensity score-matching approach is the unconfoundedness, or conditional independence assumption (CIA). Another precondition is that the matched observations have to be within the area of common support, which implies that observations with the same covariates have both a positive probability of being in the group of participants as well as being in the group of non-participants (Heckman et al., 1997). When these assumptions hold, the average treatment effect of the treated (ATT) can then be estimated as follows:

$$\begin{aligned} ATT = \mathrm{E}\left[Y_i^{ex} - Y_i^{d} | ex = 1, p(Z_i)\right] = \\ \mathrm{E}\left\{\mathrm{E}[Y_i^{ex} | ex = 1, p(Z_i)] - \mathrm{E}\left[Y_i^{d} | ex = 0, p(Z_i)\right] | ex = 1\right\} \end{aligned} \tag{3.8}$$

Thus, outcomes between the treated and the untreated groups can be compared by matching individuals of the treatment group with untreated individuals who have similar propensity scores. In this paper, we employ the nearest neighbor algorithm, which matches each partici-

[14] Experimental studies can solve the problem, since random assignment to the treatment ensures that different individuals are on average equivalent and therefore comparable. Because this is not true for the case of non-random self selection processes, the causal effect cannot be inferred from welfare differences between dissimilar farmers.

[15] In this paper, we use the Probit model to derive the propensity score.

pant with its closest neighbor with similar observed characteristics.

3.3.4 Welfare impacts of extent of participation in export cropping

While the previous analysis considered export cropping as a dichotomous decision with two outcomes, this approach may be simplistic; since farms usually specialize differently in export cropping, resulting in considerable differences in their net returns. We therefore employ the generalized propensity score for continuous treatment case suggested by Hirano and Imbens (2004) to capture the impact of export crop intensity on household welfare. For each export farm household i, we observe the vector of pre-treatment variables Z_i, the actual level of treatment received, T_i, and the outcome variable associated with this treatment level $Y_i = Y_i(T_i)$. Of interest is the average dose response function (DRF), which relates to each possible export intensity level t_i, the potential welfare outcome $Y_i(t)$ of farm household i:

$$\theta(t) = \mathrm{E}[Y_i(t)] \quad \forall \ \ t \in \mathcal{T} \ \text{ where } \ \mathcal{T} = (0, \dots, 100] \tag{3.9}$$

where θ represents the DRF, and t is the treatment level, which is measured as the share of export crops in agricultural revenues. In line with Hirano and Imbens (2004), we presume weak unconfoundedness, i.e. that the treatment assignment process is conditionally independent of each potential outcome given the pre-treatment variables.[16] This assumption essentially postulates that, once all observable characteristics are controlled for, there is no systematic selection into specific levels of export intensity left that is based on unobservable characteristics (Flores et al., 2009). In order to adjust for a large number of observable characteristics, Hirano and Imbens (2004) suggest estimating the generalized propensity score (GPS), which is defined as the conditional density of the actual treatment given the observed covariates. Formally, let $r(t, z) = f_{T|Z}(t|z)$ be the conditional density of potential treatment levels given specific covariates. Then the GPS of a household i is given as $R_i = r(T_i, Z_i)$. The GPS is a balancing score, i.e. within strata with the same value of $r(t, Z)$, the probability that $T = t$ does not depend on the covariates Z_i. Hirano and Imbens (2004) show that in combination with the weak unconfoundedness assumption, the balancing property of the GPS allows the estimation of the average DRF by using the GPS to remove the selection bias. For this, the

[16] This assumption is considered 'weak' due to the fact that it does not require joint independence of all potential outcomes, but instead requires conditional independence to hold for each value of the treatment (Hirano and Imbens, 2004).

conditional expectation of the outcome variable first needs to be calculated as $\gamma(t,r) = E[Y_i|T_i = t, R_i = r]$. The DRF in equation (3.9) can then be estimated at that particular level of treatment:

$$\theta(t) = \mathrm{E}\big[\gamma\big(t, r(t, Z_i)\big)\big] \tag{3.10}$$

Therefore, the GPS has to be estimated for each specified treatment level t of the DRF. The GPS is estimated using a normal distribution of the logarithmic treatment given covariates Z_i.[17]

The balancing property of the estimated GPS is tested by employing the method proposed by Hirano and Imbens (2004). We impose the common support condition by employing the method suggested for the continuous treatment case by Flores et al. (2009). After estimating the GPS, the conditional expectation of the outcome for each farm is estimated using a flexible polynomial function, with cubic approximations of the treatment variable and the GPS, and interaction terms (Bia and Mattei, 2008; Hirano and Imbens, 2004). The specification is estimated using OLS regression for continuous welfare outcomes, and a Logit regression for poverty status. Then the DRF of equation (3.10) is evaluated at 99 evenly distributed levels of export revenue share. Confidence bounds at 95% level are estimated using the bootstrapping procedure.

3.4 Data description

The data used in the analysis were obtained from the 5th round of the Ghana Living Standards Survey (GLSS 5). This nation-wide survey was conducted by the Ghana Statistical Service in 2005-06 and covers a total of 8687 households, including non-farm households. Given that the focus of our study is on farm households, a total of 3253 farm households were included in the analysis, with 902 households having revenues from export crops. The GLSS 5 uses census enumeration areas as primary sampling units (clusters), in which 15 households have been interviewed. Enumeration areas were stratified into the ten administrative regions of Ghana. In the sparsely populated Upper East and Upper West regions, more clusters were drawn for national representativeness, which needs to be taken into account in the estimation

[17] Because the distribution of the export revenue share was highly skewed, we again followed Hirano and Imbens (2004) and took the logarithm of the treatment variable. This proceeding lead to very low skewness (-0.0002) and kurtosis (1.8515) values and yielded a positive Kolmogorov-Smirnov test for normality at the 5% level of significance.

procedure. To deal with differences in the price levels between regions and time, a monthly regional price index is used to convert monetary values to the January 2006 Accra level. All monetary values reported afterwards are divided by 10,000 in order to be comparable to the new Cedi currency introduced in 2007. The GLSS 5 survey distinguishes three main ecological zones, which include coastal, forest and savannah zones.

In the present analysis, the farmers' extent of participation in export cropping is measured by the share of revenue from export crops in total agricultural revenues. Since farmers do not directly export their produce and information on the further use of their products is not available, we categorize crops into the categories export crops and non-export crops. Therefore, we define export crops as those crops that are mainly produced for exports, judged by the amount produced and exported in 2005-06.[18] We identified the following export crops in the GLSS 5 dataset: cocoa, pineapples, cashew nuts, cotton, coffee, and rubber. We further compared these findings with the crop classification of the Ghanaian Ministry of Food and Agriculture (MOFA, 2002) and found that their categorization of export crops match with ours. In the GLSS 5 data, cocoa farms made up more than half of the export crop farms, followed by pineapple farms that nearly had a 33% share in export crop farms. Any revenues from other crops, products from livestock, processed products at farm level, hunting and collecting were considered as non-export agricultural revenues. Farm produce for own consumption was valued at market price and considered as non-export revenues.

Descriptive statistics and explanations of the other endogenous and exogenous variables employed in the subsequent sections are provided in Table 3.A1 in the appendix. Four welfare measures are included in the analysis. The households' total expenditures represent its income level and indicate its standard of living. Since people of different gender and ages have different level of needs, simply dividing expenditure by the number of household members does not adequately capture a household's real need. As suggested by the Ghana Statistical Service (GSS), we obtained conversion factors and related household expenditures to adult equivalents, which we later denote as *per capita* expenditures (Ghana Statistical Service, 2007). The GSS further reported a food poverty line of 288.47 Cedis per adult equivalent per year (= 320 US Dollar), indicating the minimum requirement to cover an individual's dietary needs. Based on this poverty line and the actual household expenditures, we provide three poverty

[18] Source: FAO. Processed products were not converted to their equivalent in raw product units due to a lack of available conversion factors. Since the export and non-export crops defined with this method match the official classification of these crops by the Ghanaian Ministry of Food and Agriculture (MOFA, 2002), we are confident that we correctly identified the main export crops.

measures: 1) the poverty status, a dummy variable that indicates whether a household falls below the poverty line or not, 2) the poverty gap, which indicates the depth of poverty in terms of how much a household is below the poverty line, and 3) the squared poverty gap, which indicates inequality among the poor by attaching greater weight to poorer households.

The farm characteristics employed in the analysis include variables that represent information on the attributes of the household head, household composition, ecological impacts, land tenure differences, access to financial resources, access to markets and information, as well as state engagement on input and output markets. The rationale for their inclusion is explained in detail when discussing the estimates for the determinants of export cropping. Given that farm households in different regions tend to specialize in different export crops, we control for this by introducing regional fixed effects in the analysis.

Table 3.1 presents *t*-statistics of mean difference in characteristics of export farmers and non-export farmers. There is striking evidence of systematic differences between both groups, as 25 of the 31 reported farm characteristics significantly differ at conventional levels of significance. Since these dissimilarities strongly indicate self selection into export market participation, the application of estimation approaches that account for selection bias are justified. Moreover, the comparison of the mean differences does not account for the effect of other characteristics of the households and thus may confound the impact of participation on welfare with the influence of other characteristics. Multivariate approaches that account for self-selection arising from the fact that participants and non-participants differ systematically are required.

3.5 Results

3.5.1 Determinants of participation in export cropping

The determinants of participation in export cropping were estimated with Stata 10. Estimation results are presented in Table 3.2, with estimates for the marginal effects on the probability of market participation in column 3.2, coefficients of the participation equation in column 3.3 and *t*-values in column 3.4. Estimates for export intensity are reported in column 3.5, with *t*-values in column 3.6. A glance at the *F*-statistic for joint maximization shows that the exogenous variables significantly explain variations of the endogenous variables in both the probability of participation and the extent of participation equations.

Table 3.1. Differences between export and non-export farmers (sample mean)

Variable	Export crop farms	Non-export crop farms	Difference	*t*-value
Welfare indicators				
Expenditures	819.98	587.69	232.29 ***	9.39
Povertygap	6.05	32.20	-26.15 ***	-12.78
Povertystatus	0.10	0.31	-0.21 ***	-12.86
Independent variables				
Female	0.19	0.18	0.01	0.95
Age	50.08	45.84	4.24 ***	7.31
Education none	0.61	0.72	-0.11 ***	-6.18
Education basic-middle	0.34	0.21	0.13 ***	7.50
Education higher	0.05	0.07	-0.01	-1.50
Agricultural main job	0.87	0.81	0.06 ***	4.16
Children	2.14	2.40	-0.26 ***	-3.26
Household size	2.80	3.01	-0.22 ***	-3.22
Ecozone coastal	0.06	0.12	-0.06 ***	-5.16
Ecozone forest	0.79	0.33	0.46 ***	25.80
Ecozone savannah	0.16	0.55	-0.40 ***	-21.87
Owned land value	6527.35	899.16	5628.19 ***	11.03
Deeded land (share)	24.67	8.69	15.98 ***	12.82
Rented land (share)	2.07	8.17	-6.10 ***	-6.66
Sharecropped land (share)	20.89	8.50	12.40 ***	10.47
Institutional loans	47.01	23.01	24.00 *	2.42
Private loans	42.40	21.56	20.84 *	2.11
Savings	108.49	56.67	51.82	1.62
Off-farm	0.44	0.51	-0.08 ***	-3.87
Co-operative	0.23	0.02	0.21 ***	20.73
Food availability	0.32	0.35	-0.04	-1.08
Phone access	0.50	0.57	-0.08 ***	-3.99
Motor vehicle	0.05	0.06	-0.01	-1.17
Transport costs	5.36	4.11	1.25	0.95
State input costs (share)	12.38	6.31	6.07 ***	6.89
STE activity in district	35.20	7.87	27.33 ***	40.90
Number of farmers	902	2351		

Note: ***, ** and * represent 1%, 5% and 10% level of significance.

The variable representing state trading enterprise (STE) activity served as an identifying instrument and has been left out in the extent equation. STEs are a main channel between local producers and international markets.[19] While intermediation can significantly influence the farmers' access and, thus, participation in export markets, there is no economic reason why

[19] Even for export crops other than cocoa, the share of crop purchases that mainly went to STEs is considerably higher (19%) than the share for non-export crops (0.25%).

farmers, once they have access to international markets, would systematically change their export cropping intensity by the relatively dominant type of main outlets in the region. Furthermore, there is neither any evidence known to the authors that Ghanaian STEs prefer buying from farms of particularly low (or high) export intensity levels, nor that private buying companies generally do so.[20] The significance of the lambda coefficient indicates the presence of selection bias, so that simple OLS regression would have yielded biased results. Further results of Table 3.2 reveal that participation in export cropping and the degree of export cropping are determined by the exogenous variables in considerably different ways. The results are described in detail below.

The marginal effect of the female variable is 0.038 and statistically significant at 1% level. This indicates that households with female household heads are by 3.8 percentage points less likely to participate in export cropping than males. A glimpse at the coefficients of the participation equation shows that an underlying gender affinity towards export crops seems to be not the cause, as the female variable is statistically insignificant.[21] Instead, the coefficient for the interaction term between the female and land property variables shows that female household heads seem to be significantly more likely to engage in export cropping when they possess land. This finding suggests that lack of access to land may be serving as a barrier for females to participation in export cropping. The revenue share obtained from export cropping is negatively affected when the household head is female, a finding that is consistent with the notion that women in Ghana tend to work more in subsistence food crops than in cash crops. There seem to be no entry barriers for farmers without formal education, as achievements in basic and middle school do not have any significant effects on participation in export cropping. The significantly positive effect of age on participation in export cropping and extent of export cropping, however, may hint at the role of experience gained over time on export market participation. Moreover, because the majority of export crops are perennial crops that require several years before harvesting, there is a natural delay between the farmer's planting decision and the date of the first export revenues from such crops. Particularly with cocoa, the 4-5

[20] In fact, co-operatives as main outlets may be attractive for certain types of farmers as they are organized by the farmers themselves. This is however just one sort of main outlets, and its effect is separately incorporated in the extent equation by the co-operative dummy variable.

[21] As the female and land property variables are interacted, the coefficient of the female variable indicates the effect of a female household head when the land property variable (which has been centered) is at its mean value. The same holds for the age variable. Accordingly, the coefficient of the land property variable shows the effect of land possessions for a male household head at mean age. The marginal effects take into account these interactions.

years period without returns –besides unattractive labor-intensive cultivation systems– has been identified as a significant factor that discourage young people from cultivating the crop (Nyanteng, 1995).

Table 3.2. Determinants of participation in and extent of export crop cultivation

	Participation equation			**Extent equation**	
	Marg. Effect	Coefficient	(*t-value*)	Coefficient	(*t-value*)
Female	-0.0375***	-0.1387	(-1.43)	-4.5845*	(-1.82)
Age	0.0025***	0.0130***	(5.25)	0.1969***	(2.80)
Educ. basic-middle	-0.0109	-0.0600	(-0.79)	0.3565	(0.21)
Educ. Higher	-0.0527*	-0.2890*	(-1.95)	1.0505	(0.26)
Agric. main job	0.0428**	0.2348***	(2.60)	-4.4001*	(-1.69)
Children	-0.0001	-0.0007	(-0.04)	-2.1199***	(-4.63)
Household size	-0.0075*	-0.0413*	(-1.71)	0.7568	(1.14)
Ecozone coastal	-0.0627	-0.3443	(-1.29)	-2.2909	(-0.34)
Ecozone forest	0.0415	0.2276	(1.10)	13.4085***	(3.37)
Land property	0.0138***	0.0594***	(4.63)	0.2057***	(2.88)
Deeded land (share)	0.0004*	0.0021*	(1.81)	-0.0289	(-0.99)
Rented land (share)	-0.0012***	-0.0066***	(-3.34)	-0.0632	(-1.07)
Sharecropped land (share)	0.0002	0.0012	(0.95)	-0.1338***	(-4.24)
Institutional loans	0.0183	0.1007	(1.04)	1.0677	(0.50)
Private loans	0.0200	0.1100	(1.35)	2.1538**	(2.46)
Savings	-0.0002	-0.0012	(-0.05)	1.1440**	(2.05)
Off-farm	0.0022	0.0122	(0.17)	-4.8434***	(-2.67)
Co-operative	0.2472***	1.3567***	(8.17)	-6.8953**	(-2.09)
Food availability	-0.0087	-0.0478	(-0.71)	0.5273	(0.26)
Phone access	-0.0579***	-0.3175***	(-2.74)	0.6134	(0.20)
Motor vehicle	0.0402	0.2207	(1.48)	7.6732*	(1.94)
Transport costs	-0.0271	-0.1485	(-0.11)	-50.8614**	(-2.07)
State input cost (share)	0.0009***	0.0048***	(2.96)	-0.0448	(-1.23)
STE activity in district	0.0063***	0.0344***	(10.01)	-	
Land property x Female	-	0.1038***	(3.42)	0.2310	(0.96)
Land property x Age	-	-0.0022***	(-5.26)	-0.0056	(-1.23)
Constant	-	-1.5230***	(-4.96)	0.1969***	(2.80)
Lambda λ	-	-		-9.6723***	(-3.12)
Rho ρ (*t*-value)	-0.40	(3.34)***			
F-test [*p*-value]	11.10	[0.00]***			
Observations	3,253				

Notes: For better readability, all monetary values (new Ghanaian Cedi) had been divided by 1,000 before the inclusion in the model. Estimates of the regional dummy variables are not reported but available on request from the authors. ***, **, and * indicate 1%, 5% and 10% significance levels.

The results also reveal that households having agriculture as main source of income are more likely to engage in export cropping. However, once households participate in export cropping, a main occupation in agriculture tends to negatively influence the extent of participation. Strategies to diversify in export and non-export crops may be possibly more feasible for

household heads that invest most of their working time on their farms.

The results for the three ecological zones of Ghana show that ecological characteristics do not significantly influence farmers' decisions to engage in export cropping. The significantly positive effect of land assets in both equations confirms the common view that wealthier farmers find it easier to engage in export cropping and to devote more resources to the sector. This can be attributed to the fact that farmers are better able to cope with risks, as they have the opportunity to sell their land and can use land as collateral to obtain loans that they may not get due to imperfect rural credit markets. Interactions between age and owned farmland have a significantly negative impact on export participation, which indicates that land possessions decrease in their importance on the participation decision when household heads grow older.

The results also reveal that property rights tend to influence the probability of participation in export cropping. Specifically, the likelihood of participation is positively and significantly affected by land ownership, but negatively influenced by shares in rented land. Sharecropping arrangements negatively affect the farmer's extent of export cropping. A high proportion of deeded land indicates secured land rights, which may stimulate export cropping by making it easier for farmers to make long-term investments in export crops, and to acquire loans to mitigate liquidity constraints (Abdulai et al., 2011). In contrast, the negative estimate for rented land indicates that sharecroppers and fixed-renters have a lower probability of investing in export crops such as cocoa and coffee.

Despite government's efforts to support farmers cultivating export crops, institutional loans – that also include credits from state banks and government agencies– do not appear to have any significant effect on export cropping. These results may stem from imperfections in formal credit markets of remote areas, which make information and transaction costs prohibitively high, particularly for micro-credits. Private risk-sharing networks tend to be better able to meet the credit demands of export crop extensions due to the fact that they have advantages in screening and monitoring the borrower as well as enforcing repayment.[22] Moreover, a farmer's self-financing capacity, captured by her savings, foster specialization in export cropping.

The estimates further reveal that co-operatives play an essential role in overcoming export market entry barriers. Their contribution to enhancing farmers' access to input and product

[22] An analysis of the structure of taken loans supports these explanations, as private loans are taken more frequently (575 farms) than institutional loans (239 farms), and they are considerably smaller (57 Cedis at the median, compared to 189 Cedis at the median of institutional loans).

markets, gathering market information, as well as sharing knowledge among farmers appear to facilitate farmers' participation in export cropping. This can be seen in the large marginal effect of 0.24, which shows that the probability to participate rises by 24 percentage points when the farmer uses services of a co-operative. Co-operatives are also mostly associated with farms that derive only a small fraction of their revenues from export crops. Their services seem to be most profitable for less specialized farms, which probably have the most problems with insufficient market access and information costs on export markets. Since most services of co-operatives are explicitly laid out to make smaller and less experienced smallholders more competitive, these farmers are likely to have the largest gains from membership.
The importance of access to markets is indicated by the positive effect of owning a motorized vehicle and the negative influence of crop transport costs to markets or buyers on the revenue share of export crops. However, both factors do not significantly influence participation decision. In contrast, phone access has a significant adverse effect on export participation. This result probably hints at the significant role of few intermediaries in obtaining and processing the relevant information of export markets. In contrast, communication infrastructure is more important for farmers that produce for domestic markets, as they seem to need the possibility to interact with other market participants.
All regional dummy variables in the extent equation –and some in the participation equation– are significantly different from zero, indicating that variations between regions have considerable impact on export cropping behavior.[23] Ghanaian farmers from different regions tend to specialize in different crops due to environmental and infrastructural factors, and may therefore have significantly different export crop cultivation patterns.

3.5.2 Welfare impacts of participation in export cropping

Estimates of the welfare impacts of participation in export cropping are presented in Table 3.3.[24] The signs of the coefficients for the ATT for all welfare indicators are in line with a priori expectations. Specifically, households participating in export cropping have on average 98 Cedis (= $109) higher *per capita* expenditures compared to non-participants. The results also show that participation in export cropping exerts a negative and significant impact on poverty, suggesting that households producing export crops are less likely to be poor, compared to

[23] The joint test of the null hypothesis that all regional effects are equal using a Wald test gives a sample *F*-statistic of 8.09 and a critical value at the 1% level of 1.98.

[24] These results were computed using a Stata program written by Leuven and Sianesi (2003).

their counterparts who produce food crops. Sensitivity analysis on hidden bias revealed gamma values of 1.25-1.30 for the poverty status and 1.15-1.20 for all other welfare measures. These values indicate that, if households with the same Z_i-vector would differ in their odds of cultivating export crops by just 15-20% (25-30% for poverty status), the significance of the effect of export cropping on the welfare outcomes may be questionable (Rosenbaum, 2002).

Table 3.3. Welfare impact on export crop farmers: Average treatment effects and results of the sensitivity analysis

Outcome	ATT		Critical level of hidden bias (Γ)	No. of treated	No. of controls
Expenditures	97.58	(2.20)**	1.15-1.20	438	2,351
Povertystatus	-0.053	(-2.18)**	1.25-1.30	435	2,351
Povertygap	-6.16	(-2.67) **	1.15-1.20	438	2,351
Povertygap²	-890.88	(-2.38) **	1.15-1.20	438	2,351

Notes: Numbers in parentheses are *t*-values. ** indicates significance at the 5% level.

The balancing properties of the propensity score are summarized in Table 3.4. The substantial reduction in the median bias and the pseudo R^2 after matching implies that the propensity score can balance differences in the distribution of covariates between the treatment and the control group. As a further indicator of the importance of observables for the households' welfare, linear regressions of each welfare outcome on the export cropping dummy variable and the explanatory variables were estimated using OLS. The treatment effect was significant at conventional levels for all welfare outcomes and the R^2 statistic ranged from 0.30 to 0.36.[25] This implies that selection on observables account for 30 to 36 percent of the variation in the welfare outcome. Thus even if the remaining 64 to 70 percent of the variation in export cropping participation was entirely determined by unobservable factors, there is still a positive welfare effect of export cropping that could not be explained by unobservables. The fact that the simple comparison of welfare outcomes between groups (Table 3.1) showed much larger welfare effects indicates that there is a strong tendency to overestimate the welfare effects of export cropping when matching procedures are not employed.

[25] In detail, the R^2 is 0.31 for *per capita* expenditures, 0.33 for poverty status, 0.36 for poverty gap and 0.30 for the poverty gap squared. The results are not shown here but available on request from the authors.

Table 3.4. Welfare impact estimates: Indicators of covariate balancing, before and after matching

Outcome	Pseudo R^2 before matching	Pseudo R^2 after matching	Median absolute bias before matching	Median absolute bias after matching	% |bias| reduction
Expenditures	0.465	0.011	19.10	2.93	85%
Povertystatus	0.465	0.012	19.10	2.80	85%
Povertygap	0.465	0.010	19.10	3.16	83%
$Povertygap^2$	0.465	0.010	19.10	3.16	83%

Given that farmers differ in their extent of participation in export cropping, the findings in the previous section may be misleading. In this section, we therefore report results of the generalized propensity score approach, which considers the impact of the extent of participation, rather than just participation and non-participation. Before we report the results, we first discuss the nonparametric estimates of the distribution of export shares, which represents extent of participation. The kernel density estimates, which are reported in Figure 3.1, indicate that the majority of export crop farmers still rely on agricultural revenues from non-export activities.[26] Most farmers have export revenue shares below 40% and only few have export crop shares of up to 80% or higher. In particular, the results suggest that it might be misleading to simply compare outcomes of the categories "non-export crop farmers" and "export-crop farmers" in welfare analysis, since export-crop farmers differ in terms of export revenue shares.

As indicated previously, we employed the dose-response function (DRF) to examine how the extent of participation in export cropping affects household welfare.[27] In the maximum likelihood estimation of the generalized propensity score (GPS), all variables of the selection equation from the FIML estimation were included.[28] Regarding the common support condition, 771 farms were on support, which represents 85% of the initial sample of export farmers. Only these 771 farms were kept for the estimation of the DRF, as they are sufficiently similar for the comparison of welfare outcomes among different export intensity levels. Interestingly, most farms with a lack of support appeared at the 75%-100% treatment interval (118 farms). This indicates that there are significant differences in the characteristics of those farms within

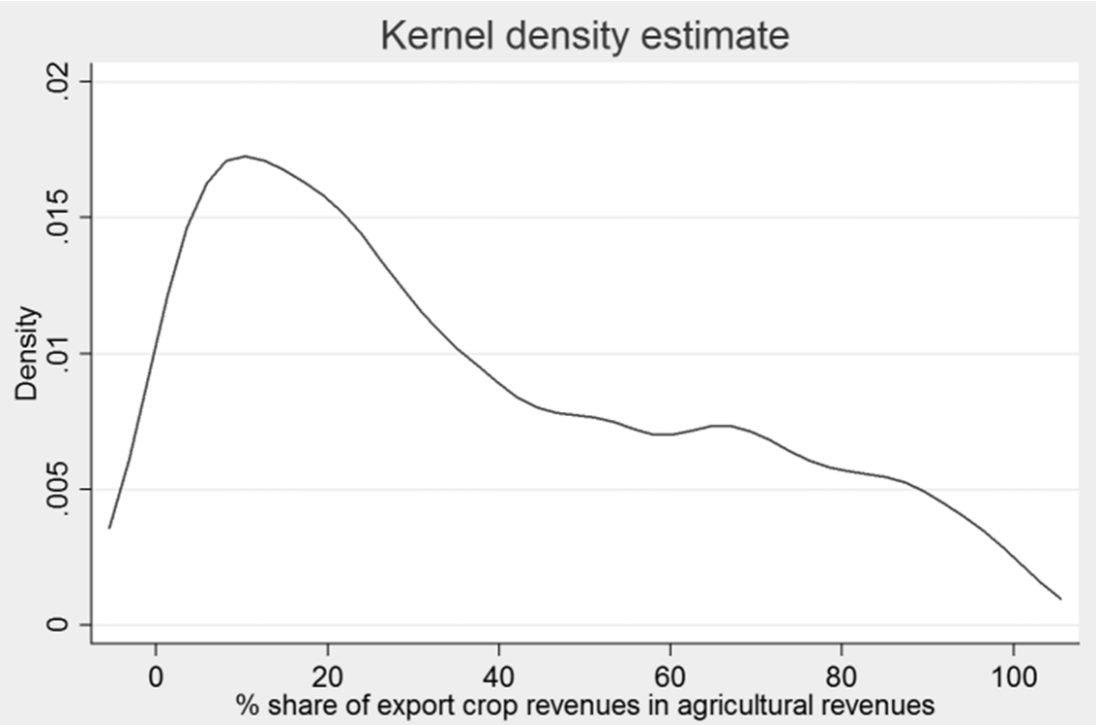
[26] We excluded non-export crop farmers from the kernel density estimates, as the considerable mass point at zero would distract from the differences among export crop planters.

[27] The GPS and DRF were estimated using a Stata program written by Bia and Mattei (2008). We extended the program in order to incorporate the common support condition.

[28] The results of the GPS estimation are not reported, because they are just to derive an appropriate balancing score and not for interpretational purposes.

and those outside these high levels of specialization. A test of the balancing properties of the GPS reveals that the GPS adjusts for characteristic differences among various export intensity levels quite well (a description of the balancing test can be found in the appendix).

Figure 3.1. Ghanaian export crop farmers: intensity of export cropping

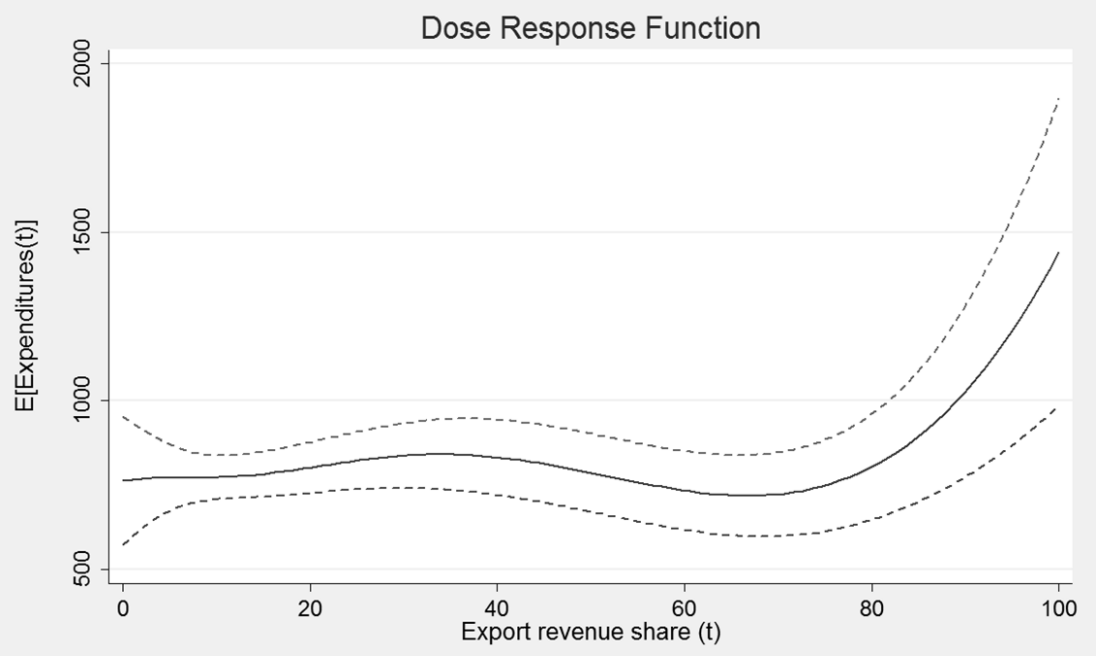


Notes: Kernel density estimation used the Gaussian kernel type with a bandwidth of 5.5.

Figure 3.2 shows the DRF of the impact of export specialization on annual household *per capita* expenditures. Because the GPS has been estimated for the sub-sample of export crop farmers, welfare outcomes of the DRF at the zero treatment level can be seen as the counter-factual outcome of export crop farmers if they had chosen not to cultivate any export crops. The results show a non-linear relationship, whereby household welfare is hardly affected at low levels of export revenue shares, but tends to rise with increasing level of specialization. While the average potential *per capita* expenditures is about 770 Cedis (= $857) for a farm at low levels of export crop cultivation, they are approximately 1440 Cedis (= $1601) at the 100% intensity level. Thus, if a farmer producing at the lowest export crop intensity levels chooses to fully specialize in export cropping, her standard of living can be expected to nearly double. However, significant income gains only occur at a high threshold around the 70% level of specialization, which suggests that export crop cultivation cannot be considered as a magic bullet in increasing farmers' living standards. Marginal benefits from low and medium export intensity may be easily outweighed by immeasurable benefits of non-export agricul-

ture, such as predictability of local markets and risk insurance through consumption of own produce. Uncertainties about foreign markets, self-sufficiency reasons as well as financial and infrastructural constraints may hinder most farmers from increasing their revenue shares from export cropping activities.

Figure 3.2. Impact of export crop cultivation on household expenditures

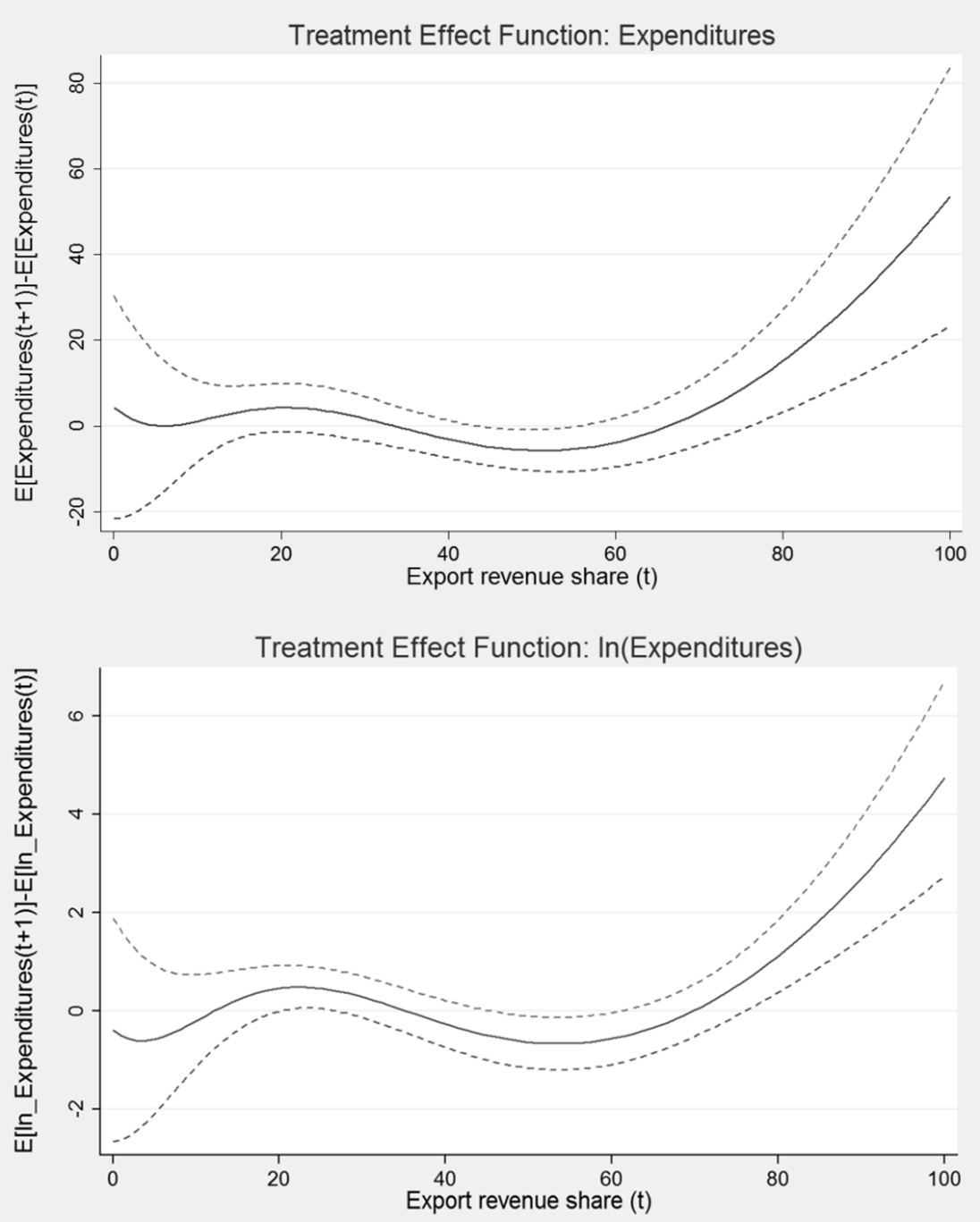


Notes: Continuous lines indicate the dose-response of *per capita* expenditures; dashed lines are the 95% confidence bounds.

Due to the balancing properties of the GPS and the imposition of common support, differences in farm characteristics are not supposed to bias the comparison of different export intensity levels. However, there is the possibility that outliers in *per capita* expenditures significantly drive the estimated average potential outcome level. Thus as a robustness check, we transformed the expenditure outcome variable by taking the natural logarithm, to ensure that outliers do not bias the results. Because the DRF on logarithmic expenditures is hardly interpretable, we focus on the corresponding treatment effects function, which captures the average effect on *per capita* expenditures (in percent) when export crop intensity increases by one percentage point. The bottom graph of Figure 3.3 shows this treatment effect function and compares it with the treatment effect function of the original *per capita* expenditures (in Cedis, depicted above). In contrast to *per capita* expenditures, the curve of logarithmized *per capita* expenditures notably falls below zero at the lowest 10% of export intensities. Above these low export intensity levels, the shape of both functions is quite similar, indicating that

the considerable increase of household welfare at high export levels is neither driven by outliers nor affected by changes in the functional form.

Figure 3.3. Treatment effect function: Expenditures and logarithmic Expenditures

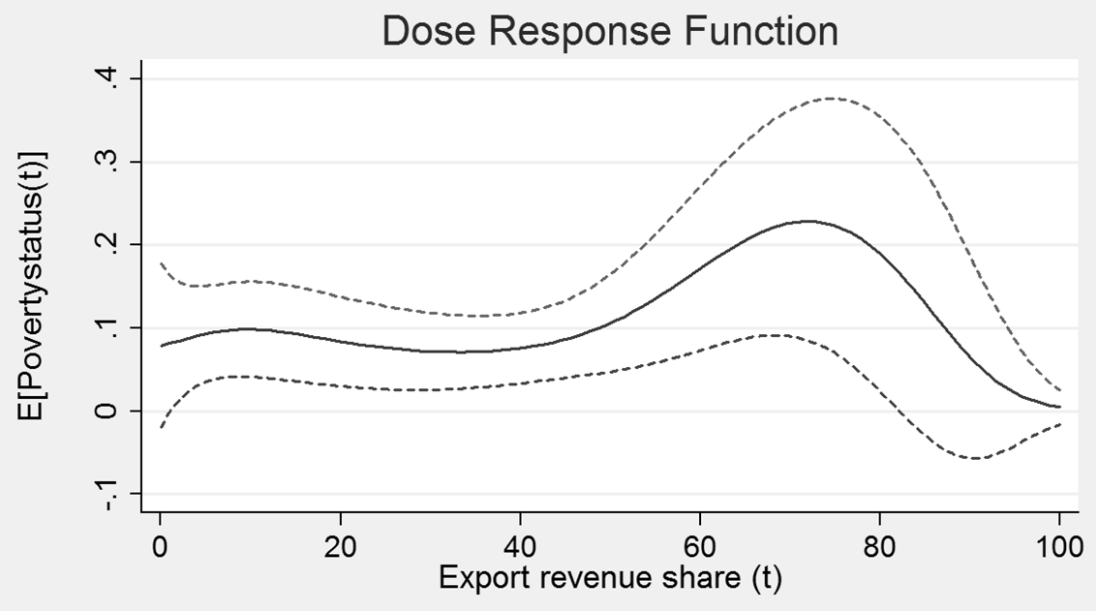


Notes: Continuous lines indicate the treatment effect for *per capita* and logarithmized *per capita* expenditures; dashed lines are the 95% confidence bounds.

The impact of export cropping on poverty reduction is more ambiguous. Figure 3.4 presents the DRFs for the effects of export cropping on the household's probability of falling below the

poverty line. The relationship, which is also non-linear, reveals that the probability of falling below the poverty line is virtually similar for export shares between zero and 40%, but begins to rise between 40% and 70%, only to decline after that threshold. Only for very high export specialization levels of approximately 90% does the probability of being poor actually drop below non-export cropping levels.

Figure 3.4. Impact of export crop cultivation on poverty status



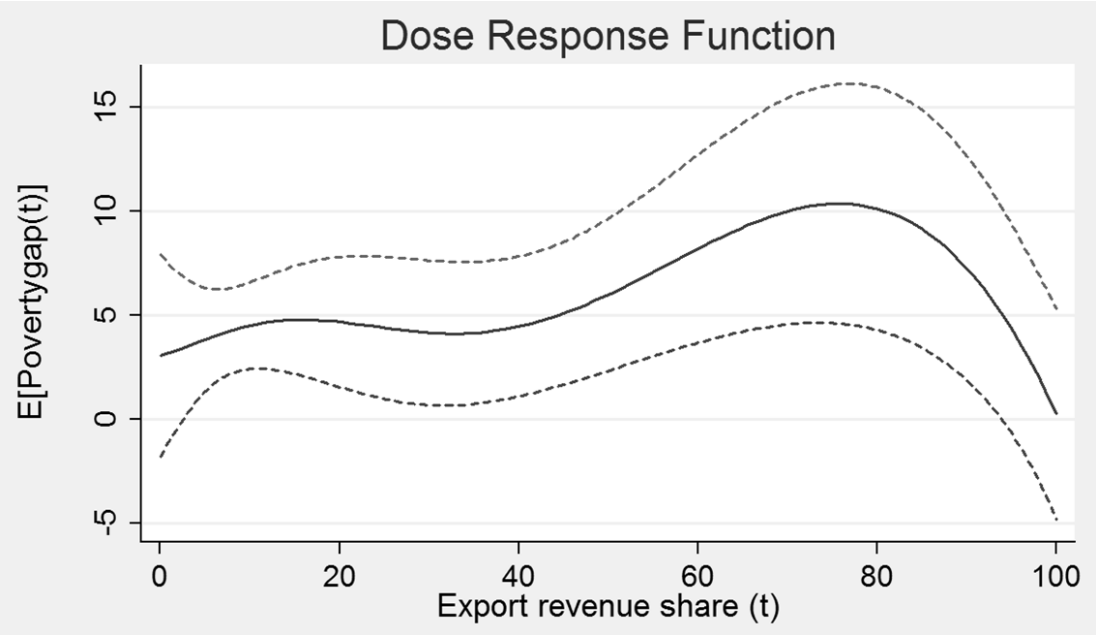
Notes: Continuous lines indicate the dose response, i.e. the effect on the probability of being poor; dashed lines are the 95% confidence bounds.

Estimates of the DRF for the poverty gap index are presented in Figure 3.5. The figure virtually exhibits a similar pattern as the incidence of poverty in Figure 3.4. Thus, the poverty gap remains virtually stable until about 40% specialization and then begins to increase until 70%, after which it declines substantially. The estimated DRF for the effects of export cropping on the squared poverty gap index is presented in Figure 3.6 and also appears to be similar to the DRF for the poverty gap. The wide confidence intervals for the poverty gap and the squared poverty gap DRFs suggest that impacts of export cropping are generally unclear among the poor and the poorest of the poor.

The results generally indicate that a farmer with low to medium levels of export cropping intensity is less likely to escape out of poverty than if she had chosen to highly specialize in export crop cultivation. Given this positive relationship between higher specialization in export cropping and household welfare, the question remains as to why farmers fail to specialize to improve their welfare. On the one hand, risk-averse farmers may opt to sacrifice some rev-

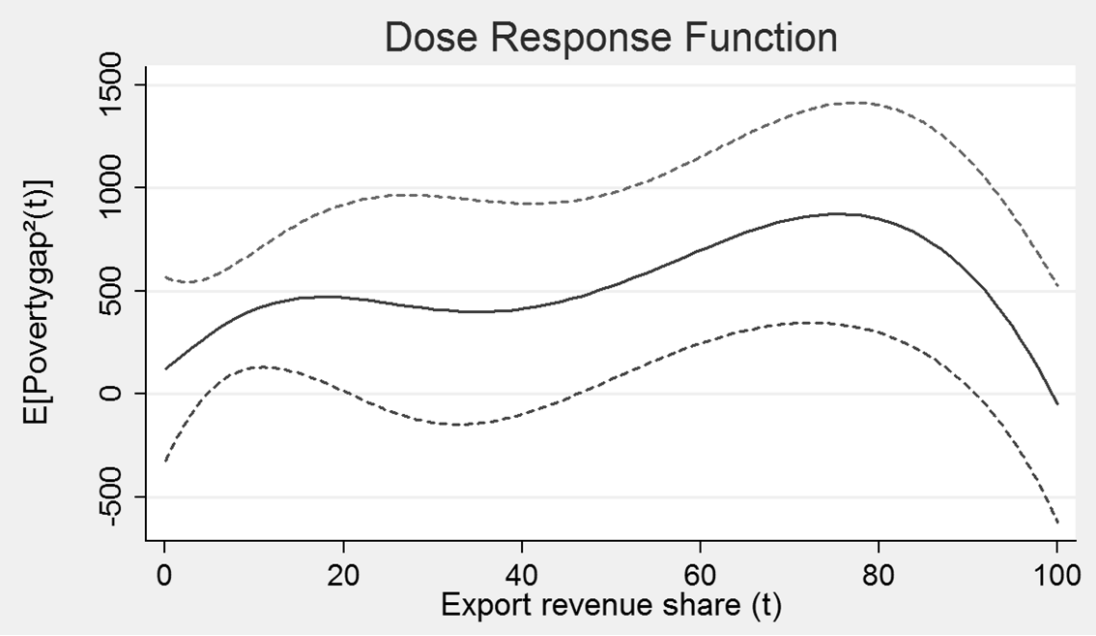
enue in order to diversify their production among export and non-export agriculture. On the other hand, financial and other constraints prevent some farmers from extending their engagement in export cropping to much higher levels.

Figure 3.5. Impact of export crop cultivation on the poverty gap



Notes: Continuous lines indicate the dose response; dashed lines are the 95% confidence bounds.

Figure 3.6. Impact of export crop cultivation on the squared poverty gap



Notes: Continuous lines indicate the dose response; dashed lines are the 95% confidence bounds.

3.6 Conclusions

This paper investigated the determinants of participation in export cropping and the impact of export cropping on household welfare, using cross-section data obtained from the Ghanaian living standard survey 2005-6. Given the problem of selectivity bias that arise when households self-select into export cropping, we employed full information maximum likelihood approach to analyze the participation decision, and generalized propensity matching approach to examine the welfare impacts of participation. Test statistics indicate that correcting for selectivity bias is crucial when investigating the determinants and welfare impacts of export cropping.

Our findings show that property rights matter for export cropping, as farmers with land rights were found to be more likely to participate in export cropping, compared to those with leased land. We also provide evidence that wealthier farmers have a higher probability of participating in export cropping, relative to less endowed farmers. Moreover, the results show that the engagement of the state in input and output markets successfully reduce barriers for farmers to participate in export markets. With regard to improving farmers' access to credit to reduce liquidity constraints, our findings indicate that banks and other formal credit lenders appear to be unable to provide farmers with loans necessary to extend export cropping. The credit demand for export intensification is largely covered by borrowings from family members, friends and neighbors.

Estimates of the welfare impacts of export cropping generally reveal a positive relationship between engagement in export cropping and farm household welfare. However, a consideration of the impact of extent of export cropping showed a non-linear relationship with household welfare indicators, with *per capita* expenditures rising only at higher levels of export specialization. Similarly, a considerable impact on poverty is only revealed at higher levels of participation in export cropping. It seems probable that specialized farmers are better able to adjust their production to the needs of export market supply chains. While the reason for welfare gains cannot be identified with the data at hand, the large revenues of export markets have probably made the exporting firms to invest more than domestic buyers in R & D and rural development. This explanation is also in line with the idea of fair trade that aims to help producers of developing countries obtain better trading conditions and promote sustainability.

The empirical findings generally give some support to the recent call for "aid for trade" to support development efforts and reduce poverty in underdeveloped economies. The results of this study have some policy implications. First, it reveals that farmers could be supported to

engage in export crop production and to intensify export cropping by improving their access to credit to enable them overcome liquidity constraints. Second, the finding that transport costs serve as a barrier to export crop intensification indicates that policies that reduce trade costs in rural areas may help facilitate export crop production and consequently improve household welfare.

Measures that can reduce trade costs include road and transport infrastructure, as well as marketing information, as is being currently done by state and private export market intermediaries. The significant impact of co-operative on both participation and extent of participation in export cropping is evidence of the positive role of co-operatives, which provides evidence that policies supporting farm-based organizations can effectively reduce trade costs. Generally, the results show that participation in export cropping as well as the extent of participation are both important issues to consider when examining the welfare impacts of export cropping activities.

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Appendix of chapter 3

Table 3.A1. Variable description

Variable	Description	Mean	Std. dev.
Welfare indicators			
Expenditures	Total *per adult equivalent* expenditures of household (hh)	652.10	640.06
Povertygap	Gap between hh's *p. a. e.* expenditures and the poverty line	24.95	53.53
Povertystatus	1 if hh falls below the poverty line, 0 otherwise	0.25	0.43
Independent variables			
Female	1 if hh-head is female, 0 otherwise	0.18	0.38
Age	Age of hh-head in years	47.02	14.94
Educ. None	1 if hh-head has no educational achievement, 0 otherwise	0.69	0.46
Educ. basic-middle	1 if hh-head completed primary or middle school, 0 otherwise	0.25	0.43
Educ. Higher	1 if hh-head completed higher educational levels, 0 otherwise	0.06	0.24
Agric. main job	1 if agriculture is the main job of the hh-head, 0 otherwise	0.83	0.38
Children	Number of children in hh aged 14 or less	2.33	2.03
Household size	Number of persons in hh aged 15 or above	2.95	1.73
Ecozone coastal	1 if farm is located in coastal area, 0 otherwise	0.10	0.30
Ecozone forest	1 if farm is located in forest area, 0 otherwise	0.45	0.50
Ecozone savannah	1 if farm is located in savannah area, 0 otherwise	0.44	0.50
Land property	Value of owned land that is operated by the farm	2459.75	13270.31
Deeded land (share)	Share of land that was acquired with deed in cultivated land	13.12	32.60
Rented land (share)	Share of rented land in cultivated land	6.48	23.56
Sharecropped l. (sh.)	Share of sharecropped land in cultivated land	11.93	30.70
Institutional loans	Value of loans from bank, gov't agency, NGO, moneylender	29.67	253.26
Private loans	Value of loans from family, friends or neighbors	27.34	252.23
Savings	Value of current savings, aggregated over all hh members	71.04	815.01
Off-farm	1 if hh had wage/nonfarm self-employment income, 0 otherwise	0.49	0.50
Co-operative	1 if co-op was trade partner or provided loan, 0 otherwise	0.08	0.27
Food availability	Number of food items rarely or not available at times (max. 7)	0.34	0.86
Phone access	1 if farm has access to telephone incl. mobile, 0 otherwise	0.55	0.50
Motor vehicle	1 if farm owns a motorcycle, car or tractor, 0 otherwise	0.05	0.22
Transport costs	Transport costs of produced crops in past 12 months	4.46	33.88
State input cost (sh.)	Costs of inputs provided by the state, share in overall costs	7.99	22.63
STE activity in district	Farms whose main outlet were STEs, share in farms per district	15.45	21.00
Region Western	1 if farm is located in Western Region, 0 otherwise	0.10	0.30
Region Central	1 if farm is located in Central Region, 0 otherwise	0.08	0.26
Region Gr. Accra	1 if farm is located in Greater Accra Region, 0 otherwise	0.01	0.10
Region Eastern	1 if farm is located in Eastern Region, 0 otherwise	0.11	0.31
Region Ashanti	1 if farm is located in Ashanti Region, 0 otherwise	0.15	0.36
Region Brong-Ahafo	1 if farm is located in Brong-Ahafo Region, 0 otherwise	0.13	0.34
Region Northern	1 if farm is located in Northern Region, 0 otherwise	0.14	0.35
Region Upper East	1 if farm is located in Upper East Region, 0 otherwise	0.11	0.32
Region Upper West	1 if farm is located in Upper West Region, 0 otherwise	0.09	0.28
Region Volta	1 if farm is located in Volta Region, 0 otherwise	0.08	0.28

Note: All monetary values have been deflated to Jan. 2006 Accra prices and divided by 10,000.

For testing the balancing property of the GPS, the treatment variable was divided into four equally wide treatment intervals, ranging from low export cropping intensities ($0\% < t \leq 25\%$) to medium ($25\% < t \leq 50\%$) and specialized levels ($50\% < t \leq 75\%$) up to highly specialized export cropping levels ($75\% < t \leq 100\%$). The characteristics of farms in these different intervals were compared using t-tests of mean difference. Without adjusting for the GPS, 39 of the 128 t-tests were significant at the 5% level (see Table 3.A2), indicating that export crop farms at different intensity levels are dissimilar in many characteristics. The balancing property of the GPS is tested by comparing farms with similar estimated GPS. For this, the GPS was subdivided into five quintile blocks, and t-tests between the treatment intervals were conducted block-wise. When adjusting for the GPS in this way, only four t-tests remained significant at the 5% level, indicating that the GPS significantly reduces selection bias when comparing outcomes of farms at different export cropping intensities.

Table 3.A2. Balancing test of estimated GPS: *t*-statistics for mean difference between treatment intervals

Variable	Unadjusted				Adjusted with GPS			
	(0, 25]	(25, 50]	(50, 75]	(75, 100]	(0, 25]	(25, 50]	(50, 75]	(75, 100]
Female	-0.35	-0.15	1.29	-0.82	-0.48	0.25	0.49	0.11
Age	**3.58**	-0.92	-1.35	**-2.61**	0.98	-1.05	0.23	1.34
Educ. basic-middle	1.28	0.93	-1.89	-0.87	0.00	0.74	-1.17	0.14
Educ. Higher	0.73	-0.08	0.40	-1.50	-0.24	0.10	1.12	-1.06
Agric. main job	0.53	-1.85	0.86	0.52	1.23	-1.82	0.14	1.63
Children	**-5.20**	0.89	**2.54**	**3.62**	-0.86	0.16	-0.02	1.11
Household size	**-2.24**	1.41	0.32	1.21	-0.78	0.83	-0.70	0.95
Ecozone coastal	**-3.39**	0.39	**2.24**	1.93	-0.67	0.12	1.22	-0.02
Ecozone forest	**7.21**	-0.25	**-4.84**	**-4.65**	-1.07	1.68	-1.26	-1.13
Land property	**3.54**	1.07	-0.97	**-5.64**	1.02	0.71	-0.95	-0.58
Female x Land property	**2.07**	0.44	0.16	**-3.93**	0.31	0.34	1.06	**-3.04**
Age x Land property	1.05	0.63	-0.17	**-2.20**	0.30	0.26	-0.20	-1.16
Deeded land (share)	**3.04**	-0.44	0.31	**-4.45**	-0.28	-0.09	**2.05**	-0.98
Rented land (share)	-0.81	-0.28	0.54	0.94	-0.06	0.15	0.31	0.62
Sharecropped l. (share)	**-5.82**	0.48	**3.66**	**3.72**	-0.95	-0.37	1.21	-0.25
Institutional loans	1.00	-1.17	-0.09	0.10	0.97	-1.50	0.33	0.82
Private loans	1.54	0.05	**-2.38**	0.45	1.84	-1.38	-1.29	0.56
Savings	**2.27**	0.01	-1.80	-1.29	**2.04**	-1.28	0.62	-0.62
Off-farm	**-4.21**	1.47	0.99	**3.28**	-1.10	0.94	-0.20	-0.77
Co-operative	-1.77	0.62	0.75	1.00	-1.44	0.23	1.28	-0.94
Food availability	0.16	0.61	-1.41	0.67	-0.64	0.86	-1.18	0.27
Phone access	1.76	-0.66	-0.60	-1.09	-0.41	-0.59	-0.53	0.63
Motor vehicle	-0.42	1.30	0.77	-1.96	-0.52	0.69	1.12	0.46
Transport costs	0.54	0.55	0.67	**-2.33**	1.10	-1.09	0.62	-0.19
State input cost (share)	0.43	0.39	-0.40	-0.68	0.10	0.60	0.17	-0.59
STE activity in district	**6.70**	0.63	**-3.82**	**-6.32**	-0.76	0.88	0.07	-0.26
Region Western	**5.38**	0.36	-1.01	**-7.52**	-0.60	0.52	1.79	**-2.67**
Region Central	0.48	-1.40	-0.93	**2.19**	1.49	-1.30	0.02	1.22
Region Eastern	**-2.44**	-0.71	1.70	**2.57**	0.52	-0.87	-0.55	0.61
Region Ashanti	1.41	0.90	**-3.41**	0.78	-1.04	1.88	-1.77	0.57
Region Brong-Ahafo	-0.72	-0.27	1.07	0.14	0.19	-0.10	-0.07	-0.74
Region Northern	-0.40	-1.84	1.64	0.99	0.80	-1.66	0.80	0.66
Region Upper East	**-3.09**	0.52	**2.04**	1.55	-0.88	0.26	0.85	0.57
Region Upper West	**-2.74**	0.39	1.31	**2.08**	0.00	-0.33	0.26	0.81

Note: Bold numbers indicate significance at the 5% level.

Chapter 4

Food Aid Allocation Policies: Coordination and Responsiveness to Recipient Country Needs

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Abstract

We employ censored least absolute deviations and multivariate Tobit estimators to investigate whether food aid flows from the main donor countries respond to recipient country needs as reflected in low food availability, low income, or both. We also explore the hypothesis that donor countries specifically coordinate their food aid shipments to recipient countries. Our findings show that food aid in aggregate and from each donor is significantly targeted at poorer countries and is highly persistent over time. Food aid responses to food availability shortfalls, natural disasters and violent conflicts are common but more modest and uneven across donors. Finally, we find strong evidence of donor coordination in food aid allocation.

Keywords: food aid, donor cooperation, censored LAD regression, multivariate Tobit, developing countries

JEL Classification Numbers: F35, I38, O19, Q18

4.1 Introduction

Food aid has long been a controversial instrument for closing the gap between food consumption needs and supply available from domestic production, inventories and commercial imports. Debates over the efficacy of food aid have grown as global deliveries have fallen precipitously over the past two decades, from 14 million metric tons (MMT) in 1988 to a record low of 5.9 MMT in 2007 (WFP, 2008). A key issue in both the literature and in policy debates – such as in the deadlocked WTO Doha Round negotiations – concerns food aid allocation patterns, in particular the question of whether they respond to recipients' needs (e.g. Gabbert and Weikard 2000; Jayne et al. 2001; Barrett and Heisey 2002; Neumayer 2005; WTO 2006). Most of the literature finds little responsiveness of food aid flows to recipient country need indicators. But existing studies suffer a range of methodological flaws that leave the matter in doubt.

One especially important issue missing in the existing literature concerns potential interactions among donor country food aid allocations. Given that ministers of developed and developing countries placed aid harmonization on their aid policy agenda in the 2005 Paris Declaration, it is of particular interest to understand the extent to which food aid flows from multiple sources have been coordinated. Are flows significantly correlated among donors, either positively, reflecting joint response, or negatively, reflecting geographic specialization by donors? Our study fills this important gap in the empirical literature while attending to a number of other methodological concerns in previous studies. Specifically, we employ a multivariate Tobit model with controls for several typically omitted relevant variables to investigate whether food aid flows from the major donor countries – the United States (US), European Union (both European Community aid and aid of individual member states), Canada, Japan and Australia – respond to recipient countries' needs and the extent to which the donors interact in their food aid allocation. We also estimate globally aggregated food aid allocation patterns using a censored least absolute deviation (CLAD) estimator, a semi-parametric approach not previously used in the food aid literature.

The rest of the paper is organized as follows. Section 4.2 briefly reviews the key issues, highlighting the literature's findings on food aid responsiveness to recipient country needs and giving an overview on food aid coordination channels. Section 4.3 describes the data used in our analysis, followed by a presentation and explanation of the employed estimation approach in section 4.4. The empirical results are then presented and discussed in Section 4.5. Section

4.6 concludes.

4.2 Food Aid Allocation Determinants

Food aid targeting matters because food aid itself has become an increasingly scarce resource. Over the 1972-2004 period we study, global cereal food aid averaged only 3.8% of total cereal food availability in recipient countries. That share has fallen subsequently. Global cereal food aid is evidently a marginal resource that can hardly fill shortfalls in local cereal production. When well targeted, however, food aid can help save lives, particularly where local food markets fail and local and regional food availability is insufficient (Barrett and Maxwell, 2005). Effective targeting at both macro and micro-level also helps avoiding potential disincentive effects on the recipient economies (Abdulai et al. 2005).

4.2.1 Food Aid and Food Needs

This paper thus builds on a literature that explores whether food aid flows effectively respond to recipient countries' needs. Ideally, one would use individual or household level food access variables as the key explanatory variable; but there are no cross-country data that enable micro-level analysis of differential targeting among donor and recipient countries.[29] However, since more than three dozen countries lack sufficient nonconcessional food supplies to meet nationwide aggregate macronutrient requirements (Barrett and Maxwell, 2005), macro-level analysis at the level of recipient countries still provides a reasonable first cut at examining donors' food aid targeting effectiveness. Food availability is thus a commonly used indicator of recipients' needs. We follow Barrett and Heisey (2002) and use food production as a proxy for nonconcessional food availability to avoid endogeneity bias associated with including commercial import volumes.

Findings for donors' response on food and dietary indicators in the literature to date are quite mixed. Gabbert and Weikard (2000) analyzed food aid allocation by four donor countries and the United Nations' World Food Program (WFP) by employing a method that weights the total amount of food donated by the amount of undernourishment in the recipient country. They found that the US performed worst in the case of project food aid, but was among the best in allocating emergency food aid according to recipient need. Barrett (2001) identified a range of flaws in the Gabbert and Weikard approach and introduced a simple econometric

[29] Jayne et al. (2001) conducted this sort of micro-level analysis for Ethiopia.

framework that differentiates between food aid's supply stabilization and progressive transfer roles. His approach has become the workhorse method for subsequent studies. We too follow that general approach, but with the refinements explained below. Barrett (2001) found that US food aid flows only modestly towards recipients with lower food availability levels and fails to stabilize food availability in recipient countries. Barrett and Heisey (2002) found that WPF food aid responded more robustly to recipient country need indicators than did US food aid.

Neumayer (2005) noted that food availability alone cannot capture the need for food in situations where hunger results from extreme poverty (i.e., poor food access) such that poor households cannot afford sufficient food to prevent malnutrition, even when local markets avail adequate food supplies. Like Neumayer, we include a control for the extent and depth of poverty, measured by recipient country gross domestic product per capita (GDPpc) in purchasing power parity terms. Neumayer (2005) found that average calorie supply and GDPpc affected a country's likelihood of receiving food aid, but not the amount of food aid delivered, conditional on being a recipient.

More recently, Young and Abbott (2008) pointed out that donors naturally respond to disasters, thus failure to account for especially dreadful events that trigger considerable food aid shipments may lead to mistaken inference. They found that although food aid flows do not seem to be well targeted to poorer countries, they do respond to severe production shortfalls in recipient countries and to violent conflict. We follow Young and Abbott's example and include controls for severe shortfalls and disasters of various sorts. In particular, we differentiate between violent conflicts and sudden ("rapid onset") and gradual ("slow onset") natural disasters, as these may induce markedly different responses from donors. For example, conflict commonly increases global awareness of a problem, which can stimulate greater humanitarian assistance levels, but also involves international political tensions and insecurity for aid workers that often impede food aid flows. Similarly, food is often harder to mobilize and less needed in response to sudden onset natural disasters such as tsunamis or earthquakes, than it is for slow onset ones such as droughts, but the former typically draw far greater international news coverage, generating additional public pressure on donors to send relief aid (Eisensee and Strömberg, 2007). It is unclear how these effects net out, but one might reasonably expect them to differ by type of disaster.

4.2.2 Donor Interests and Aid Coordination

Although the Food Aid Convention, the international treaty that governs food aid allocations,

directs donor countries to prioritize recipient country needs, the perception remains that food aid flows are driven more by agricultural surplus disposal, donor trade promotion and geopolitical interests than by humanitarian objectives (Barrett and Maxwell, 2005). This may affect the distribution of available food aid resources as well as the overall volume of food aid donor countries provide. Moreover, donors may differ in the degree to which they emphasize the needs of recipient countries in allocating food aid. For example, US food aid remains governed by legislation aimed at promoting domestic agricultural and shipping interests (Barrett and Maxwell, 2005), while the EU clearly defined recipient need as the major priority in food aid allocation more than a decade ago (Cathie, 1997). Moreover, donors' food aid policies did not remain constant over time. For example, the EU heavily reformed their food aid policy after Clay et al. (1996) had found considerable flaws in its program food aid. Over the sample period a general trend away from government-to-government food aid, and towards emergency food aid can be noticed, however with considerable differences between donor countries (WFP, 2008). This is accompanied with a shift from direct food shipments to food aid procured in developing countries, and indicates that food disposal has become less a motivation in donors' food aid policies.

A possible nonhumanitarian objective of donor countries that may bias food aid targeting, is to maintain a regional sphere of influence or to support nearby countries, with which the donor share close bonds (Neumayer, 2005). For example, Australia explicitly states in its aid program that it has a particular responsibility for countries in the Pacific region, with which it has recently negotiated special aid commitments in the 2008 Port Moresby Declaration. Donors' allocation may also be biased by preferences for recipients with similar social orders. For example, it is explicitly stated in the US Food-for-Progress program that the Freedom in the World (FIW) rating is used as an allocation criterion (USDA, 2008). While an excessive usage of food aid for rewarding policies that please the donor seems tempting, such political benefits have to be traded off against the diplomatic costs. These include diplomatic frictions between donor and recipient as well as considerable aversion to dependency on this donor's aid, as could be seen in US food aid to Egypt and India in the 1960s (Wallerstein, 1980). To test their significance, we include controls for these donor geopolitical interest variables in our regression specifications.

Complementary to the existing food aid literature, this study focuses on whether and to what extent food aid resources from multiple sources have been coordinated. Worldwide coordination of aid resources can be achieved through one of the following measures, 1) organizations

sourced by multiple donors, such as the WFP or international NGOs, 2) international institutions, such as the United Nations' Consolidated Appeals Process (CAP), which was established in 1992 to foster closer cooperation and co-financing of disaster response among donors, 3) direct negotiations between donor countries on aid targeting. The generally weak bilateral cooperation between donors at the global level was a major cause for the founding and strengthening of international institutions and multilateral organizations. During the past four decades, the WFP has become increasingly important in coordinating global food aid resources. This is not only because of its gained expertise in food aid logistics, but also due to a shift in WFP policy focus from project food aid to emergency food aid, for which dietary requirements of the suffering population make high demands on timeliness and nutritious contents of food aid deliveries (Hopkins, 1999). Even in the framework of the CAP, which is designed to involve all kinds of development organizations in a thoughtful aid response, WFP plays the lead role regarding food aid. While previous studies have analyzed WFP and NGO food aid allocation (e.g., Gabbert and Weikard, 2000; Barrett and Heisey, 2002; Neumayer, 2005), no attempt has been made to capture all possible ways of donor interaction.

4.3 Data Description

Since most non-American donors began establishing significant food aid programs as a result of their commitments made in the 1967 Food Aid Convention, it is reasonable for studies on coordination of aid from multiple donors to begin with the early 1970s. Given that food aid is a controversial policy instrument, the study aims at providing overall information on donor interaction and need-orientation, hence the most recent end year (2004) for which food aid, need indicator and donor interest indicator data are available has been chosen. Food aid flows and annual food production covering the period 1972-2004, were obtained from the FAO. Since FAO food production estimates are derived from national surveys, data quality is in some cases highly questionable. Despite this well-known limitation, it is the only source that provides annual food production data for the 151 food aid recipient countries of this long period. Given that noncereals food aid is composed of various goods of different processing grades, which are difficult to aggregate, we employ only cereals food aid data. This serves as a reasonable proxy for overall food aid trends since cereals food aid ranged from 84% to 91% of total food aid shipments over the period. All volume figures were converted to a per capita basis using annual population data also reported in the FAO Production Yearbook.

Data on real GDP per capita (with constant prices, base year: 2000) were obtained from the

April 2008 version of the Expanded Trade and GDP Data. These data extend the Penn World Table (version 6.2), primarily by plugging gaps in coverage. Such gaps occur especially during times of conflict, which are of particular interest in the study of humanitarian response (Gleditsch, 2002). Conflict is captured by data obtained from the Major Episodes of Political Violence (MEPV) database from the Center for Systemic Peace. The overall conflict intensity variable we construct is the aggregate of the MEPV category scores for ethnic violence, ethnic warfare, civil violence, civil warfare, interstate violence and interstate warfare. Since each single MEVP category ranges from 0 (no episode) to 10 (extreme violence), a higher value of total conflict intensity generally indicates a more severe level of violence/warfare in that recipient country.

Data on natural catastrophes were obtained from the Emergency Events Database provided by the Centre for Research on the Epidemiology of Disasters. The acuteness of annual disasters is measured using the number of total affected people in the country, i.e., the sum of people affected, injured or left homeless. We constructed two different disaster indicators by aggregating total affected people by disaster events annually: 1) sudden (rapid onset) disasters, which consist of volcanoes, slides, floods, earthquakes, wild fires, wind storms, waves/surges and insect infestations; and 2) gradual (slow onset) disasters, which involve droughts, extreme temperatures and disease epidemics. To account for different population sizes, these indicators were divided by the overall population of the recipient country so that the variables we use represent the proportion of the recipient country population affected by the disaster.

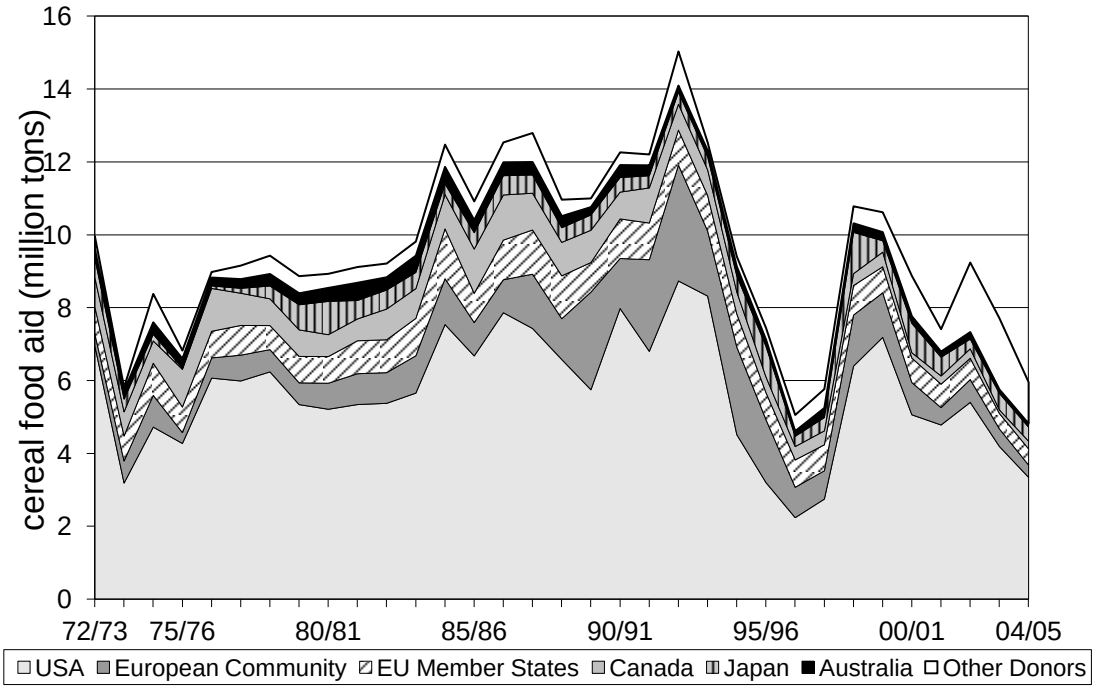
To account for donors' preferences for nearby countries, great circle distances between donors' and recipients' capital cities are included in our model, which have been obtained from the distance between capital cities dataset provided by Gleditsch and from the Topografisch Verbond Elbruz.[30] For food aid shipments coming from Europe, distances between Brussels and the recipient countries' capitals are used. Political freedom within the recipient countries is measured by the civil liberties and political rights indices reported in the Freedom in the World (FIW) publications by Freedom House (2008). These indices are based on surveys among analysts who assess the extent to which a country fulfills predetermined criteria of civil liberties and political rights. The civil liberties category incorporates issues of personal autonomy and individual rights, rule of law, freedom of expression and belief as well as asso-

[30] Gleditsch, Kristian Skrede. ND. Distance between capital cities data, v. 1.0. Available at: http://privatewww.essex.ac.uk/~ksg/data-5.html. Topografisch Verbond Elbruz data available at: http://www.elbruz.org/General/db/capitaltocapital.php

ciational and organizational rights. The political rights category involves issues of political pluralism and participation, functioning of government as well as electoral process. We use the unweighted sum of both indices and transpose the scale to derive an index that ranges from 2 (least free) to 14 (most free).

The two independent components of the European Union food aid program are analyzed separately in the present study. These components include food aid managed by the European Commission, and food aid managed individually by the European Union member states, which are aggregated into food aid flows from member states.[31] Figure 4.1 illustrates the significance of donors included in our analysis as well as other donors in global food aid shipments during the period we investigate. While the shares of donor countries varied over the period under consideration, the United States was the largest donor in every year and typically by a considerable margin. Descriptive statistics for the variables incorporated in our analysis are presented in Table 4.1.

Figure 4.1. Food aid flows of major donors (1972/73 – 2004/05)



Source: FAO

[31] The EU Member States series consists of the EU-15 states' food aid flows over the whole 1972-2004 period, except Portugal due to lack of data. While interaction between single EU Member States is also an interesting topic, inclusion of every EU country in the system of Tobit equations would require far too much computational complexity.

Table 4.1. Descriptive statistics

Variable	Definition of variables (unit)	Mean	S.d.
Dependent variables			
FA (Global)	Global cereal food aid (tons/capita)	0.0080	0.0190
FA (Australia)	Australian cereal food aid (tons/capita)	0.0003	0.0018
FA (EC)	European Community's cereal food aid (tons/capita)	0.0004	0.0037
FA (EU states)	EU Member States' cereal food aid (tons/capita)	0.0009	0.0050
FA (Canada)	Canadian cereal food aid (tons/capita)	0.0011	0.0055
FA (Japan)	Japanese cereal food aid (tons/capita)	0.0004	0.0022
FA (US)	US cereal food aid (tons/capita)	0.0044	0.0126
Common independent variables			
FC	Food crisis = Production shortfall (% negative trend deviation)	-0.086	0.205
DFP	Domestic cereal food production of the recipient (tons/capita)	0.171	0.200
GDPpc	Real GDP, constant 2000 prices (1,000 international $ / capita)	4.339	4.162
SUDDENDIS	Sudden disaster casualties (total affected people / capita)	0.009	0.057
GRADUALDIS	Gradual disaster casualties (total affected people / capita)	0.008	0.063
CONFLICT	Total conflict index (0 (no conflict) - 60 (theoretical max))	0.923	2.105
FIWTRANS	Transposed FIW-index (2 (least free) - 14 (most free))	7.356	3.729
Capital-capital distances			
DISTANCE (Australia)	Distance from recipients' capital to Canberra (1,000 km)	12.781	3.671
DISTANCE (Canada)	Distance from recipients' capital to Ottawa (1,000 km)	8.784	3.481
DISTANCE (Europe)	Distance from recipients' capital to Brussels (1,000 km)	6.767	3.472
DISTANCE (Japan)	Distance from recipients' capital to Tokyo (1,000 km)	10.757	3.644
DISTANCE (USA)	Distance from recipients' capital to Washington DC (1,000 km)	8.892	3.798
Regional fixed effects			
AMERICA	Reference region: Latin America and Caribbean	0.243	0.429
ASIA	1 if recipient is located in Asia	0.193	0.395
MIDEAST_NA	1 if recipient is located in North Africa or the Middle East	0.107	0.309
SUBSAHARA	1 if recipient is located in Sub-Saharan Africa	0.338	0.473
TRANSITION	1 if recipient is a transition country or is located in Europe	0.119	0.324

4.4 Analytical approach

As suggested by Barrett and Heisey (2002), donors' efforts to stabilize national food markets are captured by the response to deviations from the trend of nonconcessional food availability. The first stage involves an estimation of the growth rate in food availability for each recipient country:

$$\ln(DFP_{it}) = \beta_{0i} + \beta_{1i}\, year_t + \mu_{it} \tag{4.1}$$

where DFP_{it} represents the domestic food production per capita in year *t* for recipient country *i*, $year_t$ is a trend variable, and μ_{it} is the residual error term. Given that (1) is a logarithmic trend regression, β_{1i} can be interpreted as a growth rate (in %) and the residuals μ_{it} capture the deviation from the recipients' food availability trend at each year *t* in percentage points.

As argued by Young and Abbott (2008), donors may be more sensitive to severe food shocks than to deviations near or above food production trend levels. The second stage of the estimation therefore involves finding a threshold, with which these two cases can be distinguished for each donor. Therefore, we define food crises (F*C*) as the deviations below some fraction (κ) of one standard deviation from recipients' food production trend:

$$FC_{ijt} = Minimum[\mu_{it} + \kappa_j\, \sigma[\mu_{it}], 0] \tag{4.2}$$

where $\sigma[\mu_{it}]$ computes the standard deviation of the food production trend deviations of recipient country *i* in year *t*. The term $\kappa_j\, \sigma[\mu_{it}]$ represents the threshold at which donor *j* begins to respond with food aid. Because food production levels in recipient countries are likely to change over time, F*C* should indicate actual food crises more appropriately than indicators based on the deviation of the whole sample period's mean as employed by Young and Abbott (2008). To estimate a parameter κ_j that best fits the donors' response to food shocks, for each donor a series of food aid allocation models is estimated, where the fraction of one standard deviation (κ_j) is systematically varied from 0 to 3 using 0.1 steps. As proposed by Young and Abbott (2008), those κ_j parameters are chosen that maximize the allocation models' log-likelihood function for each donor.

The food aid allocation model used in this procedure is specified as a dynamic Tobit model, which accounts for the fact that the endogenous food aid variable cannot have negative values, and is defined as follows:

$$\begin{aligned} FA_{ijt} &= \gamma_{j0} + \gamma_{j1} FC_{ijt} + \gamma_{j2} DFP_{it} + \gamma_{j3} FA_{ijt-1} \\ &\quad + \sum_o \tau_{jo} Z_{ito} + \sum_r \theta_{jr} D_{ir} + \sum_t \lambda_{jt} Y_t + \eta_{ijt} && \text{if } \overline{FA_{ijt}} > 0 \\ FA_{ijt} &= 0 && \text{if } \overline{FA_{ijt}} \le 0 \end{aligned} \tag{4.3}$$

where FA_{ijt} is food aid shipped from donor *j* to recipient *i* in year *t* (in tons per recipient's population). FC_{ijt} and DFP_{it} are the crisis shock and food production per capita variables, respectively, so for a need-oriented donor both should have a negative influence, indicating that food aid generally flows countercyclically and in favor of those recipients with lower food availability. Lagged values of food aid flows (FA_{ijt-1}) are included to avoid omission bias that may occur in the estimation if past levels of food aid flows tend to affect current food aid, as well as the existence of serial correlation in the residuals. Given the availability of panel data, we employed a test for the optimal lag length proposed by Holtz-Eakin et al. (1988) and found that for each donor a single lag is appropriate.[32] This finding implies that food aid flows generally follow a firsts-order Markov process, in which all information on past food aid shipments is effectively captured by the most recent year. Z_{ito} are further food aid determinants described in section 2. Regional dummy variables (D_{ir}) are included to capture regional characteristics, and year (Y_t) fixed effects are incorporated to measure year-specific events in donor policies and global food needs, respectively. Log-likelihood ratio tests for joint significance resulted in a significant influence of both variable groups for every donor. The error term is denoted as η_{ijt}.

4.4.1 Global food aid allocation

The third estimation stage involves using the CLAD technique proposed by Powell (1984) to estimate global food aid allocation. The major advantages of this semi-parametric approach are the robustness to unknown conditional heteroscedasticity and the provision of consistent and asymptotically normal estimates for a wide range of error distributions. The median CLAD estimator is obtained by solving

$$\min_{\beta_g} S_n(\beta_g) = \frac{1}{n}\sum_{i=1}^{n}\left|FA_i - \max\{0, x_i'\beta_g\}\right| \tag{4.4}$$

where n is the sample size, FA_g is global food aid flows and x_g is the correspondent vector of regressors. For the computation of the CLAD estimator β_g, Buchinsky's iterative linear programming algorithm (ILPA) is used (Buchinsky, 1994). Given that the derivation of analytical standard errors that are robust to heteroscedasticity as well as nonindependent residuals is a

[32] Following Holtz-Eakin et al. (1988), we estimated each specification (equation 3) including more lags and the exogenous variables. We began with an arbitrarily long lag (10 periods) and reestimated the equations using successively fewer lags. Each of these models was tested against one with a single lag length using the likelihood ratio statistic distributed as χ^2. The results are not reported in the interest of brevity, but are available upon request.

non-trivial issue for quantile estimators, we follow Rogers (1993), who suggests the bootstrap procedure, and computed robust standard errors using 10,000 bootstrap samples.

4.4.2 Food aid allocation of the main donor countries

The other approach we take in the third stage sacrifices the added econometric flexibility of the CLAD estimator for the ability to estimate the system of equations describing each donor's food aid allocations to recipient countries over time. Once the optimal κ_j parameters have been estimated, under this approach we then estimate equation (4.3) in a system of m simultaneous equations, one equation for each of the six donors: Australia, Canada, European Community (EC), EU Member States, Japan and the United States. This extension merely generalizes equation (4.3) into a multivariate Tobit model wherein the errors are distributed multivariate normal, $\eta_{ijt} \sim \text{MVN}(0, \Sigma)$, where Σ is the covariance matrix, wherein we allow for 15 possible non-zero correlation coefficients (ρ) among the m donors with respect to a given recipient country in a specific year. The significance and values of the ρ-coefficients indicate whether and in what way donors' food aid shipments are coordinated. If indeed there is no coordination, then the error terms should be uncorrelated across donors, once one controls for the explanatory variables (i.e., $\text{E}[\eta_{ijt}\eta_{ikt}] = 0$, where E is the expectation operator and $j \neq k$). If the time-varying, donor-specific unobservables captured by η_{ijt} are negatively correlated across donors, this suggests coordinated specialization, with one donor reducing its food aid relative to what one would otherwise predict while another donor increases its shipments. Conversely, a positive correlation between donor-specific residuals suggests joint action, with each donor more likely to ship to a recipient country if other donors do likewise.

The m-dimensional integrals that enter the likelihood function of this model are simulated using the GHK-algorithm (Train, 2003). We employ a method documented in Williams (2000) to compute robust cluster variance estimators that avoid heteroscedasticity bias due to possible intra-country correlation.

4.5 Empirical Results

We begin by briefly reporting on the estimated donor-specific thresholds that define food crisis response, κ_j. Unlike Young and Abbott (2008), who analyzed a period from 1990 to 2002 and estimated an optimal κ_j for the US of 1.3 standard deviations below period mean domestic food production, using our slightly different method, we find that globally aggregated food aid as well as three donors – the Japan, the US and individual EU member states collectively

– do not appear to vary their responses nonlinearly. Our estimated threshold for global food aid and those three donors was equal to zero. For EC Community Action food aid, we found a small threshold effect of 0.3. But for Australia and Canada, the estimated crisis shortfall was substantial, at 1.6 and 2.4 standard deviations below the trend-adjusted year-specific domestic food production level. The results that follow all employ these donor-specific optimal threshold estimates.

4.5.1 Global food aid allocation

The estimates from the CLAD model on global food aid are reported in Table 4.2. The first two rows show the coefficient estimates for the stabilization (γ_{j1}) and progressivity (γ_{j2}) parameters, respectively. Both estimates are negative, as expected, although only the stabilization parameter estimate is significantly different from zero at the 5% level, and it is quite small in magnitude. This suggests that aggregate food aid is targeted more towards countries facing temporary food crises than towards those with low food availability levels associated with chronic hunger, although even the stabilization effect is quite modest. We do find a negative and significant effect of real GDP on food aid receipts. Given that these regressions control for food availability, the strong suggestion of this result is that food aid responds more to chronic food access problems (low income for a given level of food availability per capita) than to chronic food availability problems (low food availability for a given level of per capita income).

The estimated coefficients on the variables representing sudden disasters and conflicts are both positive and significantly different from zero, indicating that global food aid responds positively to casualties caused by sudden natural and violent conflict. The positive, but insignificant coefficient for gradual natural catastrophes shows that global food aid shipments are far less responsive to slow onset disasters even though the pace of these natural catastrophes typically gives donors early warning and adequate time to deliver commodities when they are needed.

As in previous studies, the preceding year's level of food aid receipts is quite strongly correlated with the current year's food aid flows, with an estimated autoregressive parameter of 0.78, strongly supporting the inertia hypothesis (Barrett and Heisey 2002; Gupta et al. 2004; Young and Abbott 2008). Recipient country political freedoms have no discernible effect on food aid receipts. The regional dummy variable coefficient estimates indicate that Asian coun-

tries receive less food aid, ceteris paribus, than do other regions.[33]

Table 4.2. Responsiveness of global food aid to needs and donor interests

Dependent variable: aggregate food aid receipts

	Coefficient estimate	**t-statistic**
FC	-0.0015943	(-2.50)**
DFP	-0.0013447	(-1.45)
GDPpc	-0.0003244	(-3.52)***
SUDDENDIS	0.0051166	(2.24)**
GRADUALDIS	0.0007114	(0.35)
CONFLICT	0.0000526	(1.70)*
FIWTRANS	7.87E-07	(0.03)
FA_{t-1}	0.7764186	(41.01)***
ASIA	-0.0012171	(-3.53)***
MIDEAST_NA	-0.0001814	(-0.52)
SUBSAHARA	-0.0005176	(-1.51)
TRANSITION	-0.000881	(-0.62)
CONSTANT (γ_0)	0.0016514	(2.55)**
Optimal κ	0.0	
Pseudo R^2	0.41	
Observations	4503	

Notes: ***, ** and * denote statistical significance at the 1, 5 and 10 % levels, respectively. The Pseudo R^2 reported is that of the last ILPA iteration with a final sample size of 2877 observations. Optimal κ represents the donor-specific threshold.

4.5.2 Donor-specific food aid allocation patterns

Table 4.3 reports the results of the multivariate Tobit model analysis. As reported at the bottom of Table 4.3, the multivariate Tobit specification was tested against other specifications. The likelihood ratio test of joint ρ significance overwhelmingly rejects the null hypothesis

[33] Year fixed effects are not reported but are available upon request from the authors. The multivariate Tobit model and the CLAD model have been estimated with Stata Version 10 using the program routines *MVTOBIT*, written by Mikkel Barslund, and *CLAD*, written by Dean Jolliffe, Bohdan Krushelnytskyy and Anastassia Semykina.

that the correlations among donor country food aid shipments are all equal to zero, implying that one cannot defensibly estimate six separate Tobit models, thus supporting the simultaneous estimation method used here. Indeed, all the estimated bivariate correlation coefficients are positive, ranging from 0.13-0.29, and significantly different from zero at the one percent level. Thus, donors typically respond robustly together (relative to what one might predict based on recipient food availability, income, location, past food aid receipt history, etc.), or come up somewhat short uniformly. This finding is a strong indication for an effective management of aid resources through international aid organizations like the WFP, and for the functioning of international mechanisms like the CAP that induces joint action by donors. Practical explanations for joint shipments include the efficiency gains attainable from jointly using existent aid resources such as aid workers' expertise, transport vehicles, storage facilities, and shared international perspectives on the likely cooperativeness of local authorities in facilitating timely commodity deliveries.

The statistically significant correlation coefficient estimates also signal added efficiency in estimation using the multivariate approach. Likelihood tests against multivariate and univariate constant-only models unambiguously show that the exogenous variables of model (4) jointly contribute to explaining variation in food aid flows. Donor-specific parameter estimates appear in separate columns in Table 4.3. The pattern of stabilization and progressivity effects appear similar across countries. All statistically significant point estimates have the same sign and are substantially larger in magnitude than the corresponding global food aid estimates reported in Table 4.2. Interestingly, the donor-disaggregated results suggest significant progressivity and stabilization effects for the food aid programs of Canada and Europe (both EC community action and EU member states' individual programs), but no significant effect of either sort for US, Japanese or Australian food aid.

By contrast, real GDP per capita negatively and significantly affects food aid shipments from each donor, most strongly for the US and least for Australia. There is clear, universal emphasis on shipping to countries with lower purchasing power, which might point to a general awareness among donors for acute food access problems. Donors appear to respond differently to natural and man-made disasters. In particular, food aid programs administered by EU Member States generally respond to both rapid and slow onset natural disasters with increased food aid shipments, but not in conflict situations, while the EC's joint food aid program exhibits exactly the opposite pattern.

Table 4.3. Responsiveness of and interaction between donor countries' food aid flows

	US	**EC**	**EU States**	**Canada**	**Japan**	**Australia**
Optimal κ	0.0	0.3	0.0	2.4	0.0	1.6
FC	-0.00248	-0.00380	-0.00257	-0.01449	-0.00060	0.00090
	(-1.46)	(-2.69)***	(-2.68)***	(-3.35)***	(-0.90)	(0.54)
DFP	-0.00374	-0.00917	-0.00396	-0.00857	-0.00360	0.00053
	(-1.09)	(-2.87)***	(-2.13)**	(-2.14)**	(-1.43)	(0.40)
GDPpc	-0.00148	-0.00119	-0.00061	-0.00113	-0.00070	-0.00032
	(-5.90)***	(-3.78)***	(-3.73)***	(-3.10)***	(-4.62)***	(-3.45)***
SUDDENDIS	0.01112	0.00377	0.00498	0.00686	0.00229	-0.00299
	(2.47)**	(1.31)	(2.75)***	(1.00)	(1.11)	(-0.78)
GRADUALDIS	0.00266	0.01123	0.00416	0.00427	0.00245	0.00011
	(0.57)	(1.20)	(1.72)*	(0.93)	(2.14)**	(0.08)
CONFLICT	0.00023	0.00032	0.00011	0.00023	-0.00005	0.00006
	(1.28)	(2.18)**	(1.41)	(1.43)	(-0.82)	(1.29)
FIWTRANS	0.00017	-0.00009	-0.00005	0.00017	-0.00006	0.00001
	(1.23)	(-1.03)	(-0.86)	(1.26)	(-0.61)	(0.21)
FA_{t-1}	0.77580	0.42680	0.82277	0.20545	0.73130	0.93422
	(17.60)***	(5.06)***	(14.65)***	(5.02)***	(8.93)***	(18.64)***
DISTANCE	-0.00005	-0.00024	-0.00028	-0.00013	-0.00017	-0.00019
	(-0.29)	(-1.24)	(-2.12)**	(-0.61)	(-1.35)	(-2.51)**
ASIA	-0.00691	-0.00380	-0.00075	-0.00453	0.00146	0.00229
	(-2.90)***	(-2.37)**	(-0.80)	(-1.70)*	(0.75)	(2.95)***
MIDEAST_NA	-0.00203	0.00036	0.00088	0.00121	0.00242	0.00264
	(-1.03)	(0.26)	(1.01)	(0.87)	(1.82)*	(3.50)***
SUBSAHARA	-0.00138	-0.00069	0.00088	-0.00351	0.00343	0.00272
	(-0.83)	(-0.61)	(1.17)	(-1.87)*	(2.96)***	(3.68)***
TRANSITION	-0.00081	0.00193	-0.00171	-0.00605	0.00035	-0.00429
	(-0.41)	(0.92)	(-1.50)	(-2.33)**	(0.26)	(-1.11)
CONSTANT (γ_0)	0.00146	-0.00034	0.00102	-0.00482	-0.00004	-0.00284
	(0.74)	(-0.16)	(0.72)	(-2.04)**	(-0.02)	(-2.54)**

Cross-equation correlations

ρ_{AU_CA}	0.270	(7.52)***	ρ_{CA_EC}	0.222	(5.58)***	ρ_{EC_JP}	0.179	(4.84)***
ρ_{AU_EC}	0.292	(4.62)***	ρ_{CA_ES}	0.167	(4.43)***	ρ_{EC_US}	0.181	(4.29)***
ρ_{AU_ES}	0.217	(4.41)***	ρ_{CA_JP}	0.160	(4.03)***	ρ_{ES_JP}	0.185	(7.37)***
ρ_{AU_JP}	0.206	(5.02)***	ρ_{CA_US}	0.133	(3.81)***	ρ_{ES_US}	0.191	(5.95)***
ρ_{AU_US}	0.196	(5.25)***	ρ_{EC_ES}	0.248	(6.97)***	ρ_{JP_US}	0.158	(3.54)***

Log-likelihood ratio test: joint ρ significance		
χ^2-statistic	587.2	
p-value	0.00	
Log-likelihood ratio test against constant-only model:	**univariate**	**Multivariate**
χ^2-statistic	11,830.78	8,944.01
p-value	0.00	0.00
Observations	4,318	

Notes: t-statistics in parentheses. ***, ** and * denote statistical significance at the 1, 5 and 10 % levels, respectively.

The US food aid program has a significant response only to sudden natural disasters while Japan's only responds positively and significantly to gradual disasters, but not to sudden ones. Neither Canada nor Australia exhibit any statistically significant food aid response to any sort of disaster, whether natural or man-made. Interestingly, none of the donor countries' food aid programs appear significantly responsive to political freedom in recipient countries, and the geographic distance effects, although uniformly negative, are only significant in the case of Australia and the EU member states. Geopolitical considerations, although obvious in several prominent cases, appear to be no ordinary part in overall food aid allocation patterns during the 1970-2004 period. However, all donors' food aid programs exhibit inertia, as reflected in the positive and significant estimated coefficients on the lagged food aid volumes. Along with GDPpc, this is the only variable that is highly significant in all donor equations and, moreover, has the same sign for all donors. But the differences among donors are striking. Food aid flows from Australia and EU member states are more than four times as persistent as those from Canada, which shows the least persistence in food aid programming by recipient country.

4.5 Conclusions

This paper offers a new glimpse at how food aid flows respond to the needs of recipient countries. We attend to a range of econometric concerns about the existing literature and for the first time explore the hypothesis that food aid shipments from different sources are effectively coordinated. Our results yield three important findings.

First, consistent with most of the previous literature, we find that food aid flows have been targeted towards poorer countries and countries facing temporary food production shortfalls, although the food availability stabilization effects are quite modest. Food access concerns associated with low incomes trump food availability issues in guiding food aid programming.

Second, violent conflict and sudden natural disasters induce significant added food aid response, while slow onset natural disasters such as drought generally draw no significant increase in food aid flows. The relatively greater logistical complications of response in conflict zones and to rapid onset disasters such as hurricanes, tsunamis and earthquakes appear dominated by the media attention these types of disasters bring. This explanation is substantiated by the findings of Eisensee and Söderbom (2007), who found that disasters like volcanoes, earthquakes, and fires generally reach a much higher probability of the U.S. media coverage

than droughts, and that news coverage significantly increases the probability to send relief aid.

Third, we generate the first known estimates of inter-donor food aid coordination. We find relatively large, positive and statistically significant correlation coefficients among all six food aid donors' programs. It appears that international coordination effectively induces joint food aid responses (and non-response). While positive correlations may at first seem like an indication of aid oversupply in some countries while others are neglected, this must not necessarily be the case. Given that there are huge need differences between recipient countries and at different times, it is rather much more conceivable that mechanisms like the CAP as well as aid managing organizations (WFP, NGOs) channel aid resources from different donor sources to similar needy countries. Thus, the results of this analysis suggest that the donor community has done good efforts to harmonize food aid shipments, and may therefore be a positive sign for the future will of donors to comply with their pledges of the 2005 Paris Declaration on Aid Effectiveness.

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Chapter 5

Food Aid and Malnutrition in Developing Countries: Evidence from U.S. Food Aid Allocation

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Abstract

This study investigates the allocation of dietary energy, iron, vitamin A and zinc within US food aid. A dynamic correlated random effects (CRE) Tobit model is employed to estimate the aid response to nutritional needs, donor interests and media attention. The CRE estimation strategy accounts for unobserved heterogeneity among recipient countries, and allows the unobserved effect to be correlated with the covariates. Global aid flows of the post cold war period 1993-2007 are analyzed. The empirical results show that US nutrient shipments have been allocated towards populations with high nutritional requirements and poorer countries, but also face significant inertia. Project and program food aid are both affected by donor interests, while emergency food aid is significantly biased by media coverage. Robustness checks show that our results are quite robust to different econometric strategies of modeling unobserved heterogeneity.

Keywords: food aid, nutritional value, aid allocation, dynamic Tobit, correlated random effects

JEL classification: F35, I12, C23

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5.1 Introduction

Renewed attention has been drawn on food aid since the devastating impacts of the 2007/8 food crisis became apparent. In a joint declaration of 2008, representatives and ministers of 181 countries called for a coordinated use of food assistance programs to fight hunger and malnutrition (FAO, 2008). In the wake of soaring food prices, the number of undernourished people increased up to a record high of one billion in 2009 (FAO/WFP, 2010). More than two billion people have been estimated to suffer from micronutrient deficiency even before the crisis emerged (WHO/WFP/UNICEF, 2006). Hunger and malnutrition are major causes of mortality and morbidity in developing countries, particularly in vulnerable groups such as mothers and children (Black et al., 2008).

The most essential nutrients for a healthy and active human life include energy, protein of animal and plant sources, fat, as well as vitamins and mineral nutrients. Adverse health outcomes occur when any of these nutrients is not sufficiently consumed. Major causes of inadequate dietary intake are budget constraints of poor households or unavailability of the required nutrients at local markets (WFP, 2008). In such crisis situations, food aid can be a straightforward instrument to prevent irreparable health consequences. The idea of using food aid to improve micronutrient supply was proposed in a seminal study by the National Academy of Science in 1982 (NAS, 1982). However, international agreements, such as the Food Aid Convention, measure donors' aid efforts in terms of grain equivalents, rather than their nutritional contribution. Food aid rations are primarily composed of cereals, as indicated by an average 86% share of cereal products in global food aid for the years 1993 to 2007 (WFP, 2011). While cereal products are rich in energy, they are criticized for not being able to meet the nutritional requirements of vulnerable groups (e.g. Webb et al., 2011).

Previous analyses on the responsiveness of global food aid allocation have focused on cereal aid flows (e.g. Barrett and Heisey, 2002; Gupta et al. 2003; Neumayer, 2005; Young and Abbott, 2008). Given that the human metabolism needs nutrients, and not certain product types (like cereals), findings of previous studies can only roughly approximate the responsiveness to recipients' nutritional needs. The focus on energy-rich cereals may indicate the aid response to energy needs, but as energy content varies among cereal products, and is also high in many non-cereal products in allocated food aid such as meat, nuts and soya, this remains a rough estimate. The prevalence of other nutrient deficiencies is virtually neglected in previous stud-

ies on food aid.[34] Given that a major goal of food aid is to reduce malnutrition and attain specific nutritional targets at the operational level, it certainly would be significant to examine how food aid allocation responds to recipients' needs.

The present study therefore contributes to the literature by examining how the allocation of food aid addresses nutrient requirements in the developing world. Specifically, we consider four nutrients that are severely deficient in developing countries (Black et al., 2008; WHO/WFP/UNICEF, 2006): energy, iron, vitamin A and zinc.[35] Given the leading role of the US in provision of food aid, we examine its food aid floes for the period 1993-2007. Moreover, the US still ships most of its food aid directly to the recipient countries, and has therefore considerable influence on the content of aid shipments.

A major methodological contribution of the study is that the estimation approach employed takes into account the panel structure of the data. It has become common practice in the food aid allocation literature to pool the data, which restrictively implies that unobserved characteristics of recipient countries do not affect donors' aid allocation pattern. In contrast, we employ a dynamic correlated random effects (CRE) Tobit model, which allows for unobserved heterogeneity between recipient countries. Unlike the conventional random effects model, the CRE approach allows for correlation between the unobserved effects and the independent variables (Mundlak, 1978). The initial conditions problem of dynamic panel models is treated by conditioning on the nutrient shipment of the first observable period (Wooldridge, 2005). Likelihood Ratio (LR) tests find that the CRE models are superior to the random effects and the pooled Tobit approaches.

The data stem from the Food Aid Information System (FAIS) database of the World Food Programme (WFP), and allow the separate examination of emergency, project and program food aid. Each type of food aid has its own goals and kinds of targeting practices, so that a differentiated analysis of their need response seems appropriate. Finally, we propose several nutrient-specific need indicators and introduce an indicator for measuring the effect of media attention to food crises.

The paper is structured as follows. In the subsequent section, factors and aid modalities that potentially affect US nutrient allocation are described. A presentation of the empirical strategy

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[34] This holds for impact analyses at the micro-level, which have also primarily investigated energy-related health outcomes (e.g. Yamano et al., 2005).

[35] We did not investigate allocation of iodine, which is another globally deficient micronutrient. This is because of the outstanding impact of iodization programs on regional iodine availability. Due to the lack of data on domestic iodization efforts, an analysis of food aid iodine allocation would most probably be biased.

follows in section 5.3. The data employed in our analysis are described in section 5.4. Empirical results for the three food aid types and each nutrient are presented in the first part of section 5.5. In the second part, findings of the sensitivity analysis are discussed. Section 5.6 concludes.

5.2 Potential determinants of nutrient allocation

This section presents the conceptual framework for analyzing the potential determinants of donors' global food aid shipments. For a formal illustration of the subsequent discussion, let ***NA*** represent the donor's global food aid shipments measured as amount of delivered nutrients. The relationship between food aid shipments and recipient country specific determinants can be specified as follows:

$$\boldsymbol{NA} = \boldsymbol{z}\beta_1 + \boldsymbol{a}\beta_2 + \boldsymbol{\varepsilon} \tag{5.1}$$

where ***z*** represents a vector of recipient countries' needs for nutrient aid, which includes indicators of food supply and food access as well as demographic characteristics. These are discussed in subsection 5.2.1. The vector ***a*** denotes other determinants that affect nutritional composition of food aid at the administrative level, such as donor interests and aid coordination, which are discussed in subsection 5.2.2. $\boldsymbol{\varepsilon}$ is the error term.

5.2.1 Determinants of nutrient supply and demand

Previous studies on food aid allocation have focused on its effect on mitigating food supply shocks and a lack of access to food (e.g. Gupta et al., 2003; Neumayer, 2005). Correspondingly, the allocation of nutrients via food aid can be seen as a response to shocks in nutrient supply. Thus, once the availability of food is below the minimum needs of the population for a given nutrient in a developing country, this seems as a signal to donors to deliver food aid rich in the deficient nutrient. Furthermore, high food prices and lack of purchasing power can prevent people from buying food baskets with sufficient nutrients. In addition, catastrophes can disrupt the food supply and health care system within a whole area, and therefore raise nutrient needs of the affected people (e.g. Degomme and Guha-Sapir, 2010).

Humans have different minimum nutrient requirements, which are determined by factors such as age, sex, or pregnancy in the case of women. Previous studies on global aid allocation have mostly neglected the demand requirements for nutrients, as they only slowly change. The analysis of nutrient allocation however needs the inclusion of demographic indicators in equa-

tion (5.1), since they measure the vulnerability of a country's population for severe health consequences.

A particular threat for aid planners is the non-linear relationship between nutrient gaps and health consequences (FAO/WHO, 2004). At the individual level, temporary health impairments will follow once a human cannot consume sufficient amounts of any nutrient to meet a critical level determined by physiological requirements. Formally, this occurs once the ingested amount d^k of a particular nutrient *k*, falls below its individual-specific critical level l^1, i.e. if $d_t^k < l_t^1$ at a given time *t*. Examples of transitory health impairments include hunger (energy), reduced physical work capacity (iron), night blindness (vitamin A) and diarrhea (zinc). Temporary impairments may become more severe with decreasing nutrient consumption until the amount falls below a second critical level l^2 and irreversible health damages follow, i.e. once $d_t^k < l_t^2$. Permanent health impairments are, for example, stunting (energy), delayed brain development (iron), blindness (vitamin A) and growth retardation (zinc). Finally, once for any nutrient, a vitally important threshold in consumption cannot be met (i.e. $d_t^k < l_t^3$), central functions of the human metabolism collapse and the individual dies. Physiological minimum requirements change over time, for example because of aging or temporary adverse effects of diseases on nutrient absorption. Children are particularly prone to permanent health damages and death, as they crucially need nutrients for growth and have not developed the physical capabilities to adequately handle health shocks. Nutrient supply for pregnant and breastfeeding women is also important in order to minimize complications during birth, and provide vital nutrients to the mother and the infant. Given permanent adverse effects on the individual's future well-being and the potential impact on human capital development, aid programs are particularly seen as instruments used to target these vulnerable groups during this critical window of opportunity (UN, 1993; Webb et al., 2011).

5.2.2 Nutritional composition of food aid

Knowledge on common nutrition gaps in vulnerable groups and modern food fortification technology allows aid planners to adjust their food basket at the procurement stage, so that distributed food rations can meet specific nutritional outcomes (Webb et al., 2011). The allocation of nutrients depends on their combination possibilities within the available food items. In practice, three important cases emerge when the food product level becomes relevant. Firstly, aid agencies may be prompted to use similar foodstuff due to reasons of timeliness, transaction costs and economies of scale. Secondly, there is strong evidence for inertia in food aid

flows (Diven, 2001; Jayne, 2002). This can be caused by bureaucratic momentum, while the presence of fixed costs can hinder reallocation of aid towards needier regions at the operational level. Thirdly, prominent examples illustrate that donors pursue multiple objectives when sending food aid (Barrett and Maxwell, 2005). In addition to geopolitical or economic interests, donors may have additional incentives to send aid to countries whose neediness is highly visible (Besley and Burgess, 2001). Public attention can be relevant for food aid agencies, in order to convince political decision makers to spend more resources for their field of activity, as well as the decision makers themselves, who can illustrate their efforts to the domestic and international public (Swinnen et al., 2011).

The nutritional value of other donors' food aid shipments may also influence US nutrition allocation. Aid harmonization efforts, such as similar responses to consolidated appeals processes, but also availability of similar food types in donor regions (like wheat) may result in a positive influence of other donors' aid shipments on US nutrient allocation. On the other hand, cases emerge where donors' food aid shipments are complementary in the same country, so that an undersupply in a donor's delivery is compensated by deliveries of other donors.

5.2.3 Food aid types and nutritional composition

The potential determinants of equation (5.1) are likely to have a different impact on the three food aid categories, since they are used for different goals and the distribution mechanism also differ. This section therefore discusses category-specific issues of nutrient composition. Emergency food aid is humanitarian aid used for immediate –and sometimes chronic– crisis response. Project food aid targets longer-term development goals, and include food for work schemes, school feeding programs as well as mother and child nutrition programs. Program food aid is given on a bilateral basis and sold by agents of the recipient governments on the domestic market. In the context of severe food crises and disrupted markets, the affected population often solely depends on food aid rations (WFP, 2008). Emergency food aid is therefore typically used to provide general nutrition support. In many cases, sudden emergencies also require therapeutic feeding for children and mothers, as these vulnerable groups need a continuous supply of nutrients such as vitamin A and zinc to prevent permanent disabilities. With respect to program food aid, the sale of bulk food aid shipments lacks any targeting mechanism, and has thus been criticized for being an inadequate measure to raise the micronutrient composition of local diets (Clay et al., 1996). Project food aid, on the one hand, consists of projects with a specific focus on malnutrition, e.g. child feeding programs. On the other hand, a large branch of food aid projects is not primarily intended for targeting nutrition aims. The

focus of food-for-work schemes on giving work incentives and building infrastructure particularly targets the population of rural and underdeveloped areas. Some of US project food aid was sold by NGOs in order to finance operational costs and other development projects. Nutrients in monetized project food aid are generally not targeted towards the needy.

5.2.4 US food aid modalities

In this section, we outline the common linkages between the food aid categories and the structure of US food aid in order to provide an overview of US food aid programs. Food aid under the US Public Law 480 (PL 480) Title I and PL480 Title III programs are designed as a government to government transaction and, hence, resemble the definition of program food aid. The PL 480 Title II food aid program mostly supports emergency responses but also developmental programs of multilateral organizations and NGOs. Section 416(b) and Food For Progress programs cannot be clearly categorized into the food aid categories, as they involve not only private voluntary agencies and international organizations but also recipient governments. Smaller food aid programs include the McGovern-Dole International Food for Education and Child Nutrition Program, which aims at school-feeding and maternal and child nutrition projects (= project food aid), and the Bill Emerson Humanitarian Trust, which is a reserve for emergency situations.

Considerable changes in US food aid policy have taken place during the period under investigation in this study. The 1990 Farm Bill explicitly reformulated the purpose of food aid under Public Law 480 in favor of recipient needs, stating that the enhancement of food security in the developing world is its foremost goal. Food aid shipments, particularly program food aid, declined considerably. Emergency food aid became the predominant part of US food aid program, while monetization gained in significance in project food aid. The shift away from bilateral program food aid raised the importance of multilateral and non-governmental food aid distributors. Changes in the implementing partners could not have a considerable influence on food composition, as almost all contributions of the US have been made in kind.[36] Because of the voluntary nature of donations and the predominant use of earmarked contributions, the US keeps considerable influence on the destination and usage of aid that is distributed by third parties (Clay, 2003; Barrett and Maxwell, 2005).

[36] During the study period, usually more than 98% of US food aid was directly sourced from the USA (WFP, 2011). The only year with a slightly lower share was 2003, where 93% of US food aid was directly shipped.

5.3 Empirical framework

In this section, we present the empirical strategy employed in estimating US nutrient allocation. Given that only zero or positive amounts of nutrients can be shipped, linear estimation of equation (5.1) with ordinary least squares techniques (OLS) would yield biased results. This is especially troublesome for samples with many corner solution values, as it is the case when specific nutrients in particular types of food aid are analyzed. Hence, we employ a limited dependent variable estimation approach, and rewrite equation (5.1) in the following dynamic Tobit model specification:

$$\begin{aligned} \overline{\boldsymbol{NA}}_{i,t} &= \boldsymbol{x}_{i,t}\beta + \lambda_1 \boldsymbol{NA}_{i,t-1} + \lambda_2 \boldsymbol{O}_{i,t-1} + \boldsymbol{\varepsilon}_{i,t}, \quad \boldsymbol{\varepsilon}_{i,t} \sim N\left(0, \sigma_{\varepsilon}^2\right) \\ \boldsymbol{NA}_{i,t} &= \overline{\boldsymbol{NA}}_{i,t} \quad \text{if } \overline{\boldsymbol{NA}}_{i,t} > 0 \\ \boldsymbol{NA}_{i,t} &= 0 \qquad \text{if } \overline{\boldsymbol{NA}}_{i,t} \leq 0 \end{aligned} \tag{5.2}$$

where $\boldsymbol{NA}$ is defined as in equation (5.1), $\overline{\boldsymbol{NA}}$ is a latent variable representing the donor's affinity to deliver nutrients, and $\boldsymbol{x}$ is a vector of need and donor interest indicators; $\boldsymbol{O}$ represents the quantity of nutrients shipped by other food aid donors, used to account for interaction of different aid flows. Indices $i = 1,\ldots,N$ and $t = 0,\ldots,T$ denote the recipient country and year, respectively. The inclusion of a lagged dependent variable is motivated by the strong evidence of persistence found in global food aid flows (Barrett and Heisey, 2002; Gupta et al., 2003). As the causal relationship between own and foreign aid flows is not obvious, lags of $\boldsymbol{O}$ are included to avoid endogeneity problems.

Equation (5.2) defines a pooled Tobit model, which is commonly applied in the food aid allocation literature, and fails to account for unobserved heterogeneity (e.g. Barrett and Heisey, 2002; Young and Abbott, 2008). The panel structure of the data can be considered by decomposing the residual $\boldsymbol{\varepsilon}_{i,t} = \boldsymbol{u}_i + \boldsymbol{e}_{i,t}$ to account for country specific effects:

$$\overline{\boldsymbol{NA}}_{i,t} = \boldsymbol{x}_{i,t}\beta + \lambda_1 \boldsymbol{NA}_{i,t-1} + \lambda_2 \boldsymbol{O}_{i,t-1} + \boldsymbol{u}_i + \boldsymbol{e}_{i,t}, \quad \boldsymbol{u}_i \sim N\left(0, \sigma_u^2\right), \quad \boldsymbol{e}_{i,t} \sim N\left(0, \sigma_e^2\right) \tag{5.3}$$

Where $\boldsymbol{e}_{i,t}$ is an idiosyncratic error component, and $\boldsymbol{u}_i$ is a country-specific effect that captures unobserved heterogeneity between recipient countries. Equation (5.3) is a random effects (RE) model, which captures unobservable effects as a normally distributed random term with

zero mean and variance σ_u^2.[37] A well known caveat in RE models is the restrictive assumption of independence between the random effect and the independent variables. Our model therefore builds on Mundlak's (1978) correlated random effects (CRE) model to relax this assumption. In Mundlak's approach, the country mean of each time-variant independent variable is added to the regression. Thus, any potential correlation between $\boldsymbol{u}_i$ and the mean properties of the observables is controlled for. Problems may however arise due to the fact that correlations with averages over 15 years cannot capture the developments of unobserved effects.[38] In order to capture the dynamics in unobserved heterogeneity, we altered Mundlak's modeling strategy. Instead of including the whole period's average of a variable, we included the separate time averages of three equally long sub periods.[39] This modification adds further flexibility, as it allows the partial correlation of unobserved heterogeneity to change over time.[40]

Furthermore, dynamic RE models with a lagged dependent variable exhibit the initial condition problem. Given that the disturbances in the model are serially correlated, and that the stochastic process has begun before the starting point of our investigated panel, the initial values of $\boldsymbol{NA}_{i,t}$ cannot be treated as exogenous (Heckman, 1981). As a solution for nonlinear models, Wooldridge (2005) suggests conditioning the random effect on the dependent variable's values of the period first observed (where t=0). We similarly proceed with lagged food aid flows from other donor countries ($\boldsymbol{O}_{i,t-1}$), since this variable may be a function of the lagged dependent variable. The specification employed in the empirical analysis is

$$\begin{aligned} \overline{\boldsymbol{NA}}_{i,t} &= \boldsymbol{x}_{i,t}\beta + \lambda_1 \boldsymbol{NA}_{i,t-1} + \lambda_2 \boldsymbol{O}_{i,t-1} + \mu_1 \boldsymbol{NA}_{i,t0} + \mu_2 \boldsymbol{O}_{i,t0} + \sum_{k=1}^{3} \bar{\boldsymbol{x}}_{i,k}\gamma_k + \boldsymbol{u}_i + \boldsymbol{e}_{i,t} \\ \boldsymbol{NA}_{i,t} &= \overline{\boldsymbol{NA}}_{i,t} \quad \text{if} \quad \overline{\boldsymbol{NA}}_{i,t} > 0 \end{aligned} \tag{5.4}$$

[37] Alternatively, $\boldsymbol{u}_i$ could have been estimated as country fixed effects. A major drawback of this procedure is that the influence of time-invariant variables cannot be identified in the presence of country specific fixed effect. Because we do not want to drop indicators of considerable explanatory power, we opted for the RE approach.

[38] As argued by Wooldridge (2005), a natural way to account for dynamics in unobserved heterogeneity would be the CRE model suggested by Chamberlain (1984). In Chamberlain's approach, the error term $\boldsymbol{u}_i$ is conditioned on values of every period of each time-variant variable. This estimation strategy could not be employed for our sample, as the length of the panel (t=15 years) and the number of time-variant variables (x=14) would result in the inclusion of so many additional variables (x × t = 210) that the estimation becomes unfeasible.

[39] The typical length of a sub-period is 5 years. The panel is unbalanced, as two countries were newly found (Belarus having data on 14 years and Timor-Leste on 6 years), and others did not have data over the whole period (Myanmar and the Democratic People's Republic of Korea, each having data on 12 years). Hence, the sub-periods for the calculation of separate averages were shorter for these countries.

[40] As the number of included time averages is somewhat arbitrary, we conduct a sensitivity analysis, in which results of varying numbers of sub-periods are compared.

$$\boldsymbol{NA}_{i,t} = 0 \qquad \text{if } \overline{\boldsymbol{NA}}_{i,t} \leq 0$$

where $\bar{\boldsymbol{x}}_{i,k}$ denotes a vector of country averages of each time-variant variable in $\boldsymbol{x}$, calculated for sub-period *k*. Unobserved heterogeneity is captured by the random part $\boldsymbol{u}_i$ as well as its correlation with time averages and aid inflows of the t_0 period. To reduce the effect of outliers, we transformed the dependent variables by using the common $\ln(\boldsymbol{NA}+1)$ transformation (e.g. Dollar and Levin 2006).

5.4 Data Description

The analyzed sample ranges from 1992 (=t_0 period) to 2007 and includes all US food aid recipients for which data was available. The amount of annually delivered nutrients was computed using data from the WFP FAIS database (WFP, 2011).[41] To account for the fact that nutrition targets are formulated at the individual level, we used per capita estimates for the dependent variables (energy, iron, zinc and vitamin A) and for selected explanatory variables (Barrett, 2001). All per capita calculations are based on population figures from the World Development Indicators of the World Bank.

In order to account for aid coordination, we included the per capita nutrient deliveries from all other food aid donors. In doing so, we subtracted the nutritional value of US emergency and US project food aid from overall emergency and project food aid, respectively. Due to the fact that program food aid does not have such a context-specific focus as relief and project aid, we used total food aid minus US program food aid for measuring coordination effects in US program food aid (WFP, 2008). In consistence with the dependent variable, per capita nutrient deliveries of other donors were log-transformed.

Demographic statistics on the population share of vulnerable groups were obtained from the HNP (Health, Nutrition and Population) database of the World Bank. The proportion of women in reproductive age (i.e. between 15 and 44 years) is incorporated in all nutrient equations, and serves as a proxy for increased needs of pregnant and lactating women. The share of children below five years is included in the vitamin A equation, reflecting the particular need of

[41] The WFP measured nutrition content of food aid commodities by multiplying the tons of food items with the average nutrient content. Specific product varieties, such as fortified food, were incorporated in the database as separate food categories. If the nutritional value of a commodity could not be derived, the content of the according nutrient is equated to zero. Regarding data reliability, more than 99% of the annual food aid deliveries have complete information on energy and less than five missing conversion factors for micronutrients (WFP, 2011).

these nutrients shortly after birth (FAO/WHO, 2004). For energy, iron and zinc, the population share of children below 15 years is incorporated, since they remain crucial for physical growth and mental development in later development stages.

Estimates of real GDP per adult equivalent were obtained from the Penn World Table, version 7.0. The effect of food prices on food access is taken into account by including a global food price index. The computed index is a weighted aggregate of cereal prices, which is owed to the central role of cereal products in local diets of developing countries. Data on the prices of wheat, milled rice, maize, sorghum, and barley were obtained from the International Monetary Fund. The importance of these cereals in regional consumption was accounted for by employing country specific weights. To measure targeting efforts with respect to population density and infrastructure, the share of urban population in total population was incorporated, which was obtained from the World Development Indicators.

Data on natural disasters were acquired from the EM-DAT database (version 12.07) of the Centre for Research on the Epidemiology of Disasters. As aid response probably differs by the predictability of natural disasters, we separately include indicators of sudden and gradual disasters (Albala-Bertrand, 1993). Gradual disasters include epidemic and drought disasters, while sudden disasters comprise of earthquakes, extreme temperatures, floods, insect infestations, landslides, avalanches, storms, volcanoes and wildfires. In the case of vitamin A, iron and zinc, gradual disasters are further subdivided, as their specific impacts on the immune system are likely to induce different aid responses between epidemic and other gradual disasters (FAO/WHO, 2004). The severity of catastrophes is measured as the proportion of the population affected. Conflict intensity is measured by a variable acquired from the major episodes of political violence (MEPV) database of the Center for Systemic Peace (database version of July 28, 2010). We use the aggregate MEPV score, which increases with rising conflict intensity and incorporates all forms of ethnic, civil and interstate conflicts.

Dietary energy needs are approximated by cereal availability, as cereal products prominently contribute to dietary energy supply throughout the developing world. Given insufficient data on grain storages and the problem of reverse causality with commercial imports, we follow previous studies and include per capita production as a proxy for cereal availability (Barrett, 2001). Cereal production data were obtained from the FAO. A measure for temporary shocks in energy supply is also incorporated. As argued by Young and Abbott (2008), a realistic assumption is that donors only respond to negative cereal production shocks that are of certain magnitude. Thus, a cereal production shortfall variable is included, which contains the trend

deviation that exceeds a specific threshold, and takes zero values otherwise (see the Appendix for a description on the construction of this variable). For iron, vitamin A and zinc, data on per capita food supply from the FAO are employed. We use the average share of animal products in the total energy consumption as an estimator of regional iron and zinc intake. Animal products such as meat and milk are generally rich in these nutrients, and bioavailability is higher than in vegetable products (FAO/WHO, 2004). For vitamin A, we computed the share of non-starchy food in the total energy consumption of a country's population, which generally indicates diets with high vitamin intake.

Data on news coverage stem from the LexisNexis database (accessed January to March 2011), which hosts full-text access to thousands of newspapers and magazines. We conducted a search in English press, and counted for each year the occurrence of news articles that mention the recipient country's name together with the word "famine". To improve accuracy, only news articles were considered, where "famine" and the country name had a maximum distance of 30 words between them.

To measure the influence of geographic proximity, we obtained data on distances between the recipients' capitals and Washington D.C. from the Centre d'Etudes Prospectives et d'Informations Internationales. As argued by Alesina and Dollar (2000), measures of voting similarity in the United Nations General Assembly can be used to measure similarity in geopolitical interests. We therefore include the Affinity of Nations index calculated by Erik Gartzke (dataset version of April 2010), which increases with more similar voting behavior between donor and recipient and continually ranges from -1 to 1. In order to capture military-strategic interests in a recipient, we follow Neumayer (2005) and include data from the USAID on the share of military assistance to this country. Furthermore, we follow Dreher et al. (2010) and include country-level data on proved oil reserves, which were obtained from the British Petroleum Statistical Review of World Energy (June 2011). This serves as an indicator for donor interests in keeping up relations with recipients that have rich resource endowments. Ratings on civil liberties and political rights were obtained from Freedom House (2010). The indices were aggregated and transposed, so that a positive relationship indicates aid flows directed to freer countries.[42]

Regional differences in culture, climate and donor interest are incorporated by the inclusion of region dummy variables for Asia, Latin America and the Caribbean, North Africa and the

[42] We did not include measures of freedom in our main model, but tested in a sensitivity analysis whether omission of freedom changes aid pattern significantly.

Middle East, Sub-Saharan Africa as well as transition countries. Time effects are captured by year dummy variables. Descriptive statistics for the whole dataset are presented in table 1.

Table 5.1. Descriptive statistics

Variable label	Description	Mean	Std.Dev.
Dependent variables			
Emergency energy	Energy in US Emergency food aid, (1000 kcal/pop.)	4.326	15.90
Project energy	Energy in US Project food aid, (1000 kcal/pop.)	3.845	14.65
Program energy	Energy in US Program food aid, (1000 kcal/pop.)	6.031	25.17
Emergency iron	Iron in US Emergency food aid, (mg/pop.)	42.52	166.5
Project iron	Iron in US Project food aid, (mg/pop.)	32.99	124.1
Program iron	Iron in US Program food aid, (mg/pop.)	58.04	244.7
Emergency zinc	Zinc in US Emergency food aid, (mg/pop.)	20.08	80.13
Project zinc	Zinc in US Project food aid, (mg/pop.)	21.81	95.70
Program zinc	Zinc in US Program food aid, (mg/pop.)	57.56	256.3
Emergency vitamin A	Vitamin A in US Emergency food aid, (100 µgRE/pop.)	6.306	30.90
Project vitamin A	Vitamin A in US Project food aid, (100 µgRE/pop.)	6.881	31.46
Program vitamin A	Vitamin A in US Program food aid, (100 µgRE/pop.)	1.329	13.37
Independent variables			
Cereals per capita	Cereal food production (tons/pop.)	0.183	0.196
Animal products	Animal products: share in total energy consumption (%)	13.95	8.016
Dietary diversification	Non-starchy food: share in total energy consumption (%)	54.75	12.85
Cereal price index	Country specific real price index of cereals	102.6	17.33
GDP per capita	Real GDP per adult equivalent (1000 Int$/pop)	5.448	5.555
Urban population	Urban population, share in pop. (%)	46.18	21.06
Children, 0 to 14 years	Children aged 0 to 14, share in pop. (%)	35.50	9.174
Children, 0 to 4 years	Children aged 0 to 4, share in pop. (%)	12.53	4.264
Women, reprod. age	Women aged 15 to 44, share in pop. (%)	22.77	1.545
Gradual disaster victims	Total affected by gradual disasters, share in pop. (%)	0.760	5.047
Sudden disaster victims	Total affected by sudden disasters, share in pop. (%)	0.931	4.211
Conflict intensity	Sum of MEPV scores (0 no conflict, 60 theoretical max.)	0.760	1.682
Media coverage	English press articles on country and "famine" (1000 articles)	0.0634	0.208
UN affinity index	Voting similarity in UN General Assembly (-1 least, +1 most)	-0.365	0.274
Oil reserves	Proven oil reserves, annual estimates (1000 million barrels)	3.142	13.44
Military assistance	Share of country in total US military assistance (%)	0.670	4.551
Freedom Index	Political rights + civil liberties scores (2 to 14 (=most free))	8.095	3.608
Distance	Geographic proximity to Washington D.C. (1000 km)	9.061	3.542
Asia	1 = country in Asia, 0 otherwise	0.223	0.416
Sub-Saharan Africa	1 = country in Sub-Saharan Africa, 0 otherwise	0.333	0.472
North Africa & Mideast	1 = country in North Africa or the Middle East, 0 otherwise	0.119	0.324
Central & Eastern Europe	1 = Transition country, 0 otherwise	0.110	0.313
Latin America & Caribbean	1 = country in America, 0 otherwise (reference region)	0.215	0.411

Notes: Descriptive statistics are for the whole sample of 1993-2007. For the sake of brevity, nutritional content of food aid from other donors is not reported. For the dependent variables, we report descriptive statistics before the log-transformation.

5.5 Empirical Results

5.5.1 Allocation of nutrients in US food aid

The findings from the analysis for the different food aid categories using correlated Random Effects (CRE) Tobit models are presented in tables 5.2 to 5.4. For the sake of brevity, the coefficients of the Mundlak device (including $\boldsymbol{NA}_{t0}$ and $\boldsymbol{O}_{t0}$), the constant and time dummies are not reported, but they are available upon request. In each analysis, we test the appropriateness of the CRE model against the RE and pooled Tobit specifications, using a likelihood ratio test. The results overwhelmingly indicate that the CRE suits the data better than the RE and pooled Tobit specifications.

Regarding cereal production in the energy equation, we used the search method described in the appendix to find the optimal threshold that best captures the responsiveness of donor countries to production shortfalls. The optimum threshold is zero for emergency and project food aid categories, and 0.4 for program food aid. This suggests that even low shortfalls are perceived as situations eligible for emergency and project food aid responses, while shortfalls have to be of greater magnitude to be considered in program food aid. However, the results of tables 5.2 to 5.4 indicate that the influence of cereal production shocks is not significant at conventional levels for all food aid types. Thus, US food aid is generally not stabilizing dietary energy supply in regions that were hit by cereal production shortfalls.

In the following section each food aid category is discussed, beginning with the results of nutrient allocation in emergency food aid, which are presented in table 5.2. The first column of table 5.2 reports the explanatory variables and the following columns contain the estimated coefficients and standard errors for each of the four analyzed nutrients. In the second row from the bottom, the log-likelihood ratio of the CRE Tobit model and the conventional RE Tobit model are reported, which are Chi² distributed with 44 degrees of freedom.[43] The likelihood ratio (LR) estimates range from 74.42 (energy) to 85.08 (vitamin A) and are all significantly different from zero at the 1% level, given that the critical level is 68.71. This suggests that neglecting the significant correlation between the random effect and the observables would lead to biased estimates.

[43] In the RE specification, the coefficients for variables of the Mundlak term (3 sub-period means times 14 time-varying variables), $\boldsymbol{NA}_{t0}$ and $\boldsymbol{O}_{t0}$ are jointly constrained to zero.

Table 5.2. Nutrient allocation of US Emergency food aid

	Energy		Iron		Zinc		Vitamin A	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Cereals per capita	-1.179	(0.923)						
Cereal production shock [a)]	-0.005	(0.004)						
Animal products in diet			0.024	(0.063)	0.018	(0.057)		
Dietary diversification							-0.012	(0.023)
Cereal price index	-0.013*	(0.008)	-0.027*	(0.014)	-0.026**	(0.013)	-0.024**	(0.011)
GDP per capita	-0.223***	(0.083)	-0.548***	(0.156)	-0.521***	(0.147)	-0.447***	(0.121)
Urban population	0.042	(0.027)	0.056	(0.051)	0.046	(0.046)	0.021	(0.038)
Children, 0 to 14 years	0.130**	(0.052)	0.118	(0.097)	0.192**	(0.090)		
Children, 0 to 4 years							0.145	(0.115)
Women, reprod. age	0.239*	(0.135)	0.236	(0.245)	0.422*	(0.227)	0.049	(0.163)
Sudden disaster victims	0.009	(0.010)	0.020	(0.018)	0.018	(0.016)	0.029**	(0.014)
Gradual disaster victims	0.005	(0.007)						
Epidemic victims			-0.045	(0.082)	-0.003	(0.072)	-0.005	(0.059)
Drought victims			0.010	(0.012)	0.012	(0.011)	0.004	(0.009)
Conflict intensity	0.053	(0.036)	0.083	(0.069)	0.095	(0.063)	0.100*	(0.052)
Other donor's nutrient aid$_{t-1}$	0.436***	(0.058)	0.497***	(0.066)	0.480***	(0.061)	0.457***	(0.068)
Persistence (NA_{t-1})	0.440***	(0.050)	0.506***	(0.055)	0.456***	(0.054)	0.501***	(0.055)
Media coverage	1.161***	(0.186)	2.014***	(0.393)	1.946***	(0.352)	1.814***	(0.281)
UN affinity index	-0.194	(0.369)	-0.405	(0.707)	-0.154	(0.640)	-0.435	(0.519)
Oil reserves	-0.005	(0.015)	0.002	(0.030)	-0.001	(0.027)	-0.029	(0.023)
US Military assistance	-0.048**	(0.024)	-0.247*	(0.132)	-0.235*	(0.124)	-0.173	(0.119)
Distance	-0.094**	(0.045)	-0.097	(0.076)	-0.026	(0.071)	-0.071	(0.060)
Asia	0.093	(0.522)	0.347	(0.882)	-0.381	(0.826)	-0.714	(0.696)
Sub-Saharan Africa	0.220	(0.404)	-0.482	(0.669)	-0.669	(0.628)	-0.484	(0.514)
North Africa & Mideast	0.472	(0.455)	-0.331	(0.771)	-0.660	(0.732)	-0.448	(0.575)
Central & Eastern Europe	1.257**	(0.622)	2.118**	(1.063)	1.143	(1.010)	1.182	(0.821)
σ_u	0.517***	(0.073)	0.781***	(0.131)	0.769***	(0.120)	0.518***	(0.096)
σ_e	1.155***	(0.035)	2.117***	(0.068)	1.876***	(0.062)	1.498***	(0.052)
Obs. [countries]	2022 [136]		1932 [130]		1932 [130]		1932 [130]	
Log likelihood	-1397		-1686		-1522		-1231	
LR test: χ^2 [p-value]								
CRE vs. constant-only	602.4 [0.00]		579.6 [0.00]		541.9 [0.00]		548.8 [0.00]	
CRE vs. RE Tobit	74.42 [0.00]		77.5 [0.00]		81.32 [0.00]		85.08 [0.00]	
RE vs. pooled Tobit	88.26 [0.00]		53.93 [0.00]		68.13 [0.00]		63.10 [0.00]	

[a)] A food crisis perception threshold of $\kappa = 0$ was found for emergency food aid.

Notes: ***, ** and * denote significance at 1%, 5% and 10% level, respectively. Variables capturing the correlation with unobserved heterogeneity, year dummies and the constant are not reported but available from the authors on request.

At the bottom row of table 5.2, the RE Tobit model is tested against the commonly used pooled Tobit model by constraining the variance of the random effect to zero.[44] The LR statis-

[44] Because σ_u^2 is non-negative, the LR statistics is not the usual Chi² distribution, but a 50:50 mixture of a Chi² distribution with no degrees of freedom and a Chi² distribution with one degree of freedom (case 5 in Self and

tics for significance of σ_u^2 is significant at 1% level, which shows that the assumption of zero heterogeneity is too restrictive when analyzing the recipient country panel.

Emergency food aid is not responsive to the average supply of nutrients, since cereal availability as well as the relevance of animal products and non-starchy food in the recipients' diets does not significantly influence US nutrient deliveries. This finding is not surprising, given the fact that relief aid, which does not consider nutrient availability, is in many cases the only source of food. The results also reveal that nutrient shipments tend to decline when cereal food prices increase. This finding gives a cause for concern, since emergency food aid is typically targeted towards net-food buying households in acute crisis situations. The most probable explanation is the planning of annual food aid budgets in monetary terms, which compels donors to ship fewer food volumes in times of higher food prices (Barrett, 2001). In contrast to this adverse effect, the coefficients for GDP are positive and significantly different from zero for all nutrients. This indicates that US emergency food aid is progressively targeted towards poorer countries.

Regarding the response to vulnerable and crisis affected groups there are some differences between the nutrients. Food rich in energy and zinc appear to be sent to countries with high proportions of children and women, a finding that is consistent with the crucial role of energy supply for the vulnerable, and the necessity of zinc for strengthening children's immune system (Black et al., 2008; Webb et al., 2011). In contrast, food rich in vitamin A is sent in higher amounts to people affected by sudden disasters and conflicts. Given that a continuous supply of vitamin A is crucial for vulnerable groups, this could reflect aid planners' attempts to counteract sudden disruptions of food supply. The positive and significant relationship between humanitarian food aid and media coverage is in line with previous anecdotal evidence (e.g. Albala-Bertrand, 1993; Barrett and Maxwell, 2005). Given that the US food aid budget cannot be flexibly increased within a fiscal year, media attention is likely to drive aid agencies to reallocate food aid resources from countries attracting less media coverage. Emergency food aid is therefore at risk of underestimating crises that receive little media attention.

Donor interests do not appear to play a major role in the allocation of emergency food aid. Geographic proximity negatively influences energy deliveries at 5% level of significance, while iron, zinc and vitamin A are not affected by distance. These results possibly reflect increasing transportation costs to farther distances, since most food products rich in energy re-

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Liang 1987). This is taken into account in the calculation of the *p*-value.

quire significant freight hold while micronutrients are less correlated with food size. Contrary to expectations, military grants negatively affect relief aid. This is in line with findings of Neumayer (2005) for cereal food aid of the USA. An explanation might be that different aid instruments could substitute each other. Transition countries receive significantly more energy and iron than other regions, a finding that reflects the interest of the US to strengthen relationships with former communist states. The positive and highly significant coefficients of foreign nutrient deliveries suggest that there is considerable coordination among the USA and other donors of emergency food aid. This finding confirms the fact that food aid donors follow similar appeals from countries in need of aid and respond to similar country characteristics. There seems to be considerable persistence in emergency food aid, as lagged food aid flows are statistically significant at 1% level for all nutrients. This result can reflect either continuing responsiveness to chronic needs or inertia (Jayne et al., 2002). Since important nutrient needs are already controlled for in the regression, our data tend to confirm the latter. A probable explanation for administrative inertia at the country-level is that US food aid allocation is characterized by incremental budgetary adjustments (Diven, 2001).

Table 5.3 presents the results for US project food aid. As in table 2, the LR tests clearly show that the CRE specification performs significantly better than the RE and pooled Tobit specifications. Nutrient availability in recipients' diets seems to play no significant role in global project food aid. While zinc responds to the proportion of children in the population, demographic characteristics appear to be insignificant. Given that project aid includes food for work programs, which are not primarily designed for nutrient enhancement, statistical insignificance may stem from the fact that nutrient provision is one of multiple aims in developmental aid (WFP 2008). Another explanation is the monetization practice of NGOs that became significant in the sample period. Because monetized food aid is not targeted to vulnerable groups, nutrient rich food may not be required in global allocation of project food aid. In contrast to emergency food aid, there is no adverse effect of cereal price developments on project food aid flows. This indicates its relevance as an instrument for social safety nets. Project food aid is primarily targeted to rural regions, which reflects the response to needs for development projects in these areas.

The negative influence of man-made conflicts shows that stable political environments are important for the success of development projects. The only exception is vitamin A, which is also significantly targeted to victims of sudden and epidemic disasters. Again, this may indicate the importance of a continuous provision of vitamin A for children, and increased micro-

nutrient needs in refugee camps (UN, 1993; Black et al., 2008). There is a significant persistence in all investigated nutrients, which is not surprising, as food aid given for development projects is often planned on a multi-year basis (Jayne et al., 2002). Foreign food aid also appears to be positively and significantly correlated with US aid deliveries.

Table 5.3. Nutrient allocation of US Project food aid

	Energy		Iron		Zinc		Vitamin A	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Cereals per capita	-0.285	(0.962)						
Cereal production shock [a)]	-0.006	(0.004)						
Animal products in diet			-0.061	(0.055)	-0.072	(0.061)		
Dietary diversification							0.009	(0.020)
Cereal price index	-0.006	(0.007)	-0.009	(0.013)	-0.011	(0.014)	-0.010	(0.010)
GDP per capita	-0.104	(0.083)	-0.247	(0.150)	-0.096	(0.170)	-0.101	(0.106)
Urban population	-0.091***	(0.024)	-0.153***	(0.044)	-0.152***	(0.048)	-0.097***	(0.031)
Children, 0 to 14 years	0.056	(0.046)	0.086	(0.085)	0.188**	(0.092)		
Children, 0 to 4 years							0.055	(0.095)
Women, reprod. Age	0.109	(0.110)	0.182	(0.199)	0.224	(0.213)	0.148	(0.123)
Sudden disaster victims	0.003	(0.009)	0.016	(0.016)	-0.002	(0.018)	0.022**	(0.011)
Gradual disaster victims	-0.008	(0.007)						
Epidemic victims			0.098	(0.074)	-0.025	(0.078)	0.102**	(0.048)
Drought victims			-0.018	(0.013)	-0.015	(0.013)	0.001	(0.008)
Conflict intensity	-0.108***	(0.037)	-0.189***	(0.070)	-0.145*	(0.077)	-0.080	(0.050)
Other donor's nutrient aid$_{t-1}$	0.274***	(0.059)	0.205***	(0.059)	0.226***	(0.065)	0.124*	(0.067)
Persistence (NA_{t-1})	0.552***	(0.048)	0.621***	(0.047)	0.609***	(0.055)	0.585***	(0.052)
Media coverage	0.155	(0.246)	0.445	(0.484)	0.436	(0.525)	0.078	(0.346)
UN affinity index	0.248	(0.363)	0.870	(0.668)	0.068	(0.729)	0.395	(0.470)
Oil reserves	0.082***	(0.026)	0.155***	(0.048)	0.155***	(0.055)	0.084***	(0.031)
US Military assistance	0.067***	(0.022)	0.056	(0.065)	0.119	(0.080)	0.064	(0.050)
Distance	-0.019	(0.038)	-0.002	(0.056)	-0.010	(0.063)	-0.097**	(0.045)
Asia	-0.330	(0.469)	-0.315	(0.699)	-0.450	(0.788)	-0.281	(0.556)
Sub-Saharan Africa	-0.161	(0.371)	-0.845	(0.514)	-0.949	(0.590)	-0.510	(0.430)
North Africa & Mideast	0.077	(0.446)	-0.825	(0.657)	-0.786	(0.750)	-0.047	(0.519)
Central & Eastern Europe	0.570	(0.577)	1.027	(0.880)	1.016	(0.985)	0.428	(0.718)
σ_u	0.521***	(0.066)	0.636***	(0.111)	0.678***	(0.121)	0.542***	(0.081)
σ_e	1.101***	(0.032)	2.005***	(0.059)	2.092***	(0.067)	1.290***	(0.043)
Obs. [countries]	2022 [136]		1932 [130]		1932 [130]		1932 [130]	
Log likelihood	-1540		-1921		-1733		-1292	
LR test: χ^2 [p-value]								
CRE vs. constant-only	589.7 [0.00]		622 [0.00]		522.9 [0.00]		481.5 [0.00]	
CRE vs. RE Tobit	102.87 [0.00]		124.67 [0.00]		117.03 [0.00]		101.4 [0.00]	
RE vs. pooled Tobit	95.64 [0.00]		54.31 [0.00]		50.37 [0.00]		62.56 [0.00]	

[a)] A food crisis perception threshold of $\kappa = 0$ was found for project food aid.

Notes: ***, ** and * denote significance at 1%, 5% and 10% level, respectively. Variables capturing the correlation with unobserved heterogeneity, year dummies and the constant are not reported but available from the authors on request.

There seems to be significant donor bias in project aid. All investigated nutrients are delivered in significantly higher amounts to countries possessing oil reserves. This category's focus on investments in human capital and infrastructure possibly attract donors to use project food aid as a measure to support the development of an economic partner. Moreover, food rich in energy is directed towards countries of military interest. This global allocation pattern is quite interesting, given that projects are mostly carried out by NGOs and the WFP at the operational level.

Table 5.4 reports the nutrient allocation of program food aid. Again, the CRE Tobit models have a significantly higher explanatory power than RE and pooled Tobit models. Among the nutrient availability indicators, program food aid responds only to the dietary diversification index in the vitamin A equation. The effect has the expected sign, showing that the US sends more vitamin A when dietary diversity is lacking in local diets. Media attention does not influence program food aid, but there is significant persistence in aid flows. No coordination with other donors could be found. As program food aid is donated on bilateral basis, this finding is not surprising. There seems to be a significant regional aspect in program aid allocation. Sub-Saharan Africa and North Africa and the Mideast receive significantly less nutrients than other regions. This finding probably reflects the interest of the US in maintaining influence in emerging economies of Asia, Eastern Europe and Latin America. The positive and significant impact of a similar UN voting behavior suggests that US program food aid is directed towards countries with similar geopolitical views.

5.5.2 Robustness Checks

In this section, we examine the robustness of our econometric estimates. In the interest of brevity, we focus on energy allocation, although the results for the other nutrients are available upon request. Four alternative models are considered.

Model 1 is the conventional Mundlak (1978) specification, in which the unobserved effect is conditioned on the time average of the whole period. This model is designed for the static case and lacks the ability to appropriately model dynamic changes in a panel setting. On the other hand, only one mean variable per time-variant independent variable is added, so that the estimation becomes more efficient. Model 2 adds some flexibility by estimating equation (5.3) with $k = 5$ separate time averages. However, this comes at a cost, since the estimates are less efficient.

Table 5.4. Nutrient allocation of US Program food aid

	Energy		Iron		Zinc		Vitamin A	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Cereals per capita	1.339	(2.085)						
Cereal production shock [a)]	-0.008	(0.015)						
Animal products in diet			0.106	(0.107)	0.141	(0.116)		
Dietary diversification							-0.230**	(0.110)
Cereal price index	-0.030	(0.020)	-0.043	(0.033)	-0.037	(0.036)	-0.100*	(0.059)
GDP per capita	-0.017	(0.209)	-0.011	(0.349)	0.026	(0.375)	-0.060	(0.547)
Urban population	0.124*	(0.065)	0.167	(0.114)	0.134	(0.123)	0.408**	(0.186)
Children, 0 to 14 years	0.308**	(0.132)	0.485**	(0.224)	0.578**	(0.244)		
Children, 0 to 4 years							-0.116	(0.558)
Women, reprod. Age	0.870***	(0.276)	1.465***	(0.470)	1.555***	(0.500)	1.344*	(0.736)
Sudden disaster victims	-0.014	(0.023)	-0.028	(0.039)	-0.023	(0.042)	-0.118	(0.096)
Gradual disaster victims	-0.020	(0.019)						
Epidemic victims			-0.204	(0.568)	-0.200	(0.580)	-5.321	(8.292)
Drought victims			-0.035	(0.032)	-0.037	(0.034)	0.029	(0.049)
Conflict intensity	-0.093	(0.099)	-0.103	(0.171)	-0.117	(0.186)	-0.243	(0.279)
Other donor's nutrient aid$_{t-1}$	-0.082	(0.095)	-0.046	(0.106)	-0.017	(0.118)	0.075	(0.252)
Persistence (NA_{t-1})	0.758***	(0.080)	0.789***	(0.082)	0.783***	(0.088)	1.038***	(0.222)
Media coverage	-0.058	(0.896)	-0.009	(1.636)	0.245	(1.722)	2.155	(1.950)
UN affinity index	2.269**	(0.978)	3.736**	(1.680)	4.663**	(1.839)	4.769*	(2.523)
Oil reserves	-0.001	(0.061)	0.013	(0.100)	0.015	(0.106)	0.045	(0.117)
US Military assistance	0.184**	(0.083)	0.040	(0.279)	0.030	(0.293)	0.581	(0.445)
Distance	-0.017	(0.089)	0.104	(0.164)	0.088	(0.182)	0.835***	(0.296)
Asia	-1.360	(1.079)	-1.740	(2.075)	-1.864	(2.328)	-11.86***	(3.937)
Sub-Saharan Africa	-2.906***	(0.795)	-6.330***	(1.542)	-6.522***	(1.685)	-13.53***	(2.767)
North Africa & Mideast	-1.299	(0.870)	-3.195*	(1.635)	-3.563**	(1.817)	-6.454**	(2.902)
Central & Eastern Europe	0.392	(1.181)	0.651	(2.229)	-0.372	(2.444)	0.810	(3.413)
σ_u	0.683***	(0.202)	1.580***	(0.314)	1.752***	(0.340)	0.000	(0.568)
σ_e	2.222***	(0.100)	3.759***	(0.170)	3.964***	(0.187)	3.371***	(0.323)
Obs. [countries]	2022 [136]		1932 [130]		1932 [130]		1932 [130]	
Log likelihood	-1056		-1227		-1182		-312.7	
LR test: χ^2 [p-value]								
CRE vs. constant-only	532.9 [0.00]		481.9 [0.00]		441.5 [0.00]		264.3 [0.00]	
CRE vs. RE Tobit	124.27 [0.00]		97.22 [0.00]		95.22 [0.00]		83. 41 [0.00]	
RE vs. pooled Tobit	79.00 [0.00]		65.74 [0.00]		66.36 [0.00]		15.41 [0.00]	

[a)] A food crisis perception threshold of $\kappa = 0.4$ was found for program food aid.

Notes: ***, ** and * denote significance at 1%, 5% and 10% level, respectively. Variables capturing the correlation with unobserved heterogeneity, year dummies and the constant are not reported but available from the authors on request.

Model 3 changes the specification by replacing the year dummies with a linear time trend. Model 4 tests for the omission of freedom in recipient societies, and investigates whether the terror attacks in 2001 changed food aid patterns of the USA. For this, we included a freedom index, a dummy variable indicating the period 2002 onwards, and an interaction term between

freedom and the post 2001 dummy. The underlying hypothesis is that the USA might have chosen to promote freer societies after the war on terror had been proclaimed. Food aid may be an appropriate instrument for pursuing this aim, given that terrorist sentiments have been linked to food insecurity (Falcon and Naylor, 2005). Because the post 2001 dummy prohibits a meaningful use of year dummies, a trend variable is used to measure linear changes of aid flows over time.

Results of the robustness checks are presented in the appendix in tables 5.A1, 5.A2 and 5.A3. The results show that the inclusion of a trend variable considerably increases the significance of cereal prices for all food aid categories. As a linear trend is more restrictive in capturing time effects than year dummies, this hints at a model misspecification. Time measurement errors are likely to occur in the price index, as between country variation imposed by dietary weights is fixed over time. For other explanatory variables, it can be seen that significant estimates at 5% level are very robust to different estimation strategies. There has never been a change in the direction of significant need indicators. Results of model 4 show that the inclusion of freedom and the war on terror period does not add considerable information. For project aid, only the freedom index is positive and significant at the 10% level. As the interaction term is insignificant, this however indicates that freedom was accounted for just in the pre 2002 period. There is no evidence of variable omission bias. This finding suggests that the geopolitical goal of promoting democratic regimes has not been a major determinant in global food aid allocation. In summary, the robustness checks indicate that the core results of section 5.1 remain unaffected with respect to different approaches to model time and unobserved heterogeneity.

5.6 Conclusions

This article examined how food aid is employed to reduce malnutrition and attain specific nutritional targets at the operational level. We specifically use US food aid allocation data from 1993 to 2007 for the empirical analysis. A dynamic correlated random effects Tobit model is employed to analyze the determinants of the nutrient contents of allocated food aid. The nutrients considered in the study are energy, iron, vitamin A and zinc, which are all very important nutrients that are required for healthy human development.

Overall, the results from the study reveal four important findings. Firstly, US food aid has generally been allocated towards populations with high nutritional demand and tight budgetary constraints. Deliveries of vitamin A and zinc, which require action in a particularly critical

window of opportunity, are more responsive to disaster situations and demographic determinants. These results demonstrate that the US has pursued the goal of fighting malnutrition with food aid. Secondly, each food aid type has very different allocation patterns, which indicates that the US adjusts its various food aid tools to the nutritional needs of different situations. Comparisons of different food aid types needs to be handled cautiously, since they significantly differ in intra-national targeting. Thirdly, the allocation of nutrients is influenced by media attention and donor interests. Finally, the findings suggest that managerial problems in US food aid also affect the allocation of nutrients. There is a procyclical relationship between food prices and nutrients in emergency food aid, all nutrient aid flows face significant persistence, and temporary shocks are often neglected.

The finding that US food aid does not respond to crisis shocks reaffirms the widespread call for untying US food aid, particularly in relief situations. According to Barrett and Maxwell (2005), direct shipments of emergency food aid from the USA take nearly five months at the median to arrive at the recipient's harbor. Because diet-related health damages can only be prevented when malnutrition is timely treated, a quick and effective procurement of food resources from nearby surplus regions is generally preferable. Locally procured food aid can potentially be complemented by US sourced food aid in a longer term setting. In particular, the shipment of specialized, nutrient-dense products such as CSB++ or micronutrient powders can adjust for nutrient shortcomings in regional products.

Given fixed budgets, changes in aid composition towards costly high-quality food products reduce the overall quantity of food aid. Such a shift may be wrongly captured as donors' lack of response to needs, if aid is measured in cereal equivalents in food aid empirical analyses. The investigation of food aid allocation in terms of nutrient amounts is therefore a step towards a more need oriented analysis of global food aid flows, and serves to indicate how donors allocate food aid in terms of nutrient composition.

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Appendix of chapter 5

For the calculation of the cereal production shock variable, we employed a three step procedure. Firstly, we estimated per capita cereal production (*CP*) for each recipient country with a simple OLS trend model of the form $\ln(CP) = \vartheta_0 + \vartheta_1\ year + \zeta$ (Barrett, 2001).

Secondly, a variable for annual production shortfalls (*PS*) was computed as the gap between actual and predicted cereal production (in %, equating surpluses to zero). This is used to construct the perceived production shock variable $S = \mathrm{Max}\{0, PS - \kappa\,\mathrm{SD}[PS]\}$, where SD is a function that calculates the standard deviation of *PS*. The factor κ indices the threshold at which the donor perceives a production shortfall as a crisis for which food aid is a possible response.

In the final step, food aid has been estimated with a series of Tobit models as specified in equation 5.1. Variable *S* was included among the explanatory variables, using different values of κ in each of the Tobit regressions (ranging from 0 to 2 with steps of 0.1). According to Young and Abbott (2008), the Tobit model with the highest maximum likelihood value indicates that the optimal threshold has been found. Because of the considerable time consumed by RE Tobit estimations, we used pooled Tobit models for the threshold search.

Table 5.A1. Robustness checks: Energy allocation of US Emergency food aid

	(1)		(2)		(3)		(4)	
	Original Mundlak		3yrs averages		Linear trend		War on terror	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Cereals per capita	-1.193	(0.927)	-1.138	(0.924)	-1.120	(0.921)	-1.350	(0.923)
Cereal production shock [a)]	-0.005	(0.004)	-0.005	(0.004)	-0.004	(0.004)	-0.005	(0.004)
Cereal price index	-0.013*	(0.007)	-0.013*	(0.008)	-0.010***	(0.003)	-0.011***	(0.003)
GDP per capita	-0.199**	(0.080)	-0.254***	(0.086)	-0.229***	(0.083)	-0.217***	(0.083)
Urban population	0.040	(0.027)	0.050*	(0.027)	0.047*	(0.027)	0.047*	(0.027)
Children, 0 to 14 years	0.138***	(0.051)	0.110**	(0.053)	0.128**	(0.052)	0.123**	(0.051)
Women, reprod. Age	0.251*	(0.133)	0.170	(0.138)	0.211	(0.135)	0.167	(0.136)
Sudden disaster victims	0.009	(0.010)	0.010	(0.010)	0.008	(0.010)	0.008	(0.010)
Gradual disaster victims	0.005	(0.007)	0.006	(0.007)	0.004	(0.007)	0.006	(0.007)
Conflict intensity	0.054	(0.036)	0.055	(0.036)	0.050	(0.036)	0.042	(0.037)
Other donor's nutrient aid$_{t-1}$	0.446***	(0.058)	0.453***	(0.058)	0.443***	(0.058)	0.446***	(0.058)
Persistence (NA_{t-1})	0.445***	(0.050)	0.447***	(0.048)	0.440***	(0.050)	0.426***	(0.050)
Media coverage	1.168***	(0.187)	1.167***	(0.186)	1.171***	(0.186)	1.185***	(0.185)
UN affinity index	-0.182	(0.370)	-0.177	(0.369)	-0.533*	(0.320)	-0.410	(0.334)
Oil reserves	-0.003	(0.016)	-0.002	(0.016)	-0.006	(0.015)	-0.014	(0.016)
US Military assistance	-0.047**	(0.023)	-0.047**	(0.024)	-0.049**	(0.024)	-0.048**	(0.024)
Distance	-0.086*	(0.046)	-0.045	(0.034)	-0.094**	(0.045)	-0.077*	(0.046)
Asia	0.229	(0.493)	0.203	(0.494)	0.087	(0.519)	-0.188	(0.539)
Sub-Saharan Africa	0.284	(0.400)	-0.244	(0.341)	0.208	(0.402)	0.070	(0.425)
North Africa & Mideast	0.407	(0.465)	1.099**	(0.460)	0.460	(0.453)	0.225	(0.500)
Central & Eastern Europe	0.625	(0.608)	3.071***	(0.744)	1.248**	(0.619)	1.250*	(0.659)
Post 2001							0.146	(0.151)
Freedom Index							-0.040	(0.035)
Post 2001 x Freedom							-0.043	(0.028)
σ_u	0.662***	(0.081)	0.000	(0.169)	0.511***	(0.073)	0.498***	(0.072)
σ_e	1.158***	(0.035)	1.158***	(0.035)	1.164***	(0.035)	1.156***	(0.035)
Period averages conditioned on	1 á 15 years		5 á 3 years		3 á 5 years		3 á 5 years	
Time controls	Year dummies		Year dummies		Trend		Trend	
Obs. [countries]	2022 [136]		2022 [136]		2022 [136]		2022 [136]	
Log likelihood	-1416		-1341		-1402		-1395	
LR test: χ^2 [p-value]	564.0 [0.00]		713.9 [0.00]		592.3 [0.00]		607.3 [0.00]	
[a)] Crisis perception thresh. κ	0.0		0.0		0.0		0.0	

Notes: ***, ** and * denote significance at 1%, 5% and 10% level, respectively. Variables capturing the correlation with unobserved heterogeneity, time controls and the constant are not reported but available from the authors on request.

Table 5.A2. Robustness checks: Energy allocation of US Project food aid

	(1)		(2)		(3)		(4)	
	Original Mundlak		3yrs averages		Linear trend		War on terror	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Cereals per capita	-0.332	(0.960)	-0.437	(0.957)	-0.212	(0.968)	-0.317	(0.965)
Cereal production shock [a)]	-0.006	(0.004)	-0.006	(0.004)	-0.005	(0.004)	-0.005	(0.004)
Cereal price index	-0.006	(0.007)	-0.006	(0.007)	-0.013***	(0.002)	-0.014***	(0.002)
GDP per capita	-0.100	(0.079)	-0.134	(0.085)	-0.127	(0.084)	-0.106	(0.083)
Urban population	-0.094***	(0.024)	-0.090***	(0.024)	-0.092***	(0.024)	-0.097***	(0.024)
Children, 0 to 14 years	0.052	(0.046)	0.051	(0.047)	0.051	(0.047)	0.047	(0.047)
Women, reprod. Age	0.116	(0.110)	0.111	(0.112)	0.101	(0.111)	0.080	(0.114)
Sudden disaster victims	0.003	(0.009)	0.003	(0.009)	0.002	(0.009)	0.002	(0.009)
Gradual disaster victims	-0.008	(0.007)	-0.008	(0.007)	-0.007	(0.007)	-0.006	(0.007)
Conflict intensity	-0.108***	(0.037)	-0.110***	(0.038)	-0.110***	(0.038)	-0.094**	(0.039)
Other donor's nutrient aid$_{t-1}$	0.279***	(0.059)	0.274***	(0.058)	0.255***	(0.059)	0.246***	(0.059)
Persistence (NA_{t-1})	0.549***	(0.048)	0.576***	(0.049)	0.589***	(0.047)	0.573***	(0.048)
Media coverage	0.160	(0.239)	0.174	(0.249)	0.216	(0.250)	0.195	(0.252)
UN affinity index	0.239	(0.365)	0.272	(0.366)	-0.272	(0.309)	-0.187	(0.325)
Oil reserves	0.078***	(0.023)	0.069***	(0.023)	0.090***	(0.028)	0.081***	(0.026)
US Military assistance	0.061***	(0.020)	0.068***	(0.022)	0.068***	(0.023)	0.069***	(0.023)
Distance	-0.058	(0.039)	0.025	(0.029)	-0.019	(0.037)	-0.008	(0.039)
Asia	-0.341	(0.446)	-1.836***	(0.418)	-0.320	(0.456)	-0.205	(0.480)
Sub-Saharan Africa	0.059	(0.376)	-0.805**	(0.320)	-0.171	(0.361)	-0.260	(0.385)
North Africa & Mideast	0.157	(0.441)	-0.591	(0.425)	0.048	(0.434)	-0.135	(0.476)
Central & Eastern Europe	-0.052	(0.574)	0.421	(0.634)	0.516	(0.562)	0.749	(0.582)
Post 2001							0.125	(0.139)
Freedom Index							0.057*	(0.031)
Post 2001 x Freedom							-0.039	(0.025)
σ_u	0.667***	(0.073)	0.121	(0.093)	0.495***	(0.065)	0.479 ***	(0.065)
σ_e	1.100***	(0.032)	1.110***	(0.032)	1.127***	(0.032)	1.123 ***	(0.032)
Period averages conditioned on	1 á 15 years		5 á 3 years		3 á 5 years		3 á 5 years	
Time controls	Year dummies		Year dummies		Trend		Trend	
Obs. [countries]	2022 [136]		2022 [136]		2022 [136]		2022 [136]	
Log likelihood	-1560		-1481		-1562		-1556	
LR test: χ^2 [p-value]	549.4 [0.00]		708.2 [0.00]		545.4 [0.00]		558.3 [0.00]	
[a)] Crisis perception thresh. κ	0.0		0.0		0.0		0.0	

Notes: ***, ** and * denote significance at 1%, 5% and 10% level, respectively. Variables capturing the correlation with unobserved heterogeneity, time controls and the constant are not reported but available from the authors on request.

Table 5.A3. Robustness checks: Energy allocation of US Program food aid

	(1)		(2)		(3)		(4)	
	Original Mundlak		3yrs averages		Linear trend		War on terror	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Cereals per capita	0.903	(2.091)	1.054	(2.060)	1.363	(2.111)	1.285	(2.139)
Cereal production shock [a)]	-0.006	(0.015)	-0.009	(0.015)	-0.012	(0.015)	-0.012	(0.015)
Cereal price index	-0.030	(0.020)	-0.032	(0.020)	-0.025***	(0.007)	-0.027***	(0.007)
GDP per capita	0.115	(0.193)	-0.002	(0.205)	0.050	(0.208)	0.058	(0.207)
Urban population	0.114*	(0.066)	0.138**	(0.066)	0.158**	(0.065)	0.144**	(0.065)
Children, 0 to 14 years	0.344***	(0.131)	0.299**	(0.134)	0.306**	(0.135)	0.332**	(0.135)
Women, reprod. Age	0.901***	(0.278)	0.836***	(0.278)	0.830***	(0.280)	0.908***	(0.295)
Sudden disaster victims	-0.018	(0.024)	-0.018	(0.024)	-0.007	(0.023)	-0.006	(0.023)
Gradual disaster victims	-0.021	(0.019)	-0.017	(0.019)	-0.030	(0.020)	-0.028	(0.020)
Conflict intensity	-0.083	(0.099)	-0.085	(0.096)	-0.071	(0.101)	-0.050	(0.103)
Other donor's nutrient aid$_{t-1}$	0.004	(0.095)	0.006	(0.099)	-0.058	(0.096)	-0.078	(0.097)
Persistence (NA_{t-1})	0.756***	(0.079)	0.736***	(0.075)	0.738***	(0.080)	0.734***	(0.081)
Media coverage	-0.097	(0.807)	0.048	(0.886)	0.133	(0.883)	0.110	(0.893)
UN affinity index	2.273**	(0.987)	2.056**	(0.953)	0.676	(0.803)	1.032	(0.859)
Oil reserves	-0.030	(0.060)	0.009	(0.059)	-0.016	(0.062)	-0.003	(0.062)
US Military assistance	0.152**	(0.067)	0.191**	(0.082)	0.204**	(0.084)	0.200**	(0.084)
Distance	-0.091	(0.114)	0.194**	(0.097)	-0.006	(0.087)	0.008	(0.088)
Asia	-0.615	(1.244)	-4.115***	(1.285)	-1.419	(1.065)	-1.523	(1.100)
Sub-Saharan Africa	-2.478**	(1.025)	-5.036***	(0.983)	-2.965***	(0.786)	-3.197***	(0.788)
North Africa & Mideast	-0.728	(1.154)	-1.982*	(1.114)	-1.390	(0.860)	-1.863**	(0.910)
Central & Eastern Europe	0.957	(1.484)	-0.548	(1.752)	0.297	(1.169)	-0.310	(1.228)
Post 2001							0.548	(0.384)
Freedom Index							0.076	(0.086)
Post 2001 x Freedom							0.009	(0.071)
σ_u	1.626***	(0.228)	0.000	(0.162)	0.644***	(0.209)	0.588***	(0.227)
σ_e	2.223***	(0.100)	2.202***	(0.096)	2.295***	(0.104)	2.293***	(0.104)
Period averages conditioned on	1 á 15 years		5 á 3 years		3 á 5 years		3 á 5 years	
Time controls	Year dummies		Year dummies		Trend		Trend	
Obs. [countries]	2022 [136]		2022 [136]		2022 [136]		2022 [136]	
Log likelihood	-1098		-1023		-1074		-1072	
LR test: χ^2 [p-value]	449.3 [0.00]		599.9 [0.00]		496.5 [0.00]		502.0 [0.00]	
[a)] Crisis perception thresh. κ	0.4		0.4		0.4		0.4	

Notes: ***, ** and * denote significance at 1%, 5% and 10% level, respectively. Variables capturing the correlation with unobserved heterogeneity, time controls and the constant are not reported but available from the authors on request.

Chapter 6

Methodological Appendix

In the following section, details for econometric approaches of chapter 3 are provided, as the more sophisticated methods could not be completely described within the chapter due to space limitations. The approach in chapter 5 is thoroughly explained in the chapter itself.

6.1 Estimation of the determinants of export cropping

Given that a farm household k only cultivates export crops when the utility of participation (U_k^*) is positive, the actual decision for cultivating export crops is observed as a binary choice variable Ex, which can be explicitly related to farm characteristics (Z_{1k}) as follows:

$$U_k^* = Z_{1k}\alpha + \mu_k, \qquad Ex_k = 1\,[U_k^* > 0] \tag{6.1}$$

where μ_k is the error term. However, we are interested in the extent of export crop cultivation in the empirical analysis. If export intensity is defined as export revenue share and denoted as t_k, and Z_{2k} is a vector of household characteristics that influence export cropping intensity, export intensity can be related to these characteristics in the following way:

$$t_k = Z_{2k}\beta + \varepsilon_k, \qquad \varepsilon \sim N(0, \sigma) \tag{6.2}$$

where ε_k is the error term. The export revenue share t_k can only be observed for farms that have actually chosen to participate in export marketing, i.e. when $Ex_k = 1$. Since farms with specific advantages are more likely to participate in export markets, the sample of observed export farms may not be representative. Thus, simple regression of equation (6.2) yield biased results, as the error terms of equations (6.1) and (6.2) are correlated, i.e. $\rho = \text{corr}(\varepsilon, \mu) \neq 0$. In order to get unbiased estimates of extent equation (6.2) and identify factors of equation (6.1) such as entry barriers for export market participation, we employ a full information maximum likelihood (FIML) model. In this approach, a bivariate normal distribution of the error terms is assumed and the following log likelihood function maximized:

$$\ln L = \sum_{ex} w_k \ln \Phi \left[\frac{Z_{2k}\beta + (t_k - Z_{1k}\beta)\rho/\sigma}{\sqrt{1-\rho^2}} \right] - \frac{w_k}{2} \left(\frac{t_k - Z_{1k}\beta}{\sigma} \right)^2 - w_k \ln\left(\sqrt{2\pi\sigma}\right) + \sum_{d} w_k \ln \Phi(-Z_{1k}\alpha) \tag{6.3}$$

where w_k are sample weights employed to account for the GLSS 5 survey design, in which households in the northern parts of Ghana had a slightly higher probability of being interviewed. Stratification and clustering are taken into account computing first-order Taylor linearization variance estimators for the calculation of standard errors. A similar approach for modeling self selection would have been the two-step model proposed by Heckman (1976). In the two-step model, the participation equation (6.1) is first estimated by using a Probit model in order to derive the inverse Mills ratio. Heckman then shows that selectivity bias is corrected for by inserting the inverse Mills ratio into the extent equation (6.2) as an additional explainable variable. The decisive argument against the two-step approach is that GLSS 5 survey data is weighted and not independently distributed, so that the maximized likelihood in the first step cannot be interpreted as the probability distribution, and the inverse Mills ratio can therefore not be derived (Stata Press, 2007). Another advantage of FIML over the two-step model is that its results are usually more efficient (Puhani, 2000). As can be seen in equation (6.3) FIML corrects for selectivity without adding the inverse Mills ratio to the explainable variables Z_{1k}. To be consistent with most economic studies that employ the two-step method, the selectivity effect is summarized by calculating $\lambda = (\rho\sigma)$, which is equivalent to the coefficient of the inverse Mills ratio.

6.2 Estimation of the welfare impact of export cropping

For the analysis of welfare impacts, a major focus is on the impact of different intensity levels of export cropping. The discussion below describes the according proceeding in greater detail than it is done in chapter 3.

Similar to the dichotomous treatment case, selection bias might be inherent in an analysis of the welfare effect different intensity levels, as farms with dissimilar farm characteristics may select different levels of export crop intensity. Building on the original propensity score-matching approach, Imbens (2000) suggested a generalization for the multi-valued treatment case. In the following analysis, we follow Hirano and Imbens (2004), who further extended the propensity score approach to the continuous treatment case. For each export farm household k, we observe the vector of pre-treatment variables Z_k, the actual level of treatment re-

ceived T_k, and the outcome variable associated with this treatment level $Y_k = Y_k(T_k)$. Of interest is the average dose-response function (DRF), which relates to each possible treatment level t_k the potential outcome $Y_k(t)$ of farm household k:

$$\theta(t) = E[Y_k(t)] \quad \forall \ t \in \mathcal{T} \text{ where } \mathcal{T} = (0, \dots, 1] \tag{6.4}$$

Where $\theta(t)$ indicates the DRF at a given treatment level *t*, and *t* is in our case the export cropping revenue share. As suggested by Hirano and Imbens (2004), we presume that the assignment to the treatment is weakly unconfounded given pre-treatment variables, i.e.

$$Y_k(t) \perp T_k | Z_k \quad \forall \ t \in \mathcal{T} \tag{6.5}$$

Thus, the treatment assignment process is supposed to be conditional independent of each potential outcome given the pre-treatment variables. However, it becomes increasingly difficult to simultaneously adjust for all covariates when the number of covariates in Z_k rise. Due to this reason, Hirano and Imbens (2004) suggest estimating the generalized propensity score (GPS), which is defined as the conditional density of the actual treatment given the observed covariates. Formally, let $r(t, z) = f_{T|Z}(t|z)$ be the conditional density of the treatment given the covariates. Then the GPS of a household k is given as

$$R_k = r(T_k, Z_k) \tag{6.6}$$

The GPS is a balancing score, i.e. within strata with the same value of $r(t, Z)$, the probability that $T = t$ does not depend on the covariates Z. Hirano and Imbens (2004) show that in combination with the weak unconfoundedness assumption, the balancing property of the GPS implies

$$f_T(t|r(t, Z_k), Y_k) = f_T\big(t\big|r(t, Z_k)\big) \quad \forall \ t \in \mathcal{T} \tag{6.7}$$

Thus, the GPS is suitable for eliminating any biases associated with differences in the covariates. In order to estimate an unbiased DRF, the conditional expectation of the outcome has first to be calculated as

$$\gamma(t, r) = E[Y_k | T_k = t, R_k = r] \tag{6.8}$$

Then, when this conditional expectation is averaged over the GPS at a particular level of the treatment, the DRF in equation (6.4) can be estimated at that particular level of the treatment:

$$\theta(t) = E\left[\gamma\left(t, r(t, Z_k)\right)\right] \tag{6.9}$$

In order to derive the average potential outcome at given levels of *t*, the GPS has to be estimated for each specified treatment level. In our application, we evaluated the DRF at 99 different levels of the export revenue share.

The GPS is estimated using a normal distribution of the logarithmic treatment given covariates Z:[45]

$$\ln T_k \,|Z_k \sim N(\vartheta_0 + \vartheta_1{}' Z_k, \sigma^2) \tag{6.10}$$

Estimates for ϑ_0, ϑ_1 and σ^2 have been calculated by maximum likelihood. The GPS can also be estimated using other techniques and assuming other types of distribution; however, as Kluve et al. (2007) point out, as far as the GPS is able to balance the covariates, the exact estimation of the GPS is of secondary importance.

The balancing property of the estimated GPS is tested by employing the method proposed by Hirano and Imbens (2004). They suggest subdividing the range of potential treatments into treatment classes and evaluating the GPS at a representative point (in our case the median). The GPS values are also segmented into blocks, which are defined by their quintiles. Within this framework, testing the balancing property of the GPS is possible, since farm households lying in different treatment intervals but in the same GPS block should be comparable, as if they had been randomly assigned to the treatment. This balancing test consists of t-tests that block-wise test whether the covariates in Z_k are significantly different between observations within a treatment interval and observations outside this treatment interval.

Another key element of the propensity score approaches is the common support condition, i.e. households in one treatment group have to find comparable households in other treatment groups. While in the binary treatment case, a lack of overlap in the comparison group can be detected by gauging the distributions of both treated and untreated groups, the proceeding in the continuous treatment case is not straightforward as in the binary case, because there are an infinite number of treatment levels, i.e. treatment groups, to compare (Flores et al., 2009). We impose the common support condition by employing the method suggested by Kluve et al. (2007) and Flores et al. (2009). The range of treatment is subdivided into four equally wide

[45] Because the distribution of the export revenue share was highly skewed, we again followed Hirano and Imbens (2004) and took the logarithm of the treatment variable. This proceeding lead to very low skewness (-0.0002) and kurtosis (1.8515) values and yielded a positive Kolmogorov-Smirnov test for normality at the 5% significance level.

treatment classes, and the class an individual belongs to is denoted as $C_k = \{1,2,3,4\}$. For each interval c, the GPS is computed at the interval's median ($\hat{R}_k^c = r(t^c, Z_k)$) for all individuals, i.e. those within the interval ($C_k = c$) and those outside the interval ($C_k \neq c$). Common support for each quintile c is then derived by comparing the support of the $\hat{R}_k^c$ distribution for those individuals with $C_k = c$ to those individuals with $C_k \neq c$. Formally, we define the subsample S_c of individuals within the common support of treatment class c as:

$$S_c = \left\{k: \hat{R}_k^c \in \left[\max\left\{\min_{k:C_k=c} \hat{R}_k^c, \min_{k:C_k\neq c} \hat{R}_k^c\right\}, \min\left\{\max_{k:C_k=c} \hat{R}_k^c, \max_{k:C_k\neq c} \hat{R}_k^c\right\}\right]\right\} \quad (6.11)$$

Thus, for each subsample S_c, those farm households are kept that are in the overlapping regions of the distributions. Then, only those individuals are kept for the final analysis, which are included in the common support area of all subsamples:

$$S = \bigcup_{c=1}^{5} S_c \quad (6.12)$$

In order to impose common support, we modified the program code of the user-written Stata command `doseresponse' (by Bia and Mattei, 2008), as this feature was not originally implemented. After the GPS has been estimated and common support is employed, the conditional expectation of the outcome (equation 6.8) is estimated for each farm households at different intensity levels by using a flexible polynomial function of its arguments (Bia and Mattei, 2008; Hirano and Imbens, 2004). In particular, the conditional expectation $\gamma(t, r)$ is approximated using the following cubic specification with interaction term:

$$\mathrm{E}[Y_k|T_k, R_k] = \eta + \eta_1 T_k + \eta_2 {T_k}^2 + \eta_3 {T_k}^3 + \eta_4 R_k + \eta_5 {R_k}^2 + \eta_6 {R_k}^3 + \eta_7 R_k T_k \quad (6.13)$$

Equation (6.13) is estimated using OLS regression for continuous welfare outcomes, and Logit for the dichotomous poverty status.[46] Then, the average potential outcome of any treatment level can be calculated by averaging over the estimated conditional expectation of the outcome for all farms at the given treatment level:

[46] Due to the log-transformation of the treatment variable in the estimation of the GPS, equation (6.13) does not directly predict the conditional expectation. The performed retransformations needed for the estimation of the average potential outcomes are, for the sake of simplicity, not illustrated.

$$\widehat{\mathrm{E}[Y(t)]} = \frac{1}{N}\sum_{k=1}^{N} \hat{\gamma}\left(t, \hat{r}(t, Z_k)\right) \tag{6.14}$$

The average potential outcomes of 99 evenly distributed intensity levels are calculated and illustrated by means of the DRF. The bootstrapping procedure with 100 replications has been employed to estimate 95% confidence bounds.

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Chapter 7

General Conclusions

This study examines policy measures that aim to reduce the exposure to food insecurity and increase welfare in developing countries. There are large differences in the approaches to improve food security, which is due to the fact that very different factors contribute to the food security status of individuals. Chapter 2 provides an overview of the range of domestic food security measures in developing countries. The remaining chapters focus on cross-border transactions of agricultural goods. These are of particular importance, as covariate shocks may leave whole regions prone to food insecurity and render local safety nets inoperative. The cultivation of export crops allows farmers to benefit from large and profitable foreign markets and to reduce the dependence from domestic demand. On the other hand, international food aid shipments can fill the gap between local supply and demand in times when local production and storage facilities as well as commercial imports cannot provide enough food to prevent malnutrition and hunger. Each chapter of this study contributes to the understanding of the implementation and impact of important policy instruments. The key results are summarized in the following subsections.

7.1 Food Security Policy – Developing Countries

In this chapter, an economic model is developed that provides a framework to classify how various domestic policy measures affect food security. As an individual's health status depends on the dietary composition of the consumed food, the model refines previous approaches by explicitly incorporating the demand for nutrients. Based on this model, the different strategies to improve food security are derived. In food market policies, many governments have made a shift to more liberalized market approaches, as expensive state interventions and trade regulation have in most cases failed their aim of effectively improving food security. Evidence from different countries suggests that liberalization is able to reduce the number of food insecure people, but only if market participants can adequately adjust to the withdrawal of state enterprises and subsidies. Public investments for infrastructure and agricultural R & D

have found to be vital in order to improve welfare and food security. Given the limited budgets of developing countries, a strengthening of international linkages in food security strategies between countries, international research facilities, and private and multilateral organizations seems to be a promising way to promote global food security.

7.2 Determinants and Welfare Impacts of Export Crop Cultivation

The study on export crop cultivation in Ghana investigates to what extent farmers benefit from export crop cultivation, and analyzes the driving forces and entry barriers of export crop cultivation. All analyses of this chapter account for probable self-selection of farmers into the group of export crop cultivators. By estimating the dose response functions of several welfare indicators, the study treats export crop cultivation as a continuous variable and therefore allows for changes in the welfare impact at different intensity levels of export cropping.

The findings suggest that there is a positive effect of export cropping on the farmer's welfare. Thus, the benefits of export market participation reach the farmers even when they do not directly enter the export markets. However, the positive impact is only of modest degree for farmers who produce at low to medium levels of export crop intensity. In contrast, farmers gain most from export cropping when they fully specialize in the crops. The effect on poverty measures is quite ambiguous, which indicates that the promotion of export crop cultivation may be of less usage as an antipoverty strategy. The analysis of determinants of export crop cultivation confirms the view that intermediates are of major importance for export crop producers. The significance of state engagement in input and output markets shows that state enterprise activity indeed increases farmers' engagement in export crop cultivation. Given the fact that access to financial resources seems to be of major importance, the insignificance of institutional lenders (which include government agencies) suggests that strengthening the formal credit market may be an important task in order to facilitate export crop cultivation.

7.3 Food Aid Allocation Policies: Coordination and Responsiveness to Recipient Country Needs

Food aid can be crucial to prevent hunger and starvation in crisis situations when local food suppliers are not able to provide enough food to meet the nutritional requirements of the people. Given that wrongly targeted food aid has severe negative impacts on the recipient's economy, this study investigates whether donors allocate their aid shipments according to the needs of recipient countries. First, global food aid allocation has been analyzed by employing

a semiparametric method, which is less restrictive in its assumptions on the error distribution than the commonly employed Tobit model. Then, the five largest donor countries have been studied, using a multivariate Tobit model that takes donor interaction into account. The results of this chapter show that all donors generally target their food aid towards poorer countries. This indicates that food access of the populations seems to be considered in global food aid allocation. Regarding other need indicators, the aid response of the different donors is quite uneven. The system estimation approach proposed in this study yields first evidence of donor coordination. The positive correlation between all investigated donors seem to reflect the significance of the WFP and NGOs in channeling food aid to needy countries, and the joint response to aid appeals. However, the significant persistence in all food aid flows indicates that there is significant administrative momentum in food aid planning.

7.4 Food Aid and Malnutrition in Developing Countries: Evidence from U.S. Food Aid Allocation

Suffering due to nutrient deficiencies is widespread among the developing world. This chapter therefore analyzes the response of US food aid to the recipients' nutritional needs by investigating the amounts of dietary energy, iron, zinc and vitamin A allocated to recipient countries. This is in contrast to previous studies that analyze cereal equivalent tons and therefore can only roughly estimate the response to specific nutrient deficiencies. Given that each food aid type has its own aims and distribution channels, the nutrient shipments in emergency, project and program food aid were separately analyzed.

This analysis refines previous empirical studies on food aid allocation by taking into account the unobserved heterogeneity across recipient countries. The results show that all nutrients in emergency food aid are targeted towards poorer countries. Furthermore, nutrients are sent towards populations with increased nutrient demand, but often do not respond to disasters. An interesting finding is that emergency, project and program food aid of the US have quite distinctive aid patterns, and seem to be adjusted to specific need situations. While the shift in US food aid from program to emergency food aid during the investigated period indicates a greater need orientation, the significant media bias in emergency food aid may be a matter of concern. Furthermore all analyzed nutrients face significant persistence and seem to be inadequately targeted towards transitory crises. This finding suggests that a shift to locally and regionally procured food aid may be needed in order to improve timeliness of US food aid deliveries.

Chapter 8

Zusammenfassung

Die Untersuchung der Funktionsweise staatlicher Programme zur Förderung der Ernährungssicherheit und Armutsreduktion ist vor dem Hintergrund gestiegener Preisvolatilität bei Nahrungsmitteln nach wie vor von großer Bedeutung. Die ökonomische Relevanz besteht dabei nicht allein in der akuten Wohlfahrtsminderung, sondern insbesondere auch in der Belastung ganzer Regionen durch ernährungsbedingte dauerhafte Gesundheitsschäden. Ziel dieser Dissertation ist es deshalb, Politikmaßnahmen zu untersuchen, welche die Ernährungssicherheit fördern sollen. Hierzu werden sowohl nationale Strategien beleuchtet als auch internationale Hilfsmaßnahmen. Vor dem Hintergrund, dass zumeist ganze Regionen von Nahrungsangebotsschocks betroffen sind, wenig entwickelte Gebiete aber nur geringe Finanzmittel haben und über beschränkte Lagerhaltungsmöglichkeiten verfügen, wird ein besonderes Augenmerk auf Politiken gelegt, welche den überregionalen Warenstrom betreffen. Hierbei werden insbesondere die Wohlfahrtseffekte von Exportpolitiken sowie die Verteilung von Nahrungsmittelhilfe beleuchtet. Die Beiträge der Dissertation werden im Folgenden genauer vorgestellt.

8.1 Ernährungssicherheitspolitik in Entwicklungsländern

In diesem Beitrag werden Politiken untersucht, welche Entwicklungsländer zur Verbesserung der Ernährungssicherheit ihrer Bevölkerung anwenden. Um der Komplexität des Konzeptes der Ernährungssicherheit gerecht zu werden, wird hierbei ein mikroökonomisches Ernährungssicherheitsmodell entworfen, anhand dessen die Wirkungsweisen verschiedener Politikmaßnahmen gezeigt werden können. Das Modell basiert auf einer Version des Becker-Modells (1965), welches von Barrett (2002) für den Kontext der Ernährungssicherheit angepasst wurde. Dieser Beitrag erweitert das Barrett-Modell, indem es die physiologischen Bedürfnisse des Menschen nach Nährstoffen abbildet. Hierfür werden Nährstoffe, wie von Lancaster (1971) vorgeschlagen, als Produktcharakteristika modelliert. Konkret geht das Modell von Individuen aus, welche ihren Nutzen maximieren unter einer gegebenen Budgetrestriktion, wobei der Nutzen aus den Charakteristika der konsumierten Produkte sowie dem eigenen

Gesundheitszustand gewonnen wird. Produkteigenschaften können hierbei entweder direkt Nutzen stiften oder indirekt, über die Wirkung von Nährstoffen (oder Schadstoffen) auf den Gesundheitszustand des Individuums.

Nährstoffbedingte Gesundheitsschäden treten demnach dann auf, wenn Individuen Güterbündel wählen, welche nicht genügend Nährstoffe bereithalten für die Mindestanforderungen des menschlichen Organismus. Gründe hierfür sind entweder mangelnde Kenntnis über eine gesunde Ernährung oder unzureichende finanzielle Mittel. Da Ernährungssicherheit als *ex ante* Konzept definiert ist, wird sie im Rahmen dieses Modells als das vom Individuum eingeschätzte Risiko erfasst, ernährungsbedingte Gesundheitsschäden zu bekommen. Dabei werden, wie im Modell von Barrett (2002), drei Stufen von Gesundheitsschäden unterschieden: temporäre Gesundheitseinschränkungen, dauerhafte Gesundheitsschäden und schließlich der Tod. Diese Unterscheidung ist notwendig, da irreparable Schäden erhebliche Konsequenzen auf die zukünftige Wohlfahrt sowie auf die Bildung von Humankapital haben, und damit auch Verhaltensänderungen hervorrufen können.

Die genaue Modellierung der Auswirkungen von Nahrungsbestandteilen auf spezielle Gesundheitsbereiche ermöglicht es, weitere Erkenntnisse über die Lebensmittelwahl von Haushalten zu bekommen, die ernährungsunsicher sind. Zum einen wird die Entscheidung über Lebensmittel auch zu einem Trade-Off über das nährstoffbedingte Funktionieren bestimmter Körperfunktionen, sofern ein Mensch sich nur Nahrungsbündel leisten kann, welche Mängel in unterschiedlichen Nährstoffen haben. Zum anderen wird ersichtlich, dass Menschen Mangelernährung bewusst zulassen können, entweder um die Nahrungsmittelversorgung anderer Familienmitglieder zu verbessern oder um direkten Nutzen aus Produktcharakteristika zu beziehen, welche nichts mit der Nährstoffzufuhr zu tun haben.

Die Tatsache, dass Ernährungskrisen oftmals regional fokussiert auftreten und irreparable Gesundheitsschäden somit die Wirtschaftsentwicklung ganzer Regionen hemmen können, stellt eine wesentliche Begründung von Ernährungssicherheitspolitiken dar. Das Ernährungssicherheitsmodell ermöglicht die Kategorisierung der unterschiedlichen Nahrungsmittelsicherheitspolitiken, welche die Regierungen in Entwicklungsländern verfolgen.

Basierend auf dieser formalen Grundlage folgt in den anschließenden Abschnitten des Beitrags ein Überblick über die häufig angewendeten nationalen Ernährungssicherheitspolitiken in Entwicklungsländern. Weil Lebensmittel einen erheblichen Anteil an den Ausgaben von armen Haushalten haben, nutzen Entwicklungsländer verschiedene Maßnahmen um den fi-

nanziellen Nahrungsmittel- und Nährstoffzugang zu verbessern. Direkt den Nahrungsmittelmarkt betreffende Politiken beinhalten (De)Regulierungspolitiken, staatliches Engagement bei Lebensmittelhandel und –lagerung, öffentliche Sicherheitsnetze welche den Nahrungsmittelzugang zu verbessern versuchen und Maßnahmen um die Nährstoffaufnahme von gekauften Nahrungsmitteln zu erhöhen, wie etwa Nahrungsmittelanreicherung oder Ernährungsbildungsprogramme. Obwohl diesbezüglich eine Tendenz weg von direkten staatlichen Interventionen hin zu Agrarmarktliberalisierung auszumachen ist, wurden in der Zeit hoher Nahrungsmittelpreise 2007/8 erneut diverse Handelsbeschränkungen bei Nahrungsmitteln eingeführt.

Gegenüber diesen direkten Nahrungsmittelpolitiken sind noch indirekte Politiken auszumachen, welche versuchen, das ökonomische Umfeld in unterentwickelten Regionen zu verbessern. Das Ziel solcher Maßnahmen ist es, die Agrarproduktivität zu verbessern, die Kaufkraft zu erhöhen sowie die Auswirkung von Gesundheitsschocks zu verringern. Diese Strategie umfasst öffentliche Investitionen in Infrastruktur und landwirtschaftliche Forschung und Entwicklung, die Förderung des Finanzsektors und die Bereitstellung von Gesundheitsdienstleistungen. Untersuchungen zur Fiskalpolitik von Entwicklungsländern verdeutlichen, dass öffentliche Ausgaben zugunsten von Forschung und Entwicklung im Agrarbereich und von Infrastrukturmaßnahmen die höchsten Erträge in Bezug auf Armutsreduktion erwirken (Fan et al., 2008). Im Maßnahmenüberblick dieses Beitrags wird jede der oben genannten Politiken kurz diskutiert, und wo entsprechende Belege verfügbar sind, wird über die Wirkungsweise und Effizienz der Maßnahmen berichtet.

8.2 Bestimmungsfaktoren und Wohlfahrtseffekte von Exportfruchtanbau – Empirische Ergebnisse aus Ghana

Als Folge hoher Staatsdefizite sind seit den 1980er Jahren viele Entwicklungsländer von teuren Importsubstitutionspolitiken zu Förderpolitiken von Exportprodukten aus dem Primärsektor übergegangen. Der Internationale Währungsfonds und die Weltbank haben diesen Schritt unterstützt mit der vorrangigen Begründung des komparativen Vorteils, den Entwicklungsländer bei diesen Produkten haben. Bezüglich einzelner Wirtschaftssubjekte geht die Wirtschaftstheorie davon aus, dass Unternehmen, die am Exportmarkt teilnehmen, ihre Produktivität steigern können (Grossman und Helpman, 1991). Dies geschieht zum Beispiel dadurch, dass sie von bewährten Verfahren auf internationalen Märkten lernen, technische Unterstützung von Käufern erhalten oder von Größenvorteilen bei der Produktion für große Export-

märkte profitieren. Auf der anderen Seite sind Unternehmen auf dem Exportmarkt einem starken Konkurrenzkampf ausgesetzt, dessen Entwicklung wahrscheinlich schwieriger vorhersehbar ist als die des einheimischen Marktes. Entwicklungsländer, die sich nur auf wenige Exportgüter konzentrieren, sind zudem besonders gefährdet vor externen Schocks (Sheperd, 2010). Auch wenn die meisten Landwirte nicht direkt an ausländischen Märkten teilnehmen, werden deren positive (und negative) Auswirkungen wahrscheinlich entlang der Wertschöpfungskette bis zu den Exportfruchtanbauern weitergegeben.

Dieser Beitrag untersucht die Determinanten und Wohlfahrtseffekte von Exportfruchtanbau in Ghana, und leistet damit einen wesentlichen Beitrag zu der bisherigen nur spärlichen empirischen Literatur über die Determinanten und Wohlfahrtseffekte von Exportfruchtanbau. Um neue Erkenntnisse zu gewinnen, wurden zudem ökonometrische Verfahren angewendet, die in diesem Kontext bisher nicht genutzt wurden. Ghana ist hierbei von besonderem Interesse aufgrund seines großen landwirtschaftlichen Sektors sowie seiner internationalen Vorreiterrolle bei Exportwachstumsstrategien. Anbauer von Exportfrüchten werden durch die ghanaische Regierung auf unterschiedliche Weise unterstützt. Dies geschieht z. B. durch staatliche Zwischenhändler und strenge Qualitätskontrollen im Kakaosektor, Investitionen in Forschung und Entwicklung oder die Stärkung von genossenschaftlichen Bewegungen.

Die analysierten Daten stammen aus dem *Ghanaian Living Standard Survey* 5 und sind landesweit repräsentativ für die Jahre 2005 und 2006. Um verzerrte Ergebnisse durch eine mögliche Selbstselektion von Landwirten in den Exportfruchtanbau zu vermeiden, wird bei der Untersuchung der Determinanten des Exportfruchtanbaus die *Full Information Maximum Likelihood* Methode angewendet. Diese Analyse zeigt sowohl die wesentlichen Hürden als auch die treibenden Kräfte des Exportfruchtanbaus auf und hilft daher, erfolgsversprechende Wege für die Umsetzung von exportorientierten Politiken aufzuzeigen. Die Ergebnisse deuten darauf hin, dass das Engagement in den Exportfruchtanbau wesentlich durch den Zugang zu Land und finanzielle Mittel beeinflusst wird. Die hohe Bedeutung von Zwischenhändlern (Staat und Kooperativen) zeigt zudem, dass Politiken, welche die Vermittlung auf Produkt- und Faktormärkten stärken, ein vielversprechender Weg sind, um den Exportfruchtanbau zu fördern.

Die Auswirkungen von Exportfruchtanbau auf die Wohlfahrt der Farmhaushalte werden mithilfe von Verfahren untersucht, welche die Selbstselektion der Landwirte berücksichtigen. Die von Rosenbaum und Rubin (1983) vorgeschlagene *Propensity Score Matching* (PSM) Methode wird genutzt, um die Wohlfahrt von Exportfruchtanbauern mit der Wohlfahrt von

Landwirten zu vergleichen, welche ausschließlich für den einheimischen Markt produzieren. Aufgrund der Tatsache, dass Landwirte in sehr unterschiedlichem Umfang Exportfrüchte anbauen, wird mit dem *Generalized Propensity Score* (GPS) Ansatz ein weiteres Verfahren genutzt, welches die Auswirkungen unterschiedlicher Spezialisierungsgrade verdeutlicht (Hirano und Imbens, 2004). Der GPS ist dabei in der Lage, Unterschiede in den Farmcharakteristika bei unterschiedlichen Spezialisierungsgraden auszugleichen, sodass unverfälschte Wohlfahrtsvergleiche zwischen verschiedenen Intensitäten des Exportfruchtanbaus möglich sind.

Der PSM-Ansatz zeigt, dass die Wohlfahrt der Landwirte signifikant ansteigt, wenn sie Exportfruchtanbau betreiben. Die signifikante, aber mäßige Auswirkung auf Armut und pro-Kopf-Ausgaben könnte von der Tatsache stammen, dass die Beziehung zwischen Export-Frucht-Anbau-Intensität und Wohlfahrtserfolg nicht linear ist. Ein solcher Zusammenhang wird von der *Dose Response Function* bei jedem Wohlfahrtsindikator nachgewiesen. Generell zeigt sich, dass es nur kleine Wohlfahrtsveränderungen bei niedrigen bis mittleren Exportfruchtanbau-Intensitäten gibt, aber einen steilen Anstieg bei den höchsten Spezialisierungsgraden. Beispielsweise kann eine Landwirtin, die sehr geringe Mengen an Exportfrüchten anbaut, die pro Kopf Ausgaben ihres Haushalts im Durchschnitt nahezu verdoppeln, indem sie sich vollkommen auf Exportfruchtanbau spezialisiert. Die Auswirkungen auf die Armut sind ebenfalls nichtlinear, aber weniger deutlich. Tests zeigten, dass die genutzten *Propensity Scores* in der Lage sind, Unterschiede in den beobachtbaren Farmcharakteristika auszugleichen.

8.3 Allokationspolitiken der Nahrungsmittelhilfe: Koordination und Reaktion auf die Bedürfnisse der Empfängerländer

Nahrungsmittelhilfe ist seit langem eine kontroverse Maßnahme, um die Lücke zwischen verfügbaren Nahrungsmitteln und Nahrungsmittelkonsum zu schließen. Trotz allgemeiner Bedenken zur Wirksamkeit von Nahrungsmittelhilfe, sind kritische Situationen denkbar, in denen die lokalen Märkte und Sicherheitsnetze nicht in der Lage sind, ausreichend Nahrungsmittel bereitzustellen. In solch schwerwiegenden Fällen ist Nahrungsmittelhilfe die einzige Möglichkeit, um Mangelernährung zu verhindern (Barrett und Maxwell, 2005). Aufgrund der gravierenden Konsequenzen von fehlgeleiteter Nahrungsmittelhilfe ist eine zeitnahe und zielgruppenorientierte Verteilung der Hilfslieferungen von großer Bedeutung. Neben der zielgeleiteten Verteilungspolitik einzelner Geberländer bedarf es im Sinne einer effektiven Reaktion

auf die Bedürfnisse der Empfängerländer aber auch der Koordination der Hilfsgüter verschiedener Herkunft. Während die Bestimmungsfaktoren der Verteilung von Nahrungsmittelhilfe schon von vielen Studien untersucht wurde (z. B. Gabbert und Weikard, 2000; Jayne et al., 2001; Barrett und Heisey, 2002; Neumayer, 2005), liegen bisher keine empirischen Befunde über die Interaktionen zwischen Nahrungsmittellieferungen unterschiedlicher Geber vor. Dies steht im Gegensatz zu den beachtlichen Aufwendungen von World Food Programme (WFP) und internationalen Nichtregierungsorganisationen (NGOs), welche die Nahrungsmittelhilfe verschiedenster Geber vor Ort regeln.

Dieser Beitrag schließt diese Lücke in der empirischen Literatur, und entwickelt Methoden der vorhergehenden Studien weiter. Konkret wurden die Determinanten der Nahrungsmittelhilfe für die sechs größten Geberländer in der Zeit von 1972 bis 2004 mithilfe eines multivariaten Tobit Modells geschätzt. Die methodische Neuerung, Nahrungsmittelhilfeströme unterschiedlicher Geber simultan zu schätzen, erlaubt erstmals, dass die Nahrungsmittelhilfe-Allokationen der verschiedenen Geber miteinander korreliert sein können. Anhand der Korrelationskoeffizienten kann gezeigt werden, ob und auf welche Weise die Nahrungsmittelhilfe der Geberländer interagiert. Darüber hinaus werden die Determinanten der weltweit aggregierten Nahrungsmittelhilfe geschätzt, um die gemeinsame Reaktion der Geber auf die Bedürfnisse der Empfängerländer abzubilden. Hierfür wird, im Gegensatz zu allen vorigen Studien, ein semiparametrisches *Censored Least Absolute Deviation* (CLAD) Modell geschätzt. Es ist im Vergleich zu den oft angewendeten Tobit Modellen ökonometrisch flexibler, da er Schätzergebnisse liefert, die auch bei Heteroskedaszidität und nicht-normalverteilten Fehlertermen robust sind (Powell, 1984).

Wie von Barrett und Heisey (2002) vorgeschlagen, wird die örtliche Nahrungsmittelherstellung als Approximation der Nahrungsmittelverfügbarkeit genutzt. Außerdem wird zwischen der Reaktion auf die Höhe der Nahrungsmittelproduktion (*Progressionseffekt*) und der Reaktionen auf Einbrüche in der Nahrungsmittelproduktion *(Stabilisierungseffekt*) unterschieden. Es scheint wahrscheinlich, dass Geber erst ab einem gewissen Ausmaß an Nahrungsmittelknappheit anfangen, Nahrungsmittelhilfe zu senden. Daher wird der Stabilisierungseffekt von Nahrungsmittelhilfe mithilfe einer Variable gemessen, die erst dann Produktionslücken anzeigt, wenn eine gewisse Schwelle überschritten wurde. Die geberspezifische Schwelle wird mithilfe einer modifizierten Version des Suchalgorithmus ermittelt, der von Young und Abbott (2008) vorgeschlagen wurde. Weiterhin werden Armut, Naturkatastrophen und gewaltsame Konflikte als mögliche Ursachen von Nahrungsmittelkrisen berücksichtigt. Da die Vernach-

lässigung eventueller Geberinteressen die Schätzungen der Nahrungsmittelhilfe-Reaktion beeinträchtigen kann (McGillivray, 2003), fließen Indikatoren für geopolitische Interessen in die Gleichung ein.

Die Ergebnisse zeigen, dass global aggregierte Nahrungsmittelhilfe wie auch Nahrungsmittelhilfe von einzelnen Gebern gezielt in ärmeren Ländern eingesetzt wird sowie in Ländern, die Schocks in der Nahrungsmittelproduktion ausgeliefert sind. Demzufolge scheinen die lokale Nahrungsmittelverfügbarkeit und der Nahrungsmittelzugang Auswirkungen auf die Allokation der Geberländer zu haben. Wie schon in früheren Studien (z.B. Barrett und Heisey, 2002) ist bei allen untersuchten Gebern eine ausgeprägte Verweildauer von Nahrungsmittelhilfe in den Empfängerländern festzustellen. Diese deutet darauf hin, dass Geber ihre Hilfslieferungen von Jahr zu Jahr schrittweise ändern, und ist damit ein Anzeichen von Inflexibilität in der Planung. Die Nahrungsmittelhilfereaktionen verschiedener Geber auf Naturkatastrophen und Konfliktsituationen sind zum Teil an den Bedürfnissen der betroffenen Länder orientiert, die untersuchten Geberländer geben hier allerdings ein uneinheitliches Bild ab. Den Schätzergebnissen zufolge gibt es deutliche Anzeichen für Interaktionen zwischen den Nahrungsmittelhilfegebern. Positiv signifikante Korrelationskoeffizienten legen nahe, dass internationale Koordinationsmechanismen und Hilfsorganisationen wie WFP und NGO in der Lage sind, Nahrungsmittelhilfe unterschiedlicher Herkunft zu den bedürftigen Empfängerländern zu vermitteln.

8.4 Nahrungsmittelhilfe und Mangelernährung in Entwicklungsländern: Ergebnisse für die Allokation der U.S. Nahrungsmittelhilfe

Der Mangel an Nährstoffen ist der Hauptgrund von hohen Sterblichkeits- und Krankheitsraten in Entwicklungsländern (Black et al., 2008). Die Nahrungsmittelkrise 2007/8 hat zu erneuter Aufmerksamkeit hinsichtlich internationaler Anstrengungen zur Bekämpfung von Hunger und Mangelernährung geführt. Um Ernährungssicherheit zu gewährleisten ist es dabei von zentraler Bedeutung, dass im Rahmen von Hilfsprogrammen bereitgestellte Lebensmittel genügend Mengen von allen lebensnotwendigen Nährstoffen beinhalten.

Im Fall der internationalen Verteilung von Nahrungsmittelhilfe wurde der Fokus in bisherigen Studien vorrangig auf der Untersuchung von gelieferten Getreidemengen gelegt. Dies ist vorrangig dem Umstand geschuldet, dass der überwiegende Teil von Nahrungsmittelhilfelieferungen aus Getreide besteht, und dass internationale Abkommen wie die *Food Aid Convention* die zu liefernden Mindestmengen in Getreideäquivatenten angeben. Obwohl energiereiches

Getreide als Approximation für den Gehalt von Energie in der Nahrungsmittehilfe genutzt werden kann, muss dies mit Vorsicht getan werden. Getreideprodukte unterscheiden sich zum Teil deutlich im Energiegehalt, und auch Nicht-Getreideprodukte können erhebliche Mengen an Energie aufweisen.

Diese Studie leistet zwei entscheidende Beiträge zu der vorangegangenen Literatur. Zum einen ist es die erste Analyse, welche die globalen Hilfslieferungen von speziellen Nährstoffen untersucht. Diese Vorgehensweise ist näher an den physiologischen Bedürfnissen der gefährdeten Bevölkerung als die Untersuchung von Getreidelieferungen. Zum zweiten werden frühere methodische Herangehensweisen verbessert, da nun die Panel-Struktur der untersuchten Daten berücksichtigt wird. Konkret wird ein dynamisches Correlated Random Effect (CRE) Tobit model geschätzt, welches die Korrelation zwischen der unbeobachteten Heterogenität und den unabhängigen Variablen erlaubt. Hierfür wird eine Version des Ansatzes von Mundlak (1978) genutzt, wonach für jede zeitveränderlichen Variable eine weitere Variable in das Modell aufgenommen wird, welche die empfängerlandspezifischen Mittelwerte beinhaltet. Es ist wahrscheinlich, dass die Mittelwert-Variablen über den von dieser Studie analysierten Zeitraum von 15 Jahren an Aussagekraft verlieren. Der Mundlak Ansatz wird deshalb erweitert, indem die 15 jährige Periode in drei gleichlange Unterperioden eingeteilt wird, und entsprechend pro zeitveränderlicher Variable drei Variablen mit empfängerlandspezifischen Mittelwerten für die einzelnen Unterperioden hinzugefügt wird. Da dynamische Random Effects Modelle mit dem Anfangswertproblem konfrontiert sind, wird eine Methode von Wooldridge (2005) für CRE Tobit Modelle angewendet, wonach die Korrelation der unbeobachteten Heterogenität mit den ersten beobachteten Werten der abhängigen Variable ermöglicht wird.

Es werden Nahrungsmittelhilfsströme aus der Zeit von 1993-2007 analysiert. Vier Nährstoffe werden untersucht, die oftmals Grund von ernährungsbedingten Gesundheitsschäden sind: Energie, Eisen, Vitamin A und Zink. Es werden die Nährstofflieferungen der USA untersucht, weil die USA der bei weitem bedeutendste Nahrungsmittelhilfegeber ist, und sie nach wie vor großen Einfluss auf die Zusammensetzung der Nahrungsmittelhilfe hat – selbst wenn diese von WFP oder NGOs abgewickelt wird (Clay, 2003; Barrett and Maxwell, 2005). Die drei Nahrungsmittelhilfekategorien Notfall-, Projekt- und Programmhilfe werden separat untersucht, weil jede Kategorie eigene Ziele verfolgt und unterschiedliche Methoden für die Erreichung der Bedürftigen nutzt. Neben bereits in früheren Studien genutzten Indikatoren für Bedürfnisse und Geberinteressen werden zusätzlich die mediale Aufmerksamkeit sowie nähr-

stoffspezifische und demographische Indikatoren berücksichtigt.

Die empirischen Ergebnisse zeigen, dass US Nahrungsmittelhilfe allgemein denjenigen Bevölkerungen zugutekam, die ärmer sind und einen höheren Nährstoffbedarf haben. Die Nährstoffe Zink und Vitamin A, für die eine kontinuierliche Versorgung insbesondere bei Kleinkindern kritisch ist, werden in Krisensituationen tendenziell mehr geliefert als andere Nährstoffe. In den Ergebnissen treten erhebliche Unterschiede in den Verteilungsmustern der unterschiedlichen Nahrungsmittelhilfekategorien auf. Dies lässt darauf schließen, dass die USA ihre verschiedenen Nahrungsmittelhilfeprogramme an verschiedene Bedürfnissituationen anpasst. Wie schon frühere Studien über Nahrungsmittelhilfe offenbarten, so ist auch in Nährstofflieferungen eine bedeutende Verweildauer festzustellen. Obwohl dies entweder durch chronische Bedürfnisse verursacht sein könnte, ist vor dem Hintergrund, dass akute Krisen schon durch die Vielzahl an Bedürfnisindikatoren abgebildet wurden, die wahrscheinlichste Annahme, dass die Nahrungsmittelhilfe durch inflexible schrittweise Budgetplanung beeinflusst wird (Diven, 2001). Allgemein werden kurzfristige Krisen kaum berücksichtigt. Globale Nahrungsmittelpreise haben einen negative Effekt auf Notfallhilfe, was ein klarer Hinweis auf budgetplanerische Probleme ist (Barrett and Maxwell, 2005). Geberinteressen spielen eine Rolle bei Projekt- und Programmhilfe, während Notfallhilfe vor allem von den Medien beeinflusst wird. Tests auf Robustheit zeigen, dass die Ergebnisse im Kern unverändert bleiben, wenn die unbeobachtete Heterogenität und zeitliche Einflüsse auf andere Arten modelliert werden.

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04/2002 – 04/2006	B.Sc. in Agricultural Sciences. Focus: Agricultural Economics. Christian-Albrechts-University of Kiel. Subject of the Bachelor's Thesis: Analysis of Inertial Demand Adjustment of Consumers in the USA.
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