Links between international trade, local food production, and household living standards:
Empirical insights from West Africa

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Summary

Sustainable food production, responsible consumption, poverty reduction, and decent living standards are important global objectives reflected in the United Nations' Sustainable Development Goals (SDGs). In achieving these goals, agricultural trade plays a major role. Research has shown that benefits from trade liberalization include poverty alleviation, decreasing food prices due to production advantages and competition, and an increased variety of and access to food products. In the light of continuing poverty and food insecurity in low- and middle-income countries, imports and exports are crucial as they offer income gains for producers and improved access to affordable and nutritious foods for consumers. Trade bans or protectionist policies on the other hand can lead to income losses and higher food prices. However, not all population segments necessarily benefit from trade. A large share of the population in developing countries relies on agricultural production for their income, meaning that they may potentially benefit from higher food prices associated with trade restrictions. Results in the existing literature on the overall impact of agricultural trade on low- and middle-income countries are predominantly positive, but the existing trade-offs between liberalization and protectionism and the important distributional effects in different population segments are not yet sufficiently brought into the equation.

This dissertation contributes to the literature by examining the links between international agricultural trade, local food production, household consumption, and living standards using three case studies in West Africa. The dissertation addresses gaps in the literature regarding measures to improve the conditions of trade, as well as consequences of market-distorting trade barriers on production, consumption, and welfare in developing countries.

The first essay of this dissertation takes a look at the effects of Fairtrade certification on poor and non-poor farm households' food security and living standards in Côte d'Ivoire. Sustainability standards like Fairtrade aim to improve conditions of trade and production by empowering producers of export crops in low- and middle-income countries. By providing better working conditions and offering higher market prices, certification should improve the living standards of participating farmers. While previous research found that Fairtrade has positive effects on farmers' sales prices and incomes, this analysis further explores the effects on food security and other dimensions of household living standards that have not

been subject to research before. Based on data from a survey of cocoa farmers in Côte d'Ivoire, the study looks at how Fairtrade certification affects aggregate household consumption expenditures and the consumption of specific types of consumer goods and services using regression models with instrumental variables. We find that Fairtrade increases aggregate and non-food consumption expenditures but does not have significant effects on food consumption and dietary diversity. Poor and non-poor households increase expenditures for different consumption categories. We conclude that Fairtrade improves farm household living standards but not food security. The results highlight the importance of looking at disaggregate measures of consumption, as they can mask important facets of social welfare.

The second essay discusses the impact of restrictions on chicken imports on local production and consumption of chicken and welfare of poor and non-poor households in Ghana. Chicken exports to Africa have long been criticized for their negative effects on local producers, but at the same time, they are an important source of nutrients for income-restrained consumers. Some African countries have established protectionist import policies to shield domestic producers from the competition with cheaper international products, but there is a lack of information on the effects these policies have on different population groups and whether the aggregate benefits really outweigh the costs. By utilizing a partial-equilibrium model of chicken supply and demand in Ghana, we simulate the effects of tariff policies on chicken prices, production, and consumption. Welfare analysis suggests that import restriction policies would lead to increased domestic chicken prices yielding negative effects for consumption that cannot be outweighed by positive production effects. Most poor and non-poor households are net consumers of chicken and would experience welfare losses. The findings of this essay support the advantage of trade liberalization over protectionist import policies in terms of increasing welfare and living standards, while presenting a more detailed picture of winners and losers of protectionism.

The last essay breaks down recent trends in the fishing sector of Ghana and draws a line between overfishing, local marine fish production, fish imports, and household-level consumption and fishing activities. A large share of Ghana's population works in the fishing sector or related sectors, and the majority of consumed animal protein stems from fish. However, domestic fish production has been struggling because of overfishing, threatening both, income and food security of people relying on fish. Currently, Ghana imports about half of its fish supply to meet the local demand. At the same time, foreign industrial fishing companies are strongly contributing to the issue of overexploitation in West African marine ecosystems. There is a lack of information on the relationship between the phenomenon of overfishing, household consumption, and fishing activities. Using three waves of nationally representative household-level data, this essay links household behavior to annually aggregated fish catch and import statistics to evaluate trends and relationships between overfishing, fish consumption, and household level fishing activity. The results of the analysis suggest the existence of overfishing in Ghana and imply that industrial fish production – dominated by foreign fishing fleets – and imports are positively linked to consumption but negatively related to household fishing and fish sales. Again, different links are observed for poor and non-poor households.

The results of the three essays illustrate the opposing effects of trade on producers and consumers in West Africa and also emphasize how diverse the effects are for different income groups. Essays two and three show that imported food products are relevant for consumption in Ghana, especially among the poor. In both sectors, domestic net producers are affected adversely by cheap imports, confirming the trade-off described in the public discourse. However, the results imply that simply reducing imports would not improve the overall situation, as the majority of households are net consumers. Other support measures for producers would make more sense economically and socially. One such measure for export-oriented producers could be sustainability standards like the Fairtrade certification scheme. It tries to improve the conditions of trade for low- and middle-income countries, strengthen producers through networks and higher market prices, and improve farmers' living standards by enabling participation in lucrative export markets. As chapter one shows, Fairtrade succeeds in several of those aspects. Other measures that also address production for the domestic market could be technical or infrastructure support.

This dissertation concludes that agricultural trade is important in providing access to food and securing availability of sufficient nutrients in food-insecure contexts. To offset adverse effects of trade and support producers in being competitive, a fair setting that respects social and environmental issues is crucial and sustainability standards can help create such a setting.

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List of acronyms

SDG	Sustainable Development Goal
GDP	Gross domestic product
IV	Instrumental variables
FT	Fairtrade
AE	Adult equivalent
HDDS	Household dietary diversity score
FCS	Food consumption score
PPP	Purchasing power parity
IHS	Inverse hyperbolic sine
OLS	Ordinary least squares
GLSS	Ghana living standards survey
PED	own-price elasticity of demand
PES	own-price elasticity of supply
GHS	Ghanaian Cedi
CV	Compensating variation
LME	Large marine ecosystem
IUU	Illegal, unreported, and unregulated fishing
FAO	Food and Agriculture Organization
SAU	Sea Around Us Project
EEZ	Exclusive economic zone
MoFAD	Ministry of Fisheries and Aquaculture Development
ECOWAS	Economic Community of West African States
OEC	Observatory of Economic Complexity
CPU	Catch-per-unit

1
General introduction

1.1 Background

The globalized world of today is hardly imaginable without international trade. Trade is ubiquitous, and almost every country participates in some form of it. However, some aspects of trade remain poorly understood. This relates especially to the implications of trade for low- and middle-income countries and the share of poor and vulnerable people living there. Because of the major role agriculture plays in many developing countries, agricultural trade is especially important to look at. Research has shown positive effects of trade liberalization on economic growth, agricultural output, and poverty reduction (Hertel, 2006; Minot and Goletti, 2000). On the production side, trade increases competition and thereby fosters specialization and productivity in resource allocation. It also offers access to global markets and chances for increased production. On the consumption side, trade increases consumption possibilities by raising availability of and improving access to a broader range of products, positively affecting nutrition diversity (Martin, 2018; Ackah and Morrissey, 2005). Despite the capability of agricultural liberalization to improve a populations' situation, there is controversy in the discourse about its benefits regarding importing situations (Martin, 2018; Swinnen and Squicciarini, 2012; Hertel, 2006; Anderson, 2004). Other evidence suggests a trade-off between positive effects on consumers and negative effects on producers of goods destined for the domestic market (Rudloff and Schmieg, 2017; Fritz, 2011; Hermelin, 2004) and assumes an association between the liberalization of markets and a dependency on imports (Del Mendez Villar and Lançon, 2015). This is especially true for countries where imports outweigh exports, leading to a negative trade balance that can limit possibilities for growth and increase exposure to international market volatility (Ackah and Morrissey, 2005; Minot, 2011). Additionally, unequal production conditions possibly foster trade imbalances between rich and poorer countries that further complicate international relationships and increase the likelihood of a country implementing protectionist policies (Delpeuch, Fize, and Martin, 2021; Bernhardt, 2014; Dueñas and Fagiolo, 2013).

Protectionism commonly aims at shielding local producers from cheap foreign products that they cannot compete with. Agriculture, animal husbandry, and fishing are essential income sources for a majority of the poor and can help to increase income and alleviate poverty. They are also crucial for food availability, especially in poorer rural areas where food insecurity is widespread. Agriculture accounts for up to 25% of the gross domestic product (GDP) in some developing countries and is essential for their economic growth and development. Growth in agriculture is proven to be most effective in raising incomes of poor households (World Bank, 2021a; Dercon and Gollin, 2014; Byerlee, de Janvry, and Sadoulet, 2009). A decline in the food production sector does not only affect local incomes but leads to a gap in food supply. Countries that cannot meet the demand for food through their own production fill that gap with imports (FAO et al., 2021).

Most African countries import more agricultural products than they export, but the African trade deficit has been on the decline since 2012 (Bouët, Odjo, and Zaki, 2020). To increase Africa's role in global trade, and to maximize the benefits it can reap from it, it is key to focus on agricultural commodities where African countries hold a comparative advantage over other nations. A recent report compared the production processes of different items across African countries and identified several mostly raw and unprocessed products, including cocoa and its derivatives, with a production advantage (Bouët, Odjo, and Zaki, 2020). To increase the benefits from exporting those products, farmers need to be linked to more lucrative export markets. This is where sustainability standards and certification schemes can be useful: These standards address environmental and social welfare, and they mainly focus on tropical export crops, such as coffee, cocoa, or tea. Because of the perceived benefits in aspects like social well-being and sustainability, certified products continue to grow in popularity among western consumers, and these consumers are willing to pay higher prices (Vlaeminck, Vandoren, and Vranken, 2016). Through certification farmers can access lucrative high value markets, improve their production processes with the help of training offered by sustainability schemes, and generate higher profits. Research on sustainability standards found higher incomes among certified farmers and improvements in their living standards (Meemken, 2020; Karki, Jena, and Grote, 2016; Chiputwa, Spielman, and Qaim, 2015; Dragusanu, Giovannucci, and Nunn, 2014; Becchetti, Conzo, and Gianfreda, 2012).

To evaluate whether different instruments of trade – protectionist policies, trade agreements, or certain standards – do benefit the population in low- and middle-income countries, it is useful to look at the concept of living standards. It is used to measure the well-being of people exceeding their mere financial situation. It is based on the notion that all humans have basic social, economic, and cultural rights (UN, 2022). Although several concepts measuring poverty, development, or well-being exist, living standards are still frequently used, because they are relatively easy to quantify. Commonly, they are based on factors such as income or expenditures and evaluate whether people have access to a minimum of material conditions, including at least food, housing, clothing, water, sanitation, and safety. The concept draws on other approaches that measure well-being, like the basic needs approach or the capabilities approach (Rao and Min, 2018; Nussbaum and Sen, 1993; Doyal and Ian, 1991).

Levels of living standards have drastically improved across the globe over the years, but there continue to be major discrepancies between countries. Especially people living in low- and middle-income countries still do not always have decent conditions of living and often face food insecurity (FAO et al., 2021). Currently, about 700 million people live in poverty, close to 800 million people face hunger, and both estimates recently increased (FAO et al., 2021; World Bank, 2020b). After decades of decreasing global poverty rates, the Covid-19 pandemic is estimated to reverse this trend, increasing poverty, food insecurity, and malnutrition, and affecting food production, trade, and employment worldwide (Swinnen and McDermott, 2020; World Bank, 2020b). Africa is already home to more than one-third of the world's undernourished people and the impacts of global crises like climate change or pandemics affect Africa more severely than many other regions: In 2019, 282 million people suffered from hunger in Africa. In 2020, that number increased by 16% to 328 million. While similar trends are also observable in other low- and middle-income regions – such as Latin America, the Caribbean, and large parts of Asia – the increase in food insecurity and undernourishment was sharpest in Africa and especially West Africa (FAO et al., 2021). Income and food security of poor people are disproportionally affected because many of the poor rely largely on agriculture and other physical labor for their income. Compared to richer people, the poor also spend a larger share of their income on food, making them more vulnerable to food insecurity when food prices and incomes fluctuate (Dorward, 2012; Ivanic, Martin, and Zaman, 2012; Minot and Goletti, 2000). Finally, poor people also often rely on public sector programs for food, nutrition, or financial support, and such support measures can easily be disrupted during crisis situations like the Covid-19 pandemic (Swinnen and McDermott, 2020).

1.2 Research gaps and objectives

Because of the essential role agricultural food production and trade play for income and consumption of the poor, production and trade impacts on living standards are multifaceted. Changes in the food production sector can have severe consequences for its workforce, further restricting them financially. Imports can benefit consumers but may affect producers adversely. This dissertation aims to connect international trade, local food production, and household living standards. It looks at different aspects of trade, including measures to support producers and improve the livelihoods of consumers, welfare effects of different trade policies on consumers and producers, and the coherence of international relations with imports, domestic production, and household consumption. While the three studies presented in this thesis are independent of each other, they paint a broader picture of global trade relationships and how these can affect the agricultural sector in West Africa. Because of the region's continuing high poverty rates, the separate studies all differentiate between poor and non-poor households and analyze whether measures affect these groups diversely.

To better understand the interconnections of trade, food production, and living standards, this dissertation answers the following questions: The first essay looks at how sustainability standards can support producers of cash crops for export. Can sustainability standards improve these producers' living standards beyond mere income effects? If so, are the effects equally distributed among different groups of households? The second analysis researches into the discussion around possible restrictions on the import of a food product that is important for consumers but might threaten local producers. Are protectionist policies a suitable tool to support producers and improve the overall welfare of a population? Who are possible winners and losers of such policies? The third essay of this dissertation establishes a connection between fish production, fish imports, and overfishing of marine areas. How are imports and local fish production linked to overfishing? And how do both, imports and fish production, relate to subsistence fishing and household consumption? The following sub-chapters introduce each study by shortly presenting the current state of research, the gap in the literature, and the research objectives of each analysis.

1.2.1 Sustainability standards and household living standards in Côte d'Ivoire

The first study of this thesis looks at Fairtrade certification, a global sustainability standard that is working towards improving the livelihoods of farmers and workers through trade (Fairtrade International, 2020). As a measure to improve conditions of trade, Fairtrade aims to increase output prices for producers of export crops and implements various requirements to improve working conditions beyond that. Sustainability standards, in general, have gained importance for agri-food exports from developing countries in recent years, and research on the effects of such standards has increased as well. Most studies found positive effects of certification schemes, mostly on output prices and incomes (Meemken, 2020; Karki, Jena, and Grote, 2016; Dragusanu, Giovannucci, and Nunn, 2014). A few studies went further than that and also looked at effects on living standards and food security (Akoyi and Maertens, 2018; Meemken and Qaim, 2018; Chiputwa and Qaim, 2016; Chiputwa, Spielman, and Qaim, 2015; Becchetti, Conzo, and Gianfreda, 2012; Beuchelt and Zeller, 2011). Research on other dimensions of poverty and household welfare, such as living conditions, health, or child education, remains even rarer, and the results paint a mixed picture (Schleifer and Sun, 2020; Meemken, Spielman, and Qaim, 2017). That is because much of the effects depend on the exact certification scheme, the certified export crop, the specific context, and how welfare is measured. In the analysis presented here, we focus on the effects of Fairtrade on food security and other dimensions of household living standards to better understand the dissimilar effects on different consumption categories of households. The analysis applies regression models with instrumental variables (IVs), allowing us to reduce possible issues with endogeneity of the certification status. Because consumption behavior also depends on the poverty status and income level of a household, we expect different effects for poor and non-poor households. By differentiating between households above and below the poverty line, it is possible to shed further light on the dynamics behind certification effects and how they affect different dimensions of consumption for different groups of households. Because Fairtrade is one of the most recognized sustainability labels, and Côte d'Ivoire is currently the largest cocoa producer and exporter worldwide, the results of this study do not only offer concrete country-specific insights but also a chance to learn some broader lessons applicable to other African countries.

1.2.2 Import restrictions and household welfare in Ghana

The second study analyzes the trade-offs of protectionist import policies with respect to the welfare of producers and consumers in Ghana. Agricultural trade liberalization is commonly perceived as beneficial for all countries (Winters and Martuscelli, 2014). Nevertheless, international trade can provide a challenge for producers of products destined for the domestic market in low- and middle-income countries. Because of higher input prices, higher transaction costs, and lower levels of technologies, these producers often cannot supply at the same prices as actors from richer countries (Al-Hassan Noah, Larvoe, and Adaku, 2014). One prominent example of this controversial issue is that of poultry exports from the European Union to West Africa (Rudloff and Schmieg, 2016, 2017). To protect their domestic economy and producers from such cheap imports, some African countries have imposed import restrictions in the form of tariffs or have banned imports of certain products altogether. Although there is a discourse about the potential advantages and disadvantages of import restrictions in the trade literature, the welfare and distributional effects of such import restrictions on chicken or other animal products in African countries to our knowledge have not yet been evaluated. Utilizing a nationally representative household survey from 2017 and a partial-equilibrium framework, we simulate changes in production, consumption, and overall welfare resulting from two hypothetical import restriction policies on chicken products. By comparing the status-quo of chicken imports in Ghana – where unlike in other West African countries no strict import restrictions or high import tariffs are in place yet – with two different protectionist policies, this analysis is able to identify potential winners and losers of the hypothetical regulations. We additionally focus on different effects for poor and non-poor households to evaluate whether import restrictions could be a pro-poor market instrument. The analysis thereby provides an understanding of the dissimilar effects of import restrictions on different groups of households and offers valuable insights that help lead future policy decisions on trade instruments.

1.2.3 The fishing sector: overfishing, imports, and household consumption and production in Ghana

The last study of this thesis looks at trade from another angle and assesses recent trends in the Ghanaian fishing sector while focusing on production-related indicators of overfishing and imports. The study also analyzes the relationship of fish production and imports with household-level fish production and consumption. Overfishing describes the phenomenon of overexploiting a marine or freshwater area to a point where the fish stock decreases because it cannot naturally keep up with the intensity of fish extraction from the seas anymore (Link et al., 2020). Overfishing proposes a serious environmental threat to marine ecosystems and has thus been subject to several marine ecological studies in the past (Scheren et al., 2021; Sumaila and Tai, 2020). Furthermore, fish production in affected areas is going down (FAO (FIGIS), 2021; Sea Around Us, 2021; Link et al., 2020). Because many coastal communities greatly rely on fish for protein and nutrients, and a large share of the population in these areas depends on fishing for their income, overfishing and decreasing fish stocks can have far-reaching consequences (Hasselberg et al., 2020; Ashitey, 2019; Lauria et al., 2018; Nunoo et al., 2014; Martin, Lorenzen, and Bunnefeld, 2013; Kawarazuka and Béné, 2011). A recent meta-analysis found that most African large marine ecosystems (LMEs) are already showing symptoms of overfishing (Link et al., 2020), making this topic more relevant than ever. Despite the extent and urgency of the subject, overfishing is relatively understudied from a socio-economic perspective. The links between domestic and international fish production in West African marine areas and symptoms of overfishing, as well as the relationship between overfishing and dependence on imports are not sufficiently understood yet. To address that gap the third study of this dissertation combines three waves of nationally representative household survey data with yearly aggregated production and import statistics from Ghana. The essay uses comparative analysis and simple regression models to analyze the link between production, imports, and several household outcomes, including subsistence fishing and consumption. The results help to better understand the current trends in the fishing sector and their implications on food and income security of people depending on fishing in Ghana. The study also assays the role of imports for not only household consumption but also domestic production.

1.3 Outline

The rest of this dissertation is structured as follows: Chapter two presents the first paper, analyzing the effects of Fairtrade certification on disaggregated household consumption for poor and non-poor households in Côte d'Ivoire. Chapter three presents the second paper, focusing on welfare implications of import restrictions for chicken imports in Ghana. The fourth chapter contains the last study, analyzing links between overfishing, imports, and household fishing and fish consumption in Ghana. The last chapter discusses the main findings, draws some broader conclusions, and deliberates on policy implications based on all three papers.

2

Effects of Fairtrade on farm household food security and living standards: insights from Côte d'Ivoire[1]

Abstract

Fairtrade certification has recently gained in importance for various export crops produced in developing countries. One of Fairtrade's main objectives is to improve the social conditions of smallholder farmers. Previous research showed that Fairtrade has positive effects on farmers' sales prices and incomes in many situations. However, more detailed analysis of the effects on food security and other dimensions of household living standard is rare. Here, we use data from a survey of cocoa farmers in Côte d'Ivoire to analyze how Fairtrade certification affects aggregate household consumption expenditures and the consumption of specific types of consumer goods and services. We also differentiate between poor and non-poor households. Regression models with instrumental variables suggest that Fairtrade increases aggregate consumption expenditures by 9% on average. For poor households, the effect is even larger (14%). These effects are driven by increases in non-food expenditures. We do not find significant effects on food consumption and dietary diversity. In poor households, Fairtrade primarily increases spending on other basic needs such as housing and clothing, whereas in non-poor households positive effects on education and transportation expenditures are found. We conclude that Fairtrade improves farm household living standards but not food security.

Keywords: Fairtrade; sustainability standards; cash crops; small farms; gender roles; poverty

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2.1 Introduction

Fairtrade has recently gained in importance for agri-food exports from developing countries, especially for crops such as coffee, tea, cocoa, and banana (Meemken, 2020; Minten et al., 2018; DeFries et al., 2017; Dragusanu, Giovannucci, and Nunn, 2014). One of the main objectives of the Fairtrade standard is to improve the economic and social conditions of small-scale producers through a guaranteed floor price and an additional premium to foster community development (Fairtrade International, 2020). Fairtrade also bans child labor and forced labor. Moreover, Fairtrade-certified cooperatives often assist farmers in terms of training and input supply (Sellare, Meemken, and Qaim, 2020a). But can Fairtrade really enhance the living conditions of smallholder farmers beyond agricultural output prices and access to inputs? Does Fairtrade certification improve food security and the fulfillment of other basic needs? And, if so, do poor households benefit to the same extent as non-poor households? These are important questions for development policy because smallholder farmers make up a large fraction of the world's poor and undernourished people. These questions are addressed here with survey data from cocoa farmers in Côte d'Ivoire.

Recent research showed that Fairtrade certification is associated with higher output prices and higher incomes among smallholder farmers in many situations (Sellare, Meemken, and Qaim, 2020a; Karki, Jena, and Grote, 2016; Dragusanu, Giovannucci, and Nunn, 2014). Several studies also showed positive effects of Fairtrade on aggregate household living standards (Chiputwa, Spielman, and Qaim, 2015; Becchetti, Conzo, and Gianfreda, 2012). However, higher prices in certified markets are not always sufficient to raise household incomes and living standards (Akoyi and Maertens, 2018; Beuchelt and Zeller, 2011). A few studies also went beyond aggregate living standards and analyzed effects of Fairtrade on food security and gender equity, sometimes finding positive impacts (Meemken and Qaim, 2018; Chiputwa and Qaim, 2016; Becchetti, Conzo, and Gianfreda, 2012; Becchetti and Costantino, 2008). But the picture is mixed. Meemken, Spielman, and Qaim (2017) used data from coffee farmers in Uganda showing that Fairtrade increased overall household consumption expenditures, but not food expenditures. In their recent systematic review, Schleifer and Sun (2020) concluded that food security remains a relatively blind spot in the literature on certification impacts. Research on other dimensions of poverty and household welfare – including living conditions, health, or child education – is even rarer. Furthermore, to our knowledge no previous study analyzed whether the effects of Fairtrade differ between poor and non-poor households.

Here, we address some of these knowledge gaps. First, we analyze whether Fairtrade certification increases aggregate household living standards measured in terms of total per capita consumption expenditures. Consumption expenditures are a more reliable indicator of living standard than income, especially in the context of smallholder farm households. The reason is that consumption can be smoothed, so that it fluctuates less than income with seasonal or annual patterns of crop production and prices. Second, we analyze the effects of Fairtrade on different dimensions of household living standard, such food security, health, education, and housing. We do this by disaggregating total consumption expenditures into different expenditure categories. In addition, we use household-level dietary data to examine effects on undernourishment and dietary diversity. Gains in aggregate incomes and consumption expenditures do not necessarily mean that all dimensions of living standard are affected equally. The effects may also depend on the type of income and who in the household controls the revenues and makes purchase and expenditure decisions (Meemken, Spielman, and Qaim, 2017; Duflo and Udry, 2004; Hoddinott and Haddad, 1995). Third, we differentiate between effects of Fairtrade on farm households above and below the poverty line.

The cocoa sector in Côte d'Ivoire is an interesting empirical example for this analysis. Côte d'Ivoire is the largest cocoa producer and exporter worldwide, and the share of Fairtrade certified cocoa has increased significantly in recent years (Meemken et al., 2019; Sellare et al., 2020b). We use data from a survey of cocoa farmers in 50 different certified and non-certified cooperatives collected in 2018. Regression models with instrumental variables are used to identify the Fairtrade effects while controlling for possible confounding factors.

2.2 Conceptual framework

Fairtrade can affect household living standards through different mechanisms (Figure 2.1). Positive effects on crop incomes can be expected through higher output prices and yields. Fairtrade guarantees a minimum floor price for output sold in certified markets, which leads to positive price and revenue effects especially when prices in non-certified markets are low (Fairtrade International, 2020; Chiputwa, Spielman, and Qaim, 2015). Positive price incentives can also lead to higher input intensities and yields. In addition, Fairtrade encourages collective action at the cooperative level to improve farmers' access to agronomic training, inputs, and technology, which can also lead to higher crop yields (Sellare, Meemken, and Qaim, 2020a; Dragusanu, Giovannucci, and Nunn, 2014). Additional costs for such cooperative services and for the certification process itself are typically borne by the cooperatives, so that the cost differences with and without certification for individual farmers are low.[2]

Higher prices and yields through Fairtrade without significant cost increases imply higher crop incomes and thus more cash available for household consumption expenditures. However, on what types of goods and services the additional crop income is spent depends on various factors. Fairtrade typically involves cash crops, such as cocoa and coffee, the income of which is seasonal and mostly controlled by male household members (Meemken, Spielman, and Qaim, 2017; Chiputwa and Qaim, 2016; Hill and Vigneri, 2014). Male household members tend to spend income differently than females: While women are often responsible for the purchase of food, men tend to spend more on non-food goods and services (Fischer and Qaim, 2012a; Duflo and Udry, 2004; Hoddinott and Haddad, 1995). Hence, gains in crop income and total household expenditures through Fairtrade may have uneven effects on food security and other dimensions of welfare and living standard.

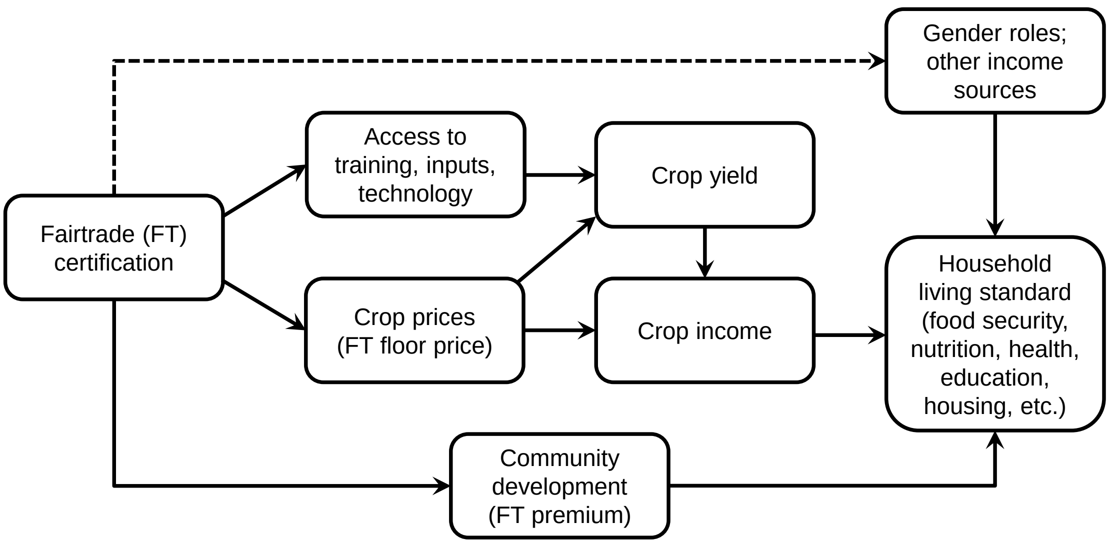

Figure 2. 1: Effects of Fairtrade on different dimensions of household living standard

As Figure 2.1 indicates, Fairtrade may indirectly also affect gender roles within farm households and other income sources through resource reallocation (Meemken and Qaim, 2018). Furthermore, the Fairtrade premium, which is paid to certified cooperatives for community development projects, may also have indirect effects on household living standards. In the empirical analysis below, we compare crop yield, price, and income data between

[2] Fairtrade prohibits the use of certain toxic chemicals and of child and forced labor, which can lead to cost increases in situations where such inputs and types of labor are commonly used in the production process. This is not the case in our setting in Côte d'Ivoire.

Fairtrade certified and non-certified households and identify the causal effects of certification on different dimensions of living standard.

2.3 Materials and methods

We compare differences in crop prices, yields, incomes, and living standards between farm households with and without Fairtrade certification. In addition to descriptive statistics, we run regression models to control for possible confounding factors. Potential issues of self-selection into certification are addressed through instrumental variables. The data and statistical approaches used are explained in more detail below.

2.3.1 Farm household survey

We use data from cocoa-producing farm households in Côte d’Ivoire. The data were collected through a survey of cooperatives and farm households carried out in 2018 in the southeastern parts of the country belonging to the traditional cocoa belt. In total, we identified 59 Fairtrade certified cooperatives and 74 non-certified cooperatives located in the three districts of Comoe, Lacs, and Lagunes. From these total lists of cocoa cooperatives, we randomly selected 25 certified and 25 non-certified cooperatives.[3] In each of these 50 cooperatives, we randomly selected 10 farm households, resulting in a total sample of 500 household observations, of which half are Fairtrade certified and the other half are not. Further details of the sampling framework are described by Sellare et al. (2020b).

In all sampled households, personal interviews were held with the household head, using a structured questionnaire. The questionnaire included sections on general farm, household, and contextual characteristics, asset ownership, income, production and marketing of cocoa, details on other farm and non-farm enterprises, and a specific module to capture food and non-food consumption. Food consumption data were collected using a 7-day recall period and covering a large number of food items from own production, market purchases, and other sources. Non-food expenditures were collected for all relevant other consumer goods and services, using

[3] Of the 25 Fairtrade certified cooperatives in the sample, 16 are additionally certified by UTZ and/or Rainforest Alliance. In a robustness check, we test whether the Fairtrade effects change when additionally controlling for double or triple certification.

monthly or annual recall periods, depending on typical expenditure patterns. The specific expenditure categories considered in this study are explained below.

In addition to the household-level interviews, we also conducted cooperative-level interviews with the leaders of each of the 50 cooperatives to collect data on cooperative characteristics, such as size, membership structure, assets owned, and types of services provided.

2.3.2 Outcome variables

We use total consumption expenditures per capita as our aggregate measure of household living standard. Consumption expenditures are the most commonly used quantitative indicator of living standard, especially in developing countries (OECD, 2015). As mentioned above, unlike income, consumption can be smoothed, so that it fluctuates less seasonally and annually and therefore represents household welfare more reliably. We calculate daily per capita expenditures by summing up all of the household's expenditures on consumption goods and services and dividing by the number of household members. Expenditures also include the market value of goods consumed from own production or received as gifts or through transfers. All expenditures are expressed in francs CFA, the local currency in Côte d'Ivoire.

In addition to total consumption expenditures, we look at food and non-food expenditures separately. Food expenditures are used as a first indicator of the household's food security and economic access to food. Rising food expenditures would indicate that the food quantity and/or the quality of the food consumed in the household increase, meaning that food and nutrition security is improved. More detailed dietary data from the 7-day consumption recall are used to calculate additional food security indicators. Calories consumed are calculated based on the food quantities reported and using a food composition table for West Africa (FAO, 2012). We compute calorie consumption per male adult equivalent (AE) and consider households with a daily consumption of less than 2400 kcal per AE as undernourished (Fongar et al., 2019). Furthermore, we calculate the household dietary diversity score (HDDS) and the food consumption score (FCS) as indicators of household-level dietary diversity (Kennedy, Ballard, and Dop, 2011).

Non-food consumption expenditures are disaggregated further using categories as described by the UN Department of Economic and Social Affairs (2018), namely: (1) basic living expenditures, including housing and clothing; (2) health expenditures, including medical costs, hygiene products, and health insurance fees; (3) education expenditures, including any school fees and learning materials; (4) transport expenditures; (5) social expenditures, including communication and social events; (6) financial expenditures, including financial services and interest rates; and (7) miscellaneous expenditures, including other goods and services not included in any other category.

2.3.3 Regression models

To identify Fairtrade effects on household living standards while controlling for possible confounding factors, we estimate regression models of the following type:

$$Y_{ik} = \beta_0 + \beta_1 FT_{ik} + \beta_2 X_i + \beta_3 D_i + \beta_4 C_k + \varepsilon_{ik} \quad (1)$$

where Y_{ik} is daily per capita consumption expenditure of farm household *i* in cooperative *k*, and FT_{ik} is a dummy variable indicating whether or not the farmer and the cooperative are Fairtrade certified. A positive and significant coefficient β_1 would confirm the hypothesis that Fairtrade improves aggregate household living standards. We run separate models for total consumption expenditures and different food and non-food expenditure categories, as explained above. In addition, we estimate models with the food security indicators as dependent variables.

In equation (1), we control for farm, household, and contextual variables that could jointly influence Fairtrade certification and household living standards. The vector X_i includes variables such as age, sex, education, and ethnicity of the household head, farm size, soil quality, asset ownership, income from sources other than cocoa, and infrastructure conditions. D_i is a vector of district dummies to control for unobserved regional factors, and C_k is a vector of cooperative characteristics, such as cooperative size, governance structure, assets owned, and education of the cooperative leader. Sellare et al. (2020b) showed that cooperative characteristics can differ considerably and matter when estimating certification effects. ε_{ik} is a random error term. We estimate all models with robust standard errors to account for possible heteroskedasticity.

In a first step, we estimate the models in equation (1) with the full sample, including all farm households. In a second step, we re-estimate all models with two subsamples, namely poor and non-poor households, in order to see whether the effects of Fairtrade differ by income group. We use the international moderate poverty line of 3.20 purchasing power parity (PPP) dollars to split the sample into poor and non-poor households. This threshold is relatively near to the official national poverty line in Côte d’Ivoire, which was equivalent 2.96 PPP dollars in 2015

(World Bank, 2020a). Moreover, the 3.20 PPP dollar poverty line splits the sample into two subsamples of almost equal size, which is advantageous for efficient statistical estimation. In a robustness check, we also use quantile regression models to estimate effects of Fairtrade on different household expenditure segments.

One possible problem in the estimation of equation (1) is non-random self-selection of households into Fairtrade certification. Only households that are member of a Fairtrade-certified cooperative can participate in Fairtrade supply chains, but households can join, leave, or switch cooperatives. The decision which cooperative to join is likely determined by observed and unobserved characteristics, which need to be controlled for in order to avoid selection bias in the estimated Fairtrade effects.

We use an instrumental variable approach to address potential issues of selection bias. Building on recent previous work (Meemken et al., 2019; Sellare et al., 2020b), we use two instruments for Fairtrade certification, namely (1) the proportion of Fairtrade certified farmers in a certain radius around the household and (2) the mobile phone network provider of the cooperative leader. These instruments exploit the fact that information about Fairtrade spreads locally through personal communication channels. Both instruments are significantly correlated with individual Fairtrade certification and do not influence household living standards through other mechanisms, as we show and explain in more detail in the Appendix. Hence, the two instruments fulfill the conditions of instrument relevance and validity.

2.4 Results

2.4.1 Descriptive statistics

Table 2.1 shows descriptive statistics of various farm, household, and contextual characteristics. The average farm in our sample has a size of about 10 ha, of which half is grown with cocoa and the other half with other crops such as maize and cassava. Cocoa is clearly the most important source of income for most of the households, accounting for 76% of total household income on average. Figure 2.2 shows that Fairtrade certified farm households obtain significantly higher cocoa yields and prices than non-certified households, as expected. Higher yields and prices also lead to significantly higher cocoa incomes among certified household. In contrast, for non-cocoa income (including all other farm and non-farm income sources), no significant differences are observed between the two groups (Table 2.1).

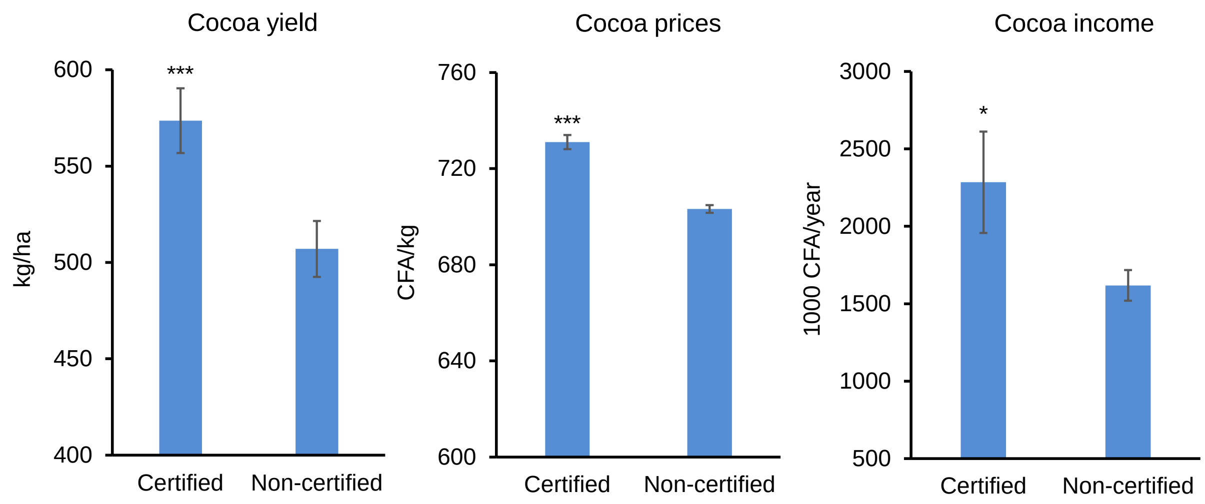

Figure 2. 2: Cocoa yield, prices, and incomes among Fairtrade certified and non-certified households

Notes: Mean values are shown with standard error bars. * Mean difference significant at 10% level. *** Mean difference significant at 1% level.

Overall income levels are higher among Fairtrade certified than among non-certified households (Table 2.1). Nevertheless, poverty rates do not differ significantly between the two groups (Table A1.5 in the Appendix). Around 29% of all households fall below the extreme poverty line of 1.90 PPP dollars, whereas 52% of the households fall below the moderate poverty line of 3.20 PPP dollars per capita and day.

For many of the sociodemographic variables in Table 2.1 (household size, age, sex, and education of the household head), differences between certified and non-certified households are small and not statistically significant. One significant difference is observed for distance to the closest tarmac road. Interestingly, Fairtrade-certified households are located further away from tarmac roads than non-certified households.

The lower part of Table 2.1 shows the food security indicators, suggesting that household food insecurity is high and dietary diversity is relatively low. Close to 50% of the households are classified as undernourished based on the 2400 kcal per male AE threshold. A mean FCS of 26 is also pointing at nutritional issues. Generally, a FCS of above 35 is considered acceptable for healthy nutrition, whereas scores between 21.5 and 35 are categorized as ‘borderline’ (Kennedy, Ballard, and Dop, 2011). We observe no significant differences between Fairtrade certified and non-certified households in terms of these food security indicators.

Table 2. 1: Farm household characteristics and food security

	(1) Full sample	(2) Fairtrade certified	(3) Non-certified	(4) Mean difference
Land owned (ha)	9.807	9.591	10.023	-0.432
	(10.118)	(11.289)	(8.811)	
Land cultivated with cocoa	4.958	5.345	4.572	0.774*
(ha)	(4.553)	(5.626)	(3.097)	
Household income in past 12	2559.577	2938.555	2180.599	757.956*
months (1000 CFA)	(4422.281)	(5890.756)	(2049.944)	
Cocoa income in past 12	1951.410	2284.677	1618.142	666.536*
months (1000 CFA)	(3836.663)	(5179.354)	(1565.359)	
Non-cocoa income in past 12	608.167	653.877	562.457	91.420
months (1000 CFA)	(1644.260)	(2051.550)	(1097.720)	
Size of household	7.126	7.308	6.944	0.364
	(3.918)	(3.846)	(3.988)	
Age of household head	49.556	49.672	49.440	0.232
	(10.872)	(10.558)	(11.197)	
Female household head (1/0)	0.038	0.052	0.024	0.028
	(0.191)	(0.222)	(0.153)	
Education of head (years)	6.110	5.867	6.352	-0.485
	(4.913)	(4.841)	(4.981)	
Distance to tarmac road (km)	15.436	17.540	13.333	4.208***
	(17.033)	(18.319)	(15.394)	
Undernourished (1/0) [a]	0.476	0.496	0.456	0.04
	(0.499)	(0.500)	(0.499)	
Household dietary diversity	8.562	8.564	8.560	0.004
score (HDDS) [b]	(1.510)	(1.496)	(1.526)	
Food consumption score	26.100	26.414	25.786	0.628
(FCS) [c]	(9.852)	(9.623)	(10.085)	
Observations	500	250	250	

Notes: Sample mean values are shown with standard deviations in parentheses. Food security indicators calculated from 7-day food consumption data at the household level. [a] Household is defined as undernourished when daily calorie consumption is below 2400 kcal per male adult equivalent. [b] HDDS counts the number of food groups consumed with a maximum of 12. [c] FCS counts food groups but gives more weight to groups with high nutritional value. * p<0.10; ** p<0.05; *** p<0.01

Table 2.2 shows descriptive statistics for per capita consumption expenditures. Aggregate expenditures are somewhat higher for Fairtrade certified households than for non-certified households, but the difference is not statistically significant. Likewise, we do not observe a significant difference in terms of food expenditures, which is consistent with the food security indicators discussed above, which also did not differ significantly between the two groups.

However, we observe significant differences in terms of non-food consumption expenditures. Non-food expenditures are 31% higher among certified households, which is primarily driven by higher basic living expenditures (including housing and clothing), higher education expenditures, and higher social expenditures. These descriptive results suggest that Fairtrade may have positive effects on household living standards but influences various dimensions of living standard differently. These patterns are analyzed more rigorously in the next subsections, using the regression models discussed above.

Table 2. 2: Daily per capita consumption expenditures (CFA)

	(1) Full sample	(2) Fairtrade certified	(3) Non-certified	(4) Mean difference
Total expenditures	1422.152	1496.182	1348.122	148.060
	(1089.682)	(1149.353)	(1023.507)	
Food expenditures	770.186	756.505	783.867	-27.362
	(621.447)	(570.220)	(669.640)	
Non-food expenditures	651.966	739.677	564.255	175.422***
	(681.337)	(785.552)	(545.678)	
Categories of non-food expenditures				
Basic living expenditures (housing,	126.919	139.814	114.025	25.789**
clothing, etc.)	(135.006)	(158.390)	(105.382)	
Health expenditures	84.130	92.939	75.320	17.620
	(121.547)	(135.521)	(105.283)	
Education expenditures	163.292	197.746	128.838	68.907***
	(284.943)	(335.181)	(219.047)	
Transport expenditures	94.123	99.251	88.994	10.257
	(146.443)	(153.309)	(139.358)	
Social expenditures (communication, social	107.038	123.389	90.687	32.701**
events, etc.)	(158.138)	(189.635)	(116.694)	
Financial expenditures	18.639	36.642	0.635	36.008
	(256.859)	(362.670)	(6.160)	
Miscellaneous expenditures	57.826	49.895	65.756	-15.861
	(156.132)	(110.326)	(191.191)	
Observations	500	250	250	

Notes: Sample mean values are shown with standard deviations in parentheses. * $p<0.10$; ** $p<0.05$; *** $p<0.01$

2.4.2 Average effects of Fairtrade

Estimation results of the full-sample regression models are summarized in Table 2.3 (complete model results are shown in Tables A1.6-8 in the Appendix). Due to non-random self-selection of farm households into Fairtrade certification, the IV model results in column (2) are more reliable than the ordinary least squares (OLS) results in column (1) of Table 2.3. The effects of Fairtrade on consumption expenditures can be interpreted in percentage form (semi-elasticities).[4] After controlling for possible confounding factors, Fairtrade certification increases total consumption expenditures by 8.5%. This estimate is statistically significant at the 95% confidence level.

[4] For the regression analysis, all consumption expenditures were transformed using the inverse hyperbolic sine (IHS) transformation for better empirical fit (Friedline, Masa, and Chowa 2015). The IHS is similar to the log transformation but helps to preserve zero observations, which occur for some of the expenditure categories. Semi-elasticities for percentage interpretation were calculated as described in Bellemare and Wichman (2019).

Table 2. 3: Effects of Fairtrade certification on per capita consumption expenditures and food security

	(1) OLS model results	(2) IV model results
Total consumption expenditures	0.0697**	0.0854**
	(0.03)	(0.04)
Food expenditures	0.00515	0.00319
	(0.04)	(0.04)
Non-food expenditures	0.146***	0.182***
	(0.04)	(0.05)
Food security indicators		
Undernourished (1/0) [a]	0.136	0.162
	(0.16)	(0.21)
HDDS	-0.0676	0.0781
	(0.18)	(0.22)
FCS	-0.544	0.409
	(1.24)	(1.46)
Categories of non-food expenditures		
Basic living expenditures	0.0656	0.112*
	(0.05)	(0.06)
Health expenditures	0.0104	0.0598
	(0.06)	(0.07)
Education expenditures	0.244**	0.330**
	(0.11)	(0.13)
Transport expenditures	0.208*	0.282**
	(0.12)	(0.14)
Social expenditures	0.107*	0.121*
	(0.06)	(0.07)
Financial expenditures	0.143**	0.188**
	(0.07)	(0.09)
Miscellaneous expenditures	-0.0111	-0.121
	(0.12)	(0.15)
Observations	500	500

Notes: The effects on consumption expenditures are semi-elasticities that can be interpreted in percentage terms. The effects on the food security indicators are marginal effects. Robust standard errors are shown in parentheses. Separate models were estimated for each outcome variable as shown in Tables A1.6-8 in the Appendix. [a] Probit specifications were used for the binary outcome variable 'undernourished'. * $p<0.10$; ** $p<0.05$; *** $p<0.01$

The positive effect of Fairtrade on total consumption expenditures is entirely driven by increases in non-food expenditures. Fairtrade increases aggregate non-food expenditures by 18.2%, with significantly positive effects in terms of most non-food expenditure subcategories. For instance, Fairtrade increases the spending on basic living (housing, clothing) by 11%, on education by 33%, on transportation by 28%, and on communication and social events by 12% (lower part of Table 2.3). These are clear indications that Fairtrade improves various dimensions of household living standard.

However, the estimates in Table 2.3 also show that Fairtrade has no significant effects on food expenditures. Also, when we use calorie undernourishment, HDDS, or FCS as dependent variables we do not find significantly positive effects of Fairtrade, suggesting that Fairtrade certification does not improve food security.

That income and expenditure elasticities are larger for many non-food goods and services than for foods is unsurprising and consistent with Engel's law: When households get richer, the expenditure share spent on food tends to decline. However, zero effects on food expenditures in spite of significant Fairtrade income gains are surprising, especially given that many of the households in the sample suffer from undernourishment and low dietary diversity. The null effects on food expenditures are probably due to the fact that Fairtrade mostly increases cocoa income, which occurs seasonally and is hardly used for regular household food purchases. This interpretation is further supported by the significantly positive effect of non-cocoa income on food expenditures in Table A1.7 in the Appendix. Interesting to observe in Table A1.7 is also that a female household head increases food expenditures, implying that more is spent on food and nutrition when the income is controlled by women. Issues of gendered control of cocoa income and possible implications for the food security effects of Fairtrade are discussed further below.

Food expenditures, as defined here, include food consumption from market purchases, own production, and other sources. Beyond expenditures, an interesting question is whether Fairtrade certification has any influence on what share of the food consumed is obtained from what particular source. As Fairtrade certified households may specialize more on cocoa production, it is possible that their income from cash cropping increases at the expense of own food production (Meemken, Spielman, and Qaim, 2017; Schleifer and Sun, 2020). This could mean that Fairtrade households rely more on food market purchases and obtain less of their food consumed from own production. However, Table 2.4 shows that such shifts in the food sources are not observed among cocoa farmers in Côte d'Ivoire. Both, certified and non-certified farm households obtain around two-thirds of all the food items consumed from market purchases and the rest mostly from own production. The share of foods from own production is even somewhat higher among Fairtrade certified households, although the differences between the groups are small.

Table 2. 4: Sources of foods in Fairtrade certified and non-certified households

	Certified	Non-certified	Mean difference
Share of food items from market purchases	0.646	0.670	-0.024
Share of food items from own production	0.331	0.300	0.030**
Share of food items from gifts	0.022	0.029	-0.007*
Share of food items from mixed sources	0.001	0.000	0.001
Observations	250	250	

* $p<0.10$; ** $p<0.05$

One aspect that deserves some further attention is the fact that of the 25 Fairtrade certified cooperatives in our sample 16 are additionally certified by UTZ and/or Rainforest Alliance. Hence, it is interesting and important to analyze whether double or triple certification has additional effects or changes any of the Fairtrade effects discussed so far. We tested this by re-running the regression models and additionally including a dummy variable for double or triple certification (Table A1.9 in the Appendix). This additional dummy variable is not significant in any of the models, while the Fairtrade effects on food and non-food expenditures remain robust.[5]

Another potential issue in our regression models is that individual control variables – especially non-cocoa income – may possibly be endogenous and correlated with Fairtrade certification, which could bias the estimated Fairtrade effects. We tested this by excluding non-cocoa income and found the Fairtrade results to be robust.

2.4.3 Effects of Fairtrade on poor and non-poor households

We now analyze the effects of Fairtrade certification separately for poor and non-poor households, using the 3.20 PPP dollar poverty line as the threshold to split the sample. Table A1.10 in the Appendix shows that in both subsamples Fairtrade certified households have higher cocoa yields, prices, and incomes than non-certified households. Interestingly, the percentage difference in cocoa income between certified and non-certified households is larger among poor households (69%) than among non-poor households (23%).

The IV regression results for the two subsamples are summarized in Table 2.5 (complete model results are shown in Tables A1.8, 11, and 12 in the Appendix). As can be seen, Fairtrade has a significantly positive effect on aggregate consumption expenditures of poor households (13.6%), but not of non-poor households. This sizeable gain in aggregate living standards for households below the poverty line indicates that Fairtrade certification is a pro-poor market intervention. It should be stressed that our sample is confined to commercial cocoa producers,

[5] Note that insignificance of the double or triple certification dummy in Table A1.9 cannot be interpreted as UTZ and/or Rainforest Alliance having zero effects on farm household living standards. We only show that these other standards have no *additional* effects on top of the Fairtrade effects discussed above. A more detailed comparison of the effects of different standards would require observations of cooperatives and households that are certified only under UTZ or Rainforest Alliance and not also under Fairtrade. Our sample does not include such observations. Another interesting question is why cooperatives and households decide to be certified under various standards, if double or triple certification does not lead to additional benefits. The reason is that different standards focus on different sustainability dimensions. For instance, while Fairtrade concentrates primarily on economic and social dimensions, Rainforest Alliance has a stronger focus on environmental criteria. Some cocoa processors and exporters require certification under specific standards.

who do not necessarily belong to the poorest of the poor, but within this group of farmers Fairtrade seems to benefit the poorer ones over-proportionally.[6] This is a welcome finding from a social development perspective.

Table 2. 5: Effects of Fairtrade on poor and non-poor households (IV model results)

	(1) Poor households	(2) Non-poor households
Total consumption expenditures	0.136***	0.00421
	(0.05)	(0.05)
Food expenditures	0.0392	-0.0754
	(0.05)	(0.07)
Non-food expenditures	0.228***	0.118*
	(0.07)	(0.06)
Food security indicators		
Undernourished (1/0)	0.0670	0.167
	(0.30)	(0.31)
HDDS	0.376	-0.0494
	(0.28)	(0.33)
FCS	0.819	0.681
	(1.81)	(2.20)
Categories of non-food expenditures		
Basic living expenditures	0.137*	0.0285
	(0.07)	(0.09)
Health expenditures	0.153	-0.0481
	(0.10)	(0.10)
Education expenditures	0.253	0.509**
	(0.18)	(0.20)
Transport expenditures	0.173	0.388**
	(0.20)	(0.18)
Social expenditures	0.107	0.0928
	(0.10)	(0.08)
Financial expenditures	0.146	0.152
	(0.14)	(0.09)
Miscellaneous expenditures	-0.0207	-0.269
	(0.20)	(0.22)
Observations	262	238

Notes: The effects on consumption expenditures are semi-elasticities that can be interpreted in percentage terms. The effects on the food security indicators are marginal effects. Robust standard errors are shown in parentheses. Poor households are those with a per capita income of less than 3.20 PPP dollars per capita and day; non-poor households have incomes above this threshold. Separate models were estimated for each outcome variable as shown in Tables A1.8, 11, and 12 in the Appendix. * $p<0.10$; ** $p<0.05$; *** $p<0.01$

Another notable result in Table 2.5 is that – despite the large positive effects on total consumption expenditures of the poor – Fairtrade has no significant effect on food expenditures or the food security indicators of this group. The aggregate Fairtrade gain is primarily due to non-food expenditures, which increase by almost 23% among the poor. Further disaggregation

[6] A larger effect of Fairtrade on the consumption expenditures of poor households alone would not necessarily mean that poor households benefit more, as it is possible that non-poor households save a larger fraction of their income gains. However, given that we also observe larger income differences between certified and non-certified households in the poor subsample, our cautious conclusion of over-proportional benefits for poor households seems to be justified.

of non-food expenditures in the lower part of Table 2.5 suggests that Fairtrade significantly increases basic living expenditures of the poor, including basic needs such as housing and clothing. Effects on several other non-food expenditure categories are also positive but not statistically significant among poor households.

While Fairtrade has no significant effects on total consumption expenditures of non-poor households, it increases their non-food expenditures by 11.8% (column 2 of Table 2.5). For non-poor households, we do not observe significant effects on basic living expenditures or health expenditures, but especially their education and transport expenditures are increased considerably through Fairtrade certification. This is plausible, as for non-poor households the most basic needs are already satisfied. In this situation, the Fairtrade income gains are used to further improve life quality and invest more into child education.

In addition to this analysis with two subsamples (poor and non-poor households), we used the whole sample to run quantile regressions and compare the effects of Fairtrade on household living standards for different expenditure segments. Results of these quantile regressions are summarized in Table A1.13 in the Appendix. These additional findings support the main results and conclusions: for all segments, Fairtrade leads to significant increases in non-food consumption expenditures, but not in food expenditures. The effects on aggregate living standards are particularly large for the poorer households and statistically insignificant for the richest segment of cocoa farmers.

2.5 Discussion and conclusion

We have analyzed the effects of Fairtrade certification on farm household living standards and food security with survey data from the cocoa sector in Côte d’Ivoire. While the concrete results are specific to Côte d’Ivoire, some broader lessons can also be learned, as the conditions of cash cropping and Fairtrade certification are similar also in many other countries of Africa. We should also stress that our survey data were collected in 50 different and randomly selected cooperatives, thus representing a broad variety of institutional conditions and allowing statements beyond a narrow case-study setting. In this final section, we discuss our main findings in the light of the existing empirical literature on Fairtrade and sustainability certification.

First, we found that Fairtrade certification increases aggregate living standards of participating farm households. We measured living standards in terms of per capita household consumption expenditures and estimated an average gain of around 9%. Positive effects of Fairtrade on farm household living standards were also found in previous studies for cocoa in Côte d'Ivoire and for coffee in Uganda (Sellare et al., 2020b; Meemken, Spielman, and Qaim, 2017; Chiputwa, Spielman, and Qaim, 2015). These positive effects are primarily the result of higher output prices in Fairtrade certified markets and higher yields through better access to inputs, technologies, and agricultural training. However, Mitiku et al. (2017) found no positive living standard effects of Fairtrade among coffee farmers in Ethiopia, largely because the coffee cooperatives there were not efficiently organized. Well-managed cooperatives or farmer groups are an important precondition for smallholders to benefit from Fairtrade and other sustainability standards, because individual certification is hardly possible in the small farm sector due to excessive transaction costs.

Second, we found that Fairtrade has larger positive effects for poor than for non-poor farm households. Fairtrade increases total consumption expenditures of farm households below the poverty line by 14%. This is a welcome finding from a social development perspective, indicating that Fairtrade can contribute to poverty reduction and pro-poor rural development. While another study in Uganda also suggested that Fairtrade helps to reduce poverty in the small farm sector (Chiputwa, Spielman, and Qaim, 2015), we are not aware of previous research that analyzed differential effects of Fairtrade on poor and non-poor farm households. Whether Fairtrade really reaches the poorest households is a different question, as Fairtrade focuses on cash crops that are not always grown on a significant scale by marginalized farms. But among those who grow cash crops and who are Fairtrade certified, the social development effects are clearly positive.

Third, in spite of positive effects on total consumption expenditures, we found no significant effects of Fairtrade on food expenditures and food security. This is surprising because many of the farm households in our sample suffer from food insecurity and undernourishment. However, Fairtrade primarily increases the cash revenue and income from cocoa sales, whereas our data show that non-cocoa income is more relevant for food purchases and food consumption. As cocoa cash revenues accrue only twice a year after the cooperatives have sold the harvested quantities at the end of the season, these revenues are typically not used for regular food purchases but for larger occasional expenses such as durable consumer goods or education-related costs. This is what many local farm households confirmed in informal discussions. The same was also observed for Fairtrade coffee certification in Uganda, which was shown to increase education expenditures but not food expenditures in smallholder farm households (Meemken, Spielman, and Qaim, 2017).

Another likely reason why Fairtrade income gains are less relevant for food expenditures is that revenues from cash crops are mostly controlled by male household members, whereas food purchases and food preparation are typically female responsibilities. While in our survey we did not collect data on who in the household controls the income generated from different sources, it is well established in the literature on smallholder farming in Africa that cash crop revenues are mostly in the male domain (Chiputwa and Qaim, 2016; Hill and Vigneri, 2014; Fischer and Qaim, 2012a; Duflo and Udry, 2004). It is equally well established that female-controlled income tends to have more positive effects on food expenditures and household diets than male-controlled income (Ogutu, Gödecke, and Qaim, 2020; Fischer and Qaim, 2012a; Hoddinott and Haddad, 1995). These patterns should not be interpreted as if income gains from cash cropping could never contribute to improved food security and nutrition. But the gender dimensions need to be considered. Chiputwa and Qaim (2016) showed that Fairtrade certification in Uganda involves gender awareness training and specific support measures for women, contributing to female empowerment and improved nutrition in certified households. But such gender equity measures are voluntary in Fairtrade certification and therefore not implemented everywhere (Meemken and Qaim, 2018). Including gender equity measures more generally in sustainability certification, and combining them with nutrition training, could be useful for improving food security and dietary quality in smallholder farm households.

Fourth, the effects of Fairtrade on different categories of non-food expenditures differ between poor and non-poor households. For poor households, positive effects are primarily observed in terms of increased basic living expenditures, such as clothing and housing. For non-poor households, larger effects are observed for education and transport expenditures. Positive effects of Fairtrade on child education were also shown in a few previous studies (Akoyi, Mitiku, and Maertens, 2020; Meemken, Spielman, and Qaim, 2017; Becchetti, Conzo, and Gianfreda, 2012). Fairtrade prohibits the use of child labor, which may possibly contribute to higher school attendance in certified households. Moreover, the Fairtrade premium is sometimes used by cooperatives to increase awareness for the importance of education and improve schooling conditions in local communities. Finally, rising incomes tend to increase the demand for child schooling, at least when households are beyond a certain minimum income threshold where child labor becomes less common (Fan, 2011; Basu and Van, 1998). This latter point is consistent with our finding that Fairtrade increases education expenditures only for households above the poverty line.

In conclusion, our findings suggest that Fairtrade helps to improve living standards of farm households when evaluated in aggregate form, but tends to have uneven effects on different dimensions of living standard. Differences are partly due to the seasonal patterns and gendered control of cash crop revenues. Food security and food expenditures are less affected by Fairtrade than non-food related dimensions of household welfare. One research implication is that studies seeking to understand the social effects should go beyond just looking at aggregate income or consumption values, as these aggregate measures can mask important facets of social welfare. One policy implication is that Fairtrade and other sustainability standards should be further improved to avoid potential tradeoffs between different welfare and sustainability dimensions.

3

Cheap chicken in Africa: would import restrictions be pro-poor?[7]

Abstract

Europe's chicken exports to Africa have long been criticized for their negative effects on local producers. However, while cheap chicken imports may hurt African poultry farmers, the same cheap imports benefit consumers and improve their access to affordable nutrients. A few African countries have established import restrictions to protect their farmers, but it is unclear how such policies affect different population groups and whether the aggregate benefits outweigh the costs. We use nationally representative household data from Ghana and a partial-equilibrium framework to simulate the production, consumption, and overall welfare effects of two hypothetical policies, namely a 50% import tariff on chicken and a complete import ban. Our results suggest that both policies would lead to increased domestic chicken prices with negative consumption effects that are larger than the positive production effects. Poor and non-poor households in rural and urban areas would suffer welfare losses from these import restrictions. Only a small fraction of very poor rural households would benefit. The findings imply that chicken import restrictions are not a useful policy. To compensate those particularly hurt by cheap chicken imports, targeted support measures would make more sense economically and socially.

Keywords: Trade policy; domestic production; consumer welfare; poverty; welfare analysis; Ghana

[7] This essay is authored by Isabel Knößlsdorfer and Matin Qaim. IK developed the research idea, curated the data, implemented the econometric modelling, conducted the analysis, wrote the first draft and revised the essay. MQ developed the research idea, commented on various stages of the analysis, and revised the essay.

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3.1 Introduction

In many African countries, imports of chicken have increased rapidly over the last 20 years (FAOSTAT, 2021a, 2021b; Zhou and Staatz, 2016). This is especially true in West Africa, where domestic chicken production has not kept pace with the rapidly rising demand (FAOSTAT, 2021c; FAO, 2014). The cheap imports of chicken – mainly coming from the European Union and to a lesser extent from the USA and Brazil – have received a lot of attention in public debates about trade liberalization, food security, and poverty (Rudloff and Schmieg, 2017, 2016; Fritz, 2011; Hermelin, 2004). On the one hand, developing countries may benefit from cheap imports, as these help to keep domestic prices low and thus improve poor people's access to nutritious foods (Cornelsen et al., 2015; Green et al., 2013; Ivanic, Martin, and Zaman, 2012; Zachary, 2004). On the other hand, cheap imports of chicken have long been criticized for hurting the local poultry production sector (Rudloff and Schmieg, 2017; Fritz, 2011; Hermelin, 2004). Agriculture is an important source of income for many of the poor (ILOSTAT, 2019; Shimeles, Verdier-Chouchane, and Boly, 2018). This is also why a few African countries have imposed protectionist policies, either by raising import tariffs or by banning chicken imports altogether (Kornher and von Braun, 2020; WTO, 2014; Fritz, 2011).

Here, we evaluate the benefits and costs of chicken import restrictions for producers and consumers in Africa. In particular, for the case of Ghana, we analyze the effects of two hypothetical policies – a 50% import tariff and an import ban – on domestic chicken production, consumption, and overall welfare, using household-level data and a partial equilibrium framework. Ghana is an interesting example because the country has been importing cheap chicken for many years, but – unlike a few other West African countries – has not yet imposed high imports tariffs (FAOSTAT, 2021a; MoFA, 2021; OEC, 2021; Johnson, 2011). Hence, we can compare the status quo of large quantities of cheap chicken imports with hypothetical scenarios in which we assume protectionist policies.

While the welfare and distributional effects of chicken import restrictions in African countries have not been evaluated previously, our study builds on the broader literature about the impacts of trade and price policies on poverty, inequality, and food security (Mahadevan, Nugroho, and Amir, 2017; Soumahoro, 2017; Swinnen and Squicciarini, 2012; Winters and Martuscelli, 2014; Bureau, Jean, and Matthews, 2006; Panagariya, 2005; Chen and Ravallion, 2003; Litchfield, McCulloch, and Winters, 2003). This existing literature suggests that trade liberalization – meaning the reduction or abolition of protectionist policies – has mostly positive effects on incomes and poverty in general (Winters and Martuscelli, 2014). Protectionist policies can lead to higher prices and higher profits for domestic producers, but are also associated with higher prices for consumers. In the case of food, higher prices hurt poor consumers over-proportionally, as poor people spend a higher share of their income on food than rich people (Dorward, 2012; Ivanic, Martin, and Zaman, 2012; Minot and Goletti, 2000). The total welfare effects typically depend on whether a country or household is a net producer or consumer (Kornher and von Braun, 2020; Magrini, Balié, and Morales-Opazo, 2017; Mahadevan, Nugroho, and Amir, 2017; Chauvin and Ramos, 2013; Swinnen and Squicciarini, 2012). While smallholder farmers often make up a large fraction of the poor in Africa, many of them are net consumers of food, meaning that they buy more food than they sell (Ivanic and Martin, 2014). In addition to the direct price effects, protectionist policies can lead to unintended side-effects, as the example of Nigeria shows: after a long history of import restrictions (International Trade Administration, 2021; Oyejide, Ogunkola, and Bankole, 2005), a complete import ban on poultry and other meat products is now leading to rising incidents of border smuggling, undermining not only the domestic price targets, but also food safety, health, and other policy objectives (Rudloff and Schmieg, 2017; Ogunleye et al., 2016; Golub, 2012).

The rest of this article is structured as follows. In section two, we provide an overview of chicken consumption, production, and trade in Ghana. In section three, we explain the methodological approach used for the policy simulations and welfare analysis, including the data and assumptions. The results are presented in section four, while section five discusses the findings and draws some conclusions.

3.2 Background

In Ghana, chicken meat is popular and consumption levels are rising steadily. Nevertheless, with an average current consumption of 8.6 kg per capita and year, consumption levels still remain below the worldwide average (FAOSTAT, 2021b). One reason is the relatively high consumption of fish, which accounts for 60% of all animal protein consumed in Ghana (Netherlands Enterprise Agency, 2020; Komatsu and Kitanishi, 2015).

Ghana’s growth in chicken consumption occurs in urban and rural areas alike (USDA Foreign Agricultural Service, 2017). Domestic production has not kept pace with this growth in demand, so the imported quantities have been rising over time. Figure 3.1 shows that imports now account for three-quarters of the total poultry meat supply in Ghana. Chicken is mostly imported from European countries, especially the Netherlands, Poland, Belgium, and Germany (OEC, 2021).

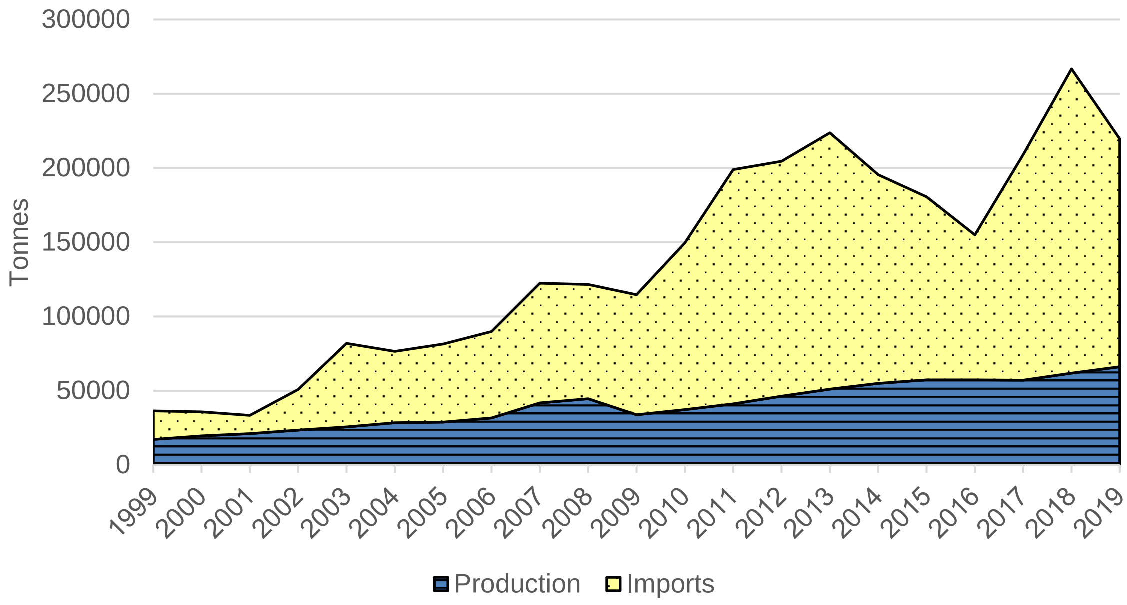

Figure 3. 1: Total supply of poultry meat in Ghana, domestic production, and imports (FAOSTAT, 2021b, 2021c)

Table 3.1 provides an overview of domestically-produced and imported chicken quantities and consumer market prices in 2017, the reference year for our analysis (as explained below, the household survey data were collected in 2017). Prices paid for domestic chicken meat are almost 40% higher than for imported products. This means that both types of chicken are not perfect substitutes. Domestic and imported chicken differ in terms of freshness, taste, convenience, and other attributes (Kwakwa, 2013; Woolverton and Frimpong, 2013; Opoku and Akorli, 2009). Most of the imported chicken meat comes in the form of pre-cut, frozen pieces (Kornher and von Braun, 2020; USDA Foreign Agricultural Service, 2017), whereas local chickens are sold fresh and often live. Households choose their preferred type of chicken according to their preferences and accessibility in the local context. Price is obviously not the only determinant, even though the availability of cheap chicken imports is a strong reason for the rapidly rising poultry meat consumption in Ghana (Osei-Asare and Eghan, 2014).

Table 3. 1: Domestic production and imports of chicken meat in Ghana (2017)

	Supply (tonnes)	Market price (GHS per kg) mean/sd
Domestic production: live chicken	57,099	15.206 (2.107)
Imports: frozen chicken	147,538	9.503 (5.131)
Total supply of chicken (domestic and imported)	204,637	
Average consumer market price		11.092 (3.752)

Notes: Production and import measures taken from (FAOSTAT, 2021c). Market prices in Ghanaian cedi (GHS) per kg estimated from the 7th round of GLSS community survey data, showing means across regions.

Different types of producers are involved in domestic chicken production in Ghana. Large and medium-sized commercial farms account for a significant share of the country’s broader poultry sector, but these commercial poultry farms mainly focus on egg production (Netherlands Enterprise Agency, 2020). In other words, selling chicken meat is not their main business. This focus on eggs in the commercial poultry sector is partly a result of the cheap chicken meat imports that local producers can hardly compete with (USDA Foreign Agricultural Service, 2017; Banson, Muthusamy, and Kondo, 2015; FAO, 2014). Most of the broilers in Ghana are kept by small-scale farms for home consumption and market sales. Market sales of live birds often increase especially around festivals and public holidays (Amanor-Boadu, Nti, and Ross, 2016).

One reason why broiler farms in Ghana can hardly compete with imports from Europe is the lower productivity of the locally used breeds. In addition, feed, energy, and transport costs are relatively high, especially for farmers in remote locations (Al-Hassan Noah, Larvoe, and Adaku, 2014). In the European Union, farmers also benefit from subsidies, which are not directed at chicken but lead to higher farm incomes anyway. Moreover, European consumers have a strong preference only for certain chicken parts, such as breasts, meaning that other parts are often exported at low prices (Kornher and von Braun, 2020; Rudloff and Schmieg, 2016; Fritz, 2011). The government of Ghana has tried to increase productivity and competitiveness in the local poultry sector through various support programs, including input subsidies (MoFA, 2021, 2020; Republic of Ghana, 2019). Also, import tariffs for chicken and most other types of meat were raised to 35% according to the Economic Community of West African States’ (ECOWAS) ‘common external tariff’ regulations in 2015 (WTO, 2021; ECOTIS, 2021), after a period of frequent tariff changes between the 1990s and around 2010 (Banson, Muthusamy, and Kondo, 2015; WTO, 2014; FAO, 2014; Johnson, 2011). So far, the effect of these policies in terms of reducing imports seems to be limited. Potential effects of higher import tariffs are analyzed in the following.

3.3 Materials and methods

We want to evaluate effects of higher import tariffs for chicken on household consumption, production, and overall welfare in Ghana. As explained above, Ghana currently has an import tariff of 35% for chicken meat in place. This is the status quo in our analysis. As counterfactuals, we use two hypothetical tariff scenarios, namely (i) an import tariff of 50% and (ii) a prohibitive tariff that would lead to zero imports, equivalent to an import ban. We assume a homogeneous market for domestically-produced and imported chicken with one average domestic price. As explained in the previous section, both types of chicken are not perfect substitutes in reality, but the market segments are closely related, so the simplified assumption should be acceptable for getting a general idea of the likely effects.

A higher import tariff on chicken meat will lead to lower import quantities and higher average domestic prices. The magnitude of the price change depends on the level of the tariff and on domestic chicken supply and demand curves, which are characterized by the own-price elasticities of supply and demand. We use results from the price change calculations for further analysis with household-level data. For each household, we calculate how the price change would affect chicken production and consumption in quantity terms. In addition, we evaluate welfare effects in monetary terms by computing the compensating variation (CV) for each household. Results are summarized for different groups of households, including poor and non-poor households in rural and urban areas, building on official poverty lines per adult equivalent for Ghana (Ghana Statistical Service, 2018). Further details of the data and approaches are explained in the following.

3.3.1 Survey and data

We use data from the 7th round of the Ghana living standards survey (GLSS7), a nationally representative household survey with about 14,000 household observations (Ghana Statistical Service, 2019). The survey was conducted in 2016/2017 and includes a wide range of data on household agricultural and other economic activities as well as food and non-food expenditures. Food consumption quantities and expenditures were collected over the course of 12 months through multiple household visits. In each visit, households were asked to report on quantities of various food items consumed over a five-day recall period. The survey data differentiate between the consumption of fresh and frozen chicken meat. We show the consumption of both categories in the descriptive statistics, but then aggregate to one joint category for the further analysis, as explained above.

In addition to the household-level data, local market price data were also collected (Ghana Statistical Service, 2019). We use regional-level average market price data for chicken to represent the status quo of consumer prices in our analysis. These average consumer prices are calculated by weighting prices for fresh and frozen chicken with regional quantity shares. Producer sales prices are calculated as unit values based on the household-level data by dividing the monetary revenues from chicken sales by the quantities sold. Hence, chicken sales prices are available only for those households that actually sold chicken during the survey year.

3.3.2 Modeling framework

We use a simple partial-equilibrium model of chicken supply and demand in Ghana, assuming that other sectors of the economy would be unaffected. This assumption seems justified since chicken is only a small part of the country's overall economy. Higher import tariffs will lead to higher domestic prices. For the calculation of the price changes, we need the own-price elasticities of domestic demand and supply.

For the own-price elasticity of chicken demand (PED), several estimates are available for Ghana (Ansah, Marfo, and Donkoh, 2020; Osei-Asare and Eghan, 2014). The study by Ansah, Marfo, and Donkoh (2020) is the most recent one; it used the 6th round of the GLSS. We use their PED estimates for rural and urban areas and weighted by the proportion of households in rural/urban areas in GLSS7, resulting in a mean PED of -0.86. Note that this PED only applies to chicken purchased in the market. The consumption of own-produced foods is typically much less price-responsive than market purchases. Indeed, for own-produced foods often a price elasticity of zero is assumed in the literature (Alston, Norton, and Pardey, 1995). In the absence of more concrete estimates, we follow this assumption of a zero PED for own-produced chicken meat.

For the own-price elasticity of chicken supply (PES), we reviewed the literature but could not find available estimates for Ghana or other African countries. Studies from other parts of the world report PES values for chicken between 0.36 and 0.94 (Revell, 2015; Rezitis and Stavropoulos, 2011; Dagdemir, Demir, and Keskin, 2004; Shiptsova, Thomsen, and Goodwin, 2002; Bhati, 1987). Based on these estimates from other regions, we assume a PES for chicken in Ghana of 0.5. In a sensitivity analysis, we use a somewhat higher PES of 0.8.

Using these elasticities and based on consumer market prices and producer sales prices as observed in the status quo, we calculate price changes as well as production and consumption changes for chicken in the two hypothetical tariff scenarios. Consumption is measured in kilograms consumed per AE and year and consumption expenditures in Ghanaian cedi (GHS). Production is measured in kilogram of chicken sold per household and year and in terms of annual chicken income in GHS.

Based on the estimated changes in consumption and production, we also calculate welfare effects for each of the two tariff scenarios by computing the compensating variation. The CV was originally proposed and defined by Hicks (1942) and is a frequently-used measure of the welfare effects of price policies (Magrini, Balié, and Morales-Opazo, 2017; Benfica, 2014; Osei-Asare and Eghan, 2013; Azzam and Rettab, 2012; ul Haq, Nazli, and Meilke, 2008)). The CV is a measure of the monetary transfer required to compensate households for the price change experienced such that the household would remain at the same level of utility. It can be expressed as:

$$CV = e(p_1, u_0) - e(p_0, u_0),$$

where p_0 and p_1 are the price with and without the policy, and u_0 is the initial utility level that shall not change (Benfica, 2014; Osei-Asare and Eghan, 2013; Friedman and Levinsohn, 2002). We calculate the CV for each household, first looking at the consumption and production sides separately and then adding up both effects to obtain the overall welfare impact. Since import tariffs lead to higher prices, we expect welfare losses on the consumption side and welfare gains on the production side. The CV is calculated such that welfare losses would require positive transfers and welfare gains negative transfers as compensation to restore the initial utility levels. In our calculations, we switch the signs of the CV for more straightforward interpretation, meaning that welfare gains are shown as positive and welfare losses as negative values. Welfare gains and losses are expressed in GHS per household.

3.3.3 Limitations

The analysis uses a few simplified assumptions, which should be kept in mind to avoid over-interpretation. First, as already mentioned we assume a homogenous market for chicken meat, even though domestically-produced and imported chicken are not perfect substitutes in reality.

The data available do not allow us to calculate substitution effects more precisely. Second, by looking at consumption and production effects separately, we implicitly assume that markets and household decisions are fully separable, which may not be the case. High transaction costs and other types of market imperfections mean that household production and consumption decisions are often made simultaneously (Key, Sadoulet, and Janvry, 2000). This may possibly mean that we overestimate the market supply response in semi-subsistence farm households.

The possible issue of non-separability also relates to a third limitation, namely our assumption of a zero price-elasticity of demand for chicken from own production. In reality, consumption from own production will likely be adjusted to price changes at least to some extent, especially when prices increase substantially. Unfortunately, the data do not allow us to estimate more detailed demand elasticities for chicken from different sources. A final limitation relates to the time frame of the analysis. Drastic price and quantity changes may lead to short- and long-term effects that are not perfectly predictable with a comparative static partial equilibrium model as used here. For instance, in a situation where over 70% of all chicken comes from imports, a sudden import ban would likely lead to severe shortages in the short term, because domestic supply cannot be increased instantaneously. In the long term, new types of domestic producers and technologies may emerge, possibly leading to larger supply responses than those assumed here. Our estimates are best interpreted as effects that could be expected in the medium-term.

Against the background of these limitations, this study only provides tentative estimates of the general consumption, production, and welfare effects that can be expected from import restrictions for chicken in Ghana. The results should not be over-interpreted as precise measurements.

3.4 Results

We start this section by presenting descriptive statistics of households in the GLSS7 sample and their chicken consumption and production patterns. Then, we look at the estimated price changes in the two import tariff scenarios and their likely effects on chicken consumption and production, before analyzing the overall welfare effects.

3.4.1 Consumption and production of chicken

Table 3.2 shows descriptive statistics for the total sample of households in Ghana, as well as differentiated for poor and non-poor households in rural and urban areas. Around 39% of all households consumed chicken in 2017, mostly frozen chicken products. About 7% consumed chicken from own production, and 5% consumed fresh chicken purchased from the market. Close to 23% of all households owned chicken for meat or egg production, but only 7% sold any chicken during the 12-month survey period. Hence, the proportion of households hurt directly by cheap chicken imports is small. Table A2.1Table A2. 1 and A2.2 in the Appendix show consumption and production including only those households that consumed or produced chicken in 2017.

The disaggregation by household type in Table 3.2 shows that rural households are more likely to own chicken and to sell any chicken than urban households. Also, the quantities sold and the incomes earned from chicken are larger in rural areas, as one would expect. Poor households are more likely to sell chicken than non-poor households, which is true in both rural and urban areas. This means that the poor population segments deserve particular attention when analyzing potential welfare losses from cheap chicken imports. On the consumption side, urban households are more likely than rural households to purchase chicken from the market (frozen or fresh). In both rural and urban areas, non-poor households consume more purchased chicken than poor households, whereas poor households consume more chicken from own production.

Table 3. 2: Chicken consumption and production by households in Ghana (2017)

	Total sample	Total		Urban		Rural	
		Poor	Non-poor	Poor	Non-poor	Poor	Non-poor
Household size (AE)	3.192	4.502	2.742	4.253	2.636	4.531	2.867
	(2.153)	(2.413)	(1.853)	(2.119)	(1.716)	(2.444)	(1.996)
Total expenditure	4357.266	1003.603	5509.353	1256.256	6583.990	974.412	4239.798
	(4827.266)	(415.430)	(5104.665)	(328.385)	(6063.869)	(414.570)	(3229.539)
Food expenditure	2150.734	583.983	2688.962	647.622	2966.394	576.630	2361.209
	(1970.979)	(302.394)	(2013.690)	(260.754)	(2218.518)	(306.025)	(1683.228)
Chicken consumption							
Any chicken (1/0)	0.387	0.264	0.429	0.270	0.416	0.264	0.444
	(0.487)	(0.441)	(0.495)	(0.444)	(0.493)	(0.441)	(0.497)
Frozen chicken (1/0)	0.307	0.144	0.362	0.237	0.372	0.134	0.351
	(0.461)	(0.351)	(0.481)	(0.426)	(0.483)	(0.340)	(0.477)
Consumption quantity of frozen chicken	3.902	0.711	4.998	1.030	5.284	0.674	4.662
	(10.892)	(2.647)	(12.340)	(3.077)	(12.842)	(2.591)	(11.712)
Expenditures for frozen chicken	38.557	6.471	49.580	9.203	52.841	6.155	45.728
	(118.409)	(23.844)	(134.786)	(26.412)	(138.641)	(23.513)	(129.994)
Fresh/live chicken (1/0)	0.052	0.027	0.060	0.022	0.061	0.027	0.059
	(0.222)	(0.161)	(0.238)	(0.145)	(0.240)	(0.162)	(0.236)
Consumption quantity of fresh chicken	0.875	0.262	1.086	0.521	1.068	0.232	1.107
	(5.609)	(3.185)	(6.214)	(7.628)	(5.739)	(2.146)	(6.733)
Expenditures for fresh chicken	11.983	1.769	15.493	1.235	18.081	1.830	12.434
	(77.412)	(16.683)	(88.926)	(9.125)	(101.024)	(17.345)	(71.953)
Own produced chicken (1/0)	0.074	0.122	0.057	0.027	0.018	0.133	0.104
	(0.262)	(0.328)	(0.232)	(0.162)	(0.133)	(0.340)	(0.305)
Consumption quantity of own produced chicken	0.307	0.354	0.291	0.105	0.154	0.383	0.454
	(2.214)	(1.406)	(2.430)	(0.901)	(2.827)	(1.450)	(1.843)
Value of own produced chicken consumed	14.023	14.538	13.846	4.415	7.264	15.708	21.622
	(112.740)	(103.185)	(115.845)	(33.532)	(130.601)	(108.328)	(94.948)
Chicken production							
Household owns chicken (1/0)	0.228	0.389	0.172	0.151	0.067	0.416	0.297
	(0.419)	(0.488)	(0.378)	(0.358)	(0.250)	(0.493)	(0.457)
Chicken sold (1/0)	0.068	0.135	0.045	0.032	0.013	0.147	0.083
	(0.252)	(0.342)	(0.207)	(0.177)	(0.112)	(0.354)	(0.276)
Quantity of chicken sold	1.049	1.577	0.868	0.388	0.630	1.714	1.148
	(17.495)	(6.318)	(19.935)	(2.538)	(23.204)	(6.603)	(15.190)
Value of chicken sold	7.578	12.106	6.022	9.369	2.963	12.422	9.636
	(64.313)	(59.187)	(65.913)	(126.129)	(76.959)	(45.534)	(49.565)
Observations	14009	3582	10427	371	5647	3211	4780

Notes: Own calculations bases on GLSS7. Mean values are shown with standard deviations in parentheses. The survey data include live chicken as whole animals. We used a conversion factor of 2 kg per chicken, as suggested in recent studies for Ghana (Netherlands Enterprise Agency, 2020; USDA Foreign Agricultural Service, 2017). Expenditures are expressed in GHS per AE and year. Quantities consumed are expressed in kg per AE and year. Quantities produced are expressed in kg per household and year. Value of chicken sold is expressed in GHS per household and year.

3.4.2 Effects of higher import tariffs on prices, consumption, and production

Table 3.3 shows current mean market prices for chicken in Ghana and the price changes we calculated for the two hypothetical import tariff scenarios. With a 50% import tariff (up from the current 35% tariff), mean prices for chicken meat would increase by about 7%. With a prohibitive tariff and zero chicken imports, mean prices would increase by 37%.

Table 3. 3: Chicken prices in status quo and hypothetical import tariff scenarios

	Consumer market price	Producer selling prices
Mean meat price at current 35% import tariff in GHS (status quo)	11.093 (3.752)	9.695 (7.919)
Average percentage change in price at 50% import tariff	6.86	
Mean meat price at 50% import tariff in GHS	11.854 (4.158)	10.360 (8.463)
Average percentage change in price at prohibitive import tariff	37.04	
Mean meat price at prohibitive import tariff in GHS	15.202 (2.108)	13.286 (10.853)
Observations	14009	955

Notes: Mean values are shown with standard deviations in parentheses. Prices are shown in GHS per kg.

Table 3.4 shows the effects of these higher prices on the consumption of chicken meat, using the own-price elasticity of demand estimates discussed above. Only those households who purchased any chicken from the market (frozen or fresh) are included here, as these are the only ones affected by changing market prices on the consumption side. With a 50% import tariff, chicken consumption in these households would decrease by about 6%. With a prohibitive import tariff, consumption would decrease by about 32%.

Table 3. 4: Change in consumption through higher import tariffs among households that purchased any chicken

	(1) Total	(2) Rural households	(3) Urban households
Current consumption of purchased chicken	14.373 (20.129)	13.219 (19.064)	15.501 (21.059)
Current expenditures for purchased chicken	149.329 (216.113)	129.632 (194.083)	168.565 (234.095)
Average percentage change in consumption at 50% import tariff		-5.912	
Consumption of purchased chicken at 50% import tariff	13.524 (18.939)	12.437 (17.937)	14.584 (19.815)
Expenditures for purchased chicken at 50% import tariff	159.577 (230.944)	138.528 (207.402)	180.133 (250.160)
Average percentage change in consumption at prohibitive import tariff		-31.906	
Consumption of purchased chicken at prohibitive import tariff	9.787 (13.706)	9.001 (12.981)	10.555 (14.340)
Expenditures for purchased chicken at prohibitive import tariff	204.638 (296.159)	177.646 (265.969)	230.999 (320.801)
Observations	4732	2338	2394

Notes: Mean values are shown with standard deviations in parentheses. Consumption quantities are expressed in kilogram per AE and year. Consumption expenditures are expressed in GHS per AE and year.

Table 3.5 shows the effects of the higher prices on production levels among those households that sold any chicken. With a 50% import tariff, production quantities would increase by about 3%. With a prohibitive import tariff, production quantities would increase by about 19%. Average incomes from chicken would increase by 10% and 62% in the two scenarios, respectively. While these are quite large effects, especially in the prohibitive import scenario with zero imports, it should be stressed that only about 7% of all households are involved in any chicken sales. Hence, the proportion of households that would gain from the import restrictions is much smaller than the proportion of households that would lose as consumers. For the results in Table 3.5, a PES of 0.5 was assumed. Table A2.3 in the Appendix shows alternative results with a PES of 0.8. The production and income effects are slightly larger, but the overall findings remain unchanged.

Table 3. 5: Change in production through higher import tariffs among households that sold any chicken

	(1) Total sample	(2) Rural households	(3) Urban households
Current production of chicken	15.388	12.620	44.095
	(65.371)	(35.873)	(186.320)
Current income from chicken	111.160	98.677	240.595
	(221.826)	(111.698)	(645.146)
Average percentage change in production at 50% import tariff		3.431	
Production of chicken at 50% import tariff	15.917	13.053	45.608
	(67.615)	(37.104)	(192.713)
Income from chicken at 50% import tariff	123.298	109.542	265.928
	(245.068)	(123.263)	(713.076)
Average percentage change in production at prohibitive import tariff		18.519	
Production of chicken at prohibitive import tariff	18.238	14.957	52.261
	(77.478)	(42.517)	(220.825)
Income from chicken at prohibitive import tariff	181.180	160.967	390.769
	(360.116)	(181.129)	(1047.830)
Observations	951	867	84

Notes: Mean values are shown with standard deviations in parentheses. An own-price elasticity of supply of 0.5 is assumed. Production quantities are expressed in kilogram per household and year. Incomes are expressed in GHS per household and year.

It should be stressed that the results reported here are medium-term effects, when domestic production has adjusted to the new situation. In the short term, especially the prohibitive import tariff with zero imports would lead to a sharp drop of chicken supply in Ghana with temporary shortages and price rises that could be much larger than those shown in Table 3.3. But over time, higher prices would incentivize larger domestic production and sales, leading to a new medium-term equilibrium as shown in Tables 3.4 and 3.5.

3.4.3 Welfare effects

Figure 3. 2 presents welfare effects of higher import tariffs for the average household in Ghana (total sample) and for different subgroups of households. We computed CV effects on the consumption and production side separately and then added them up to derive the overall welfare effects. As expected, higher import tariffs would lead to welfare losses on the consumption side and to welfare gains on the production side. The average consumption losses are much bigger than the average production gains, so the overall welfare effects of higher import tariffs would be negative. With a prohibitive import tariff (panel b of Figure 3.2) the

total effects are more than five times larger than with a 50% import tariff (panel a of Figure 3.2).

(a) 50% import tariff

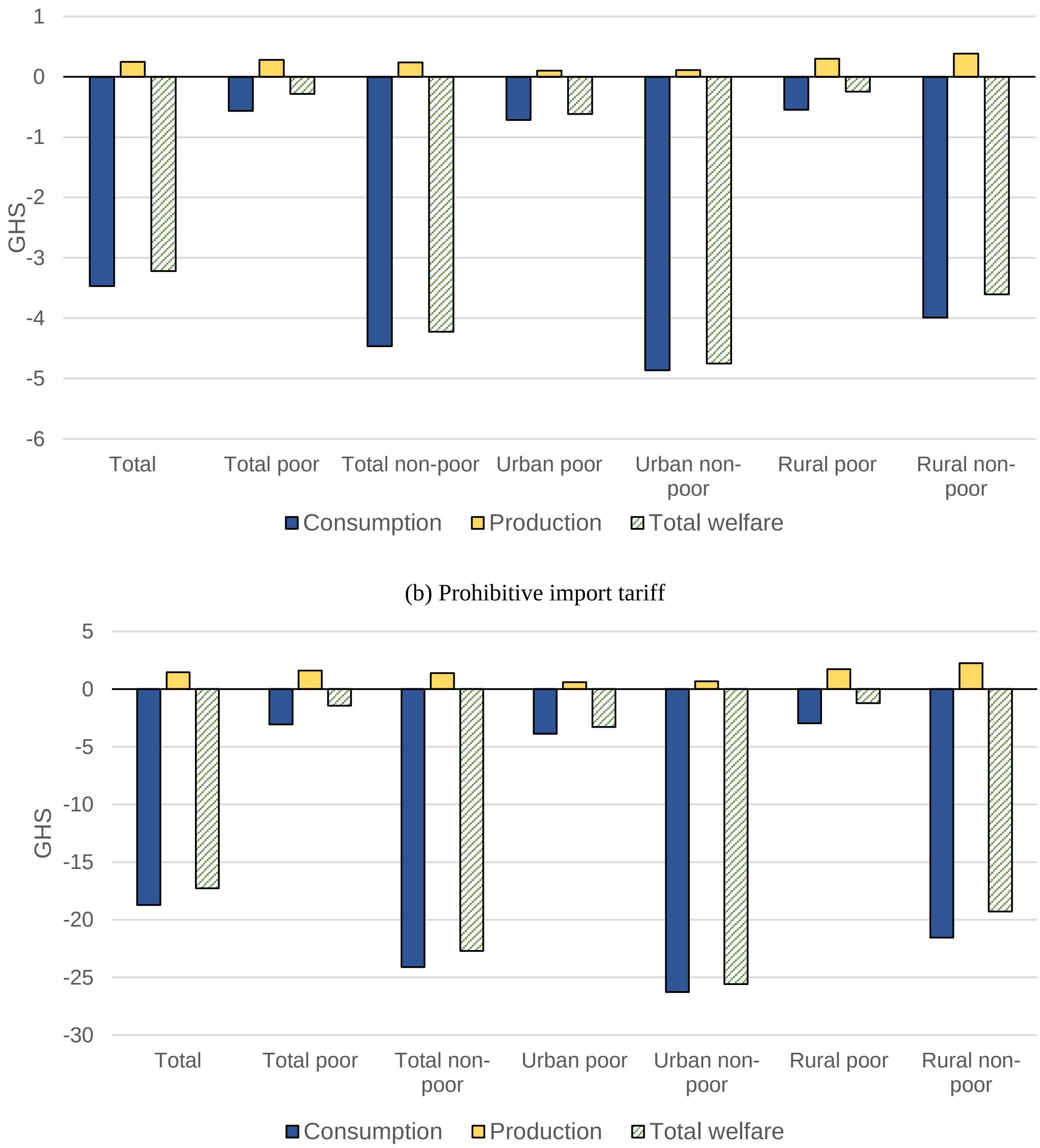

Figure 3. 2: Welfare effects of higher import tariffs for chicken in Ghana (GHS per household)

Notes: Average results are shown for the total sample and for different groups. The analysis includes all households regardless of whether or not they consumed or produced and sold any chicken. Hence, welfare effects can be interpreted as gains and losses for average households in Ghana. Results, including welfare effects in percentage relative to food expenditures, are shown in Table A2.4 in the Appendix.

The finding that the losses through higher import tariffs on the consumption side are larger than the gains on the production side is true for all population groups shown in Figure 3.2, including poor and non-poor and rural and urban households. Non-poor households would suffer more from chicken import restrictions than poor households, as non-poor households in all groups tend to purchase more chicken from the market. However, this does not mean that import restrictions would be pro-poor, because all households would suffer welfare losses.

To get a better sense of the magnitude of the welfare effects shown in Figure 3.2, we also calculated what the gains and losses mean relative to the household's total food expenditures. In both import tariff scenarios and for all groups of households, the total welfare losses would account for less than 1% of total food expenditures, meaning that the effect sizes are small. The main reason for the small effect sizes is that chicken consumption, production, and sales quantities are small for the average household in Ghana. As explained, much of the animal protein in Ghana comes from fish. Less than 40% of all households in Ghana consume any chicken meat at all, and less than 23% produce any chicken.

When we confine the analysis to those households that consumed or produced any chicken, the welfare effects increase in magnitude, but the direction of the effects remains unchanged (Table A2.5 in the Appendix). The overall welfare effects of higher import tariffs remain negative for poor and non-poor households in rural and urban areas. This means that at least in qualitative terms our results may also hold if chicken consumption in Ghana continues to rise. Furthermore, the results may also have some important lessons for other African countries, where chicken consumption is larger than in Ghana.

Table A2.6 in the Appendix shows results of the welfare analysis for all households but assuming a higher own-price elasticity of supply (PES=0.8 instead of 0.5). As one would expect, the gains from higher import tariffs on the production side increase to some extent, but the overall welfare effects remain negative for all groups of households.

In Table A2.7 in the Appendix, we use the standard assumption of PES=0.5 but further disaggregate the group of poor households. In particular, we differentiate between poor and very poor households, using Ghana's extreme poverty line, which in 2017 was 45% below the regular poverty line (Ghana Statistical Service, 2018). While the share of very poor households in urban areas is low, in rural areas more than 40% of all the poor fall into this category. The results in Table A2.7 suggest that for very poor rural households the positive effects of higher import tariffs on the production side outweigh the negative effects on the consumption side, such that the overall welfare effects are positive. This is interesting and different from the other results. However, the positive welfare effects for very poor rural households are small in magnitude: even with a prohibitive import tariff, they would only account for 0.25% of this group's total food expenditures. Also, this group represents only 10% of Ghana's total population, whereas for the other 90% higher import tariffs would be associated with welfare losses. Hence, chicken import restrictions would hardly be an efficient policy to support very poor rural households.

3.5 Discussion and conclusion

Cheap imports of chicken meat coming from Europe and other regions are often perceived as hurting African countries is general, and rural smallholder farmers in particular. A few African countries have established import restrictions to protect farmers, but whether such protectionist measures are really welfare-enhancing and, if so, for what type of households has not been analyzed previously. In this article, we have addressed this research gap by using nationally representative household-level data from Ghana. Ghana has moderate import tariffs for chicken meat in place. Nevertheless, over 70% of the total chicken supply in Ghana comes from imports, mostly in the form of frozen chicken pieces from Europe, and the imported quantities continue to grow. In our analysis, we have used a partial-equilibrium approach to simulate the effects of tightened import restrictions for chicken in two scenarios: (i) a higher import tariff of 50% and (ii) a prohibitive import tariff that would be equivalent to an import ban.

In the status quo, less than 40% of all households in Ghana consumed any chicken. For those households that consumed chicken, frozen imported products were the main source, making up 79% of total consumption. Only 5% of all households consumed fresh, domestically-produced chicken purchased from the market. Around 23% of the households produced chicken, but only 7% of the households sold any chicken during the 12-month survey period.

As expected, higher import tariffs would lead to higher domestic chicken prices. Our analysis revealed that a complete import ban would raise medium-term chicken prices (after adjustments have taken place) by 37%. Higher prices would decrease chicken consumption levels. In the 50% tariff scenario, average consumption would decrease by 6%, whereas in the prohibitive tariff scenario average consumption would decrease by over 30%. On the other hand, average chicken production would increase by around 3% and 19% in the two scenarios, respectively. Accordingly, incomes from chicken production and sales would rise.

We also calculated welfare effects by using the compensating variation as the welfare measure. The welfare losses resulting from higher chicken import tariffs on the consumption side are much larger than the welfare gains on the production side, meaning that the overall welfare effects of the protectionist policies for households in Ghana are negative. The magnitude of the negative welfare effects is larger in the prohibitive tariff scenario than in the 50% tariff scenario, but otherwise the results of both scenarios are similar. We also disaggregated the analysis for different types of households, including poor and non-poor and rural and urban households. Interestingly, for all these groups the overall welfare effects of higher import tariffs would be negative. The reason is that most households that produce and/or consume any chicken are net consumers. Only for very poor households in rural areas (those below the extreme poverty line), higher import tariffs would have small positive welfare effects. But very poor rural households account for only 10% of the total population in Ghana, whereas the other 90% would suffer welfare losses. These other 90% include poor urban households and also moderately-poor rural households.

Given these results, additional import restrictions for chicken cannot be considered a pro-poor policy. In other words – unlike a few other countries in Africa – Ghana has rightly not increased its tariffs to keep cheap chicken imports out of the country. One may consider policy measures to compensate very poor rural households for the small losses they suffer from cheap imports, but higher tariffs would be a very inefficient way of doing so. Targeted support – for instance through technical assistance or direct income transfers – could be much more effective and also less costly. Overall, the cheap chicken imports do not seem to be as harmful for Ghana as often claimed. The same may also hold true for other countries in Africa. Chicken meat is a rich source of protein and micronutrients, so increasing consumption that is facilitated by cheap imports contributes to improved nutrition of income restrained households.

The absolute magnitude of the welfare effects of chicken import restrictions in Ghana is relatively small, largely because the average quantities of chicken consumed and produced per household in Ghana are small. Around 60% of all the animal protein consumed in Ghana comes from fish. The sensitivity analyzes we carried out suggest that the effects would increase in magnitude with rising chicken consumption and production. This may be important also for other African countries, where chicken plays a larger role than in Ghana. In qualitative terms, we expect our results to be similar also in other countries and regions of Africa.

In closing, we should stress that our analysis builds on a few simplified assumptions, so that the exact magnitude of the effects should not be over-interpreted. Nevertheless, the simulations probably provide reasonable estimates of the medium-term effects of tightened import restrictions. In the long-term, import bans might possibly help to build up a commercial broiler sector in Africa, which at least in Ghana hardly exists due to the availability of cheap imports. But, apart from the fact that an import ban would hurt many domestic households, a relevant question is also whether it would really make economic sense for countries in Africa to foster a commercial broiler sector for which developing international comparative advantage will be very difficult under current conditions. Probably, fostering other agricultural subsectors for which African countries have stronger comparative advantages would make more sense economically and socially. More generally, policies to strengthen local infrastructure, technology, and institutions are much better suited to promote sustainable development than import restrictions.

4

Overfishing in West Africa – links between marine fish production and household consumption in Ghana[8]

Abstract

In low-income coastal countries, a large share of the population depends on fishing and related sectors for their income, and the majority of animal protein consumed comes from fish. While traditionally known as a fishing nation, domestic fish production in Ghana has been struggling in the past and fish imports are increasing. Reason for that are illegal fishing, overfishing, and related symptoms like decreasing catch rates. Currently, there is a lack of information on the relationship between these phenomena and households which rely on fish for both income and food. This analysis uses three waves of nationally representative household-level data and links them to annually aggregated fish catch and import statistics to evaluate trends and relationships between fish production, household-level fishing, and fish consumption. Results suggest that industrial fish production is associated with overfishing and strongly correlated to imports. Both are positively linked to household fish consumption but negatively related to household fishing and fish sales. Small-scale fishing is positively associated with both own consumption and fish sales. Different links are observed for poor and non-poor households.

Keywords: West Africa; overfishing; consumption; illegal fishing; imports

[8] This paper is authored by Isabel Knößlsdorfer, who developed the research idea, curated the data, implemented the econometric modelling, conducted the analysis, wrote the first draft and revised the essay.

Acknowledgment: The author is grateful for comments from Matin Qaim which greatly improved this essay.

4.1 Introduction

In many countries with widespread food insecurity poor households depend on fish as a source of protein, because fish is relatively cheap compared to other sources of animal protein (Hasselberg et al., 2020; Lauria et al., 2018; Nunoo et al., 2014; Kawarazuka and Béné, 2011; Roos et al., 2007). Many households also rely either solely or partly on fishing and related sectors for their income (Ashitey, 2019; Martin, Lorenzen, and Bunnefeld, 2013; Lauria et al., 2018; Akyeampong, 2007; Atta-Mills, Alder, and Sumaila, 2004). The food security and livelihood of these households are threatened as many marine ecosystems show symptoms of overfishing – a consequence of extensive fish production, where fish stocks cannot naturally keep up with the rate of exploitation (Link et al., 2020).

This article looks into recent developments in the fishing industry and explores the relationship between fish production and household behavior using data from Ghana. Ghana's marine area belongs to the Guinea Current LME and already experiences declining fish stocks and marine biodiversity loss (Scheren et al., 2021; Link et al., 2020; Sumaila and Tai, 2020). Based on an extensive review of relevant literature, the utilization of fish production statistics from the Ghanaian marine area, and information on fish imports, this study examines the changes in the fishing sector and their relationships to overfishing. Do recent trends in fishing and fish imports indicate the occurrence of overfishing in Ghanaian waters? By combining fish production and import statistics with three waves of nationally representative household-level data, this study also analyzes the implications of the recent developments in the fishing sector on household consumption and fishing activities. The analysis offers new insights into the relationships between households and possible overfishing. The analysis also differentiates between production of industrial and small-scale fishing sectors, as well as poor and non-poor households, to evaluate dissimilar relationships between fishing and households of different income levels.

In West African coastal communities, it is becoming more difficult for small-scale fishermen and women to sustain their livelihoods through fishing (Hasselberg et al., 2020; Onumah et al., 2020). Declining catch rates – less fish caught per area and unit of effort – forced many fishers to migrate closer to better fishing grounds or switch towards different economic activities to generate sufficient income (Abobi and Alhassan, 2015). Reasons for declining catch rates include the application of illegal and unsustainable fishing methods, as well as the overexploitation of marine areas. Illegal, unreported, and unregulated fishing (IUU) is common (Belhabib et al., 2020; Ashitey, 2019; Merem et al., 2019; Okafor-Yarwood, 2019; Belhabib, Greer, and Pauly, 2018; FAO, 2016; Nunoo et al., 2014; Pramod et al., 2014) and describes fishing without permission, operating against conservation measures, or the violation of other obligations, including the use of illegal fishing methods like dynamite or light fishing (FAO, 2021b; Owusu and Andriesse, 2020). Additionally, registered vessel numbers in marine areas of West Africa have increased for all sectors: industrial, artisanal, subsistence, and recreational (Pauly and Zeller, 2016). As a reaction to decreasing catch rates and increasing competition for resources, many fishers have increased their efforts. Extended fishing periods, more crew members, and the use of unsustainable and illegal fishing methods are supposed to help generate sufficient income but in fact worsen the situation at sea (Yang et al., 2019; Pauly and Zeller, 2016). Over time, fisheries reach economically unprofitable catch rates for the fish population they are targeting and shift their activities towards other more abundant fish populations, where the whole process repeats itself (Link et al., 2020; Alder and Sumaila, 2004). This is called fishing down (from larger species towards smaller ones) and explains how overall production statistics can remain constant or even on the rise in many global fisheries despite overexploitation (Alder and Sumaila, 2004).

All these factors contribute towards overfishing, or ecosystem-overfishing, a situation where catch rates and total landings exceed suitable limits for the ecosystem, because more fish is taken from the sea than can be naturally replaced by the fish population. Thus, fish stocks decrease and total catch declines, which leads to diminishing returns for fisheries (Scheren et al., 2021; Hasselberg et al., 2020; Link et al., 2020; Asiedu and Nunoo, 2015; Srinivasan et al., 2010). Overfishing has severe ecological consequences, including the extinction or near-extinction of some species, the destruction of whole ecosystems, and decreasing the ocean's resilience to climate change (Scheren et al., 2021; Sumaila and Tai, 2020). In addition, it has been estimated that illegal and unreported fishing – two major drivers behind overexploitation – cost African countries more than 10 billion USD each year (Link et al., 2020) and the loss of catch caused by overfishing could have prevented around 20 million people worldwide from being undernourished in the year 2000 (Srinivasan et al., 2010).

Although the topic of overfishing in West Africa is not new, most scientific studies did not specifically look at the link between fish production and household fish consumption. The implications of overfishing and related changes in the fishing industry for the population of low- and middle-income coastal countries have been underrepresented in the literature. This paper addresses this gap by contributing important new aspects on the topic from a socioeconomic perspective in a nationally representative form. First, three waves of nationally representative household data are utilized to compare changes in household fish consumption, production, and sales between 2005, 2012, and 2017. Second, the trends in fish production in Ghana over the years are examined and linked to indicators of overfishing. Third, we combine yearly aggregate fish production and import data on the national level with household data to analyze the relationship between fish production in different fishing sectors, imports, and household fish consumption and production. The analysis differentiates between poor and non-poor households, because fishing is a more important economic activity for the poor.

The rest of the article is structured as follows. In section two, an overview of fish consumption and production in Ghana is given, including trade and production statistics. In section three, the conceptual framework and methodological approach are explained, including the data and methods used for the analysis. Results are presented in section four, and section five discusses the findings.

4.2 Background: fish and fishing in Ghana

With a 550-kilometer coastline and many inland freshwater sources, the fishing sector has always been of great importance for food security, livelihoods, and the economy in Ghana (UNCTAD, 2021; Hasselberg et al., 2020; FAO, 2016; Nunoo et al., 2014). For the most part, the fish consumed in Ghana stems from domestic marine production (Ashitey, 2019; FAO, 2016) and is constituted by small pelagic fish (Hasselberg et al., 2020; Onumah et al., 2020). The majority of this domestic marine catch is landed by small-scale artisanal fishers, operating on approximately 20,000-30,000 artisanal canoes, mostly wooden and some motorized. The rest of the sector consists of about 500 semi-industrial and roughly 70 industrial vessels (Hasselberg et al., 2020; Ashitey, 2019; FAO, 2016; Akyeampong, 2007).

Total fish production in Ghana is estimated to be around 400,000-500,000 metric tonnes a year (Sea Around Us, 2021; Ashitey, 2019; FAO, 2016), with some discrepancies between data sources. Figure 4.1 illustrates production statistics, using data from the Food and Agriculture Organization (FAO) and the Sea Around Us Project (SAU). The SAU data show only landings for the Ghanaian exclusive economic zone (EEZ), while the FAO data include both EEZ and freshwater inland catch. The EEZ is a marine area within which coastal countries exercise sovereign rights and exclusive authority over fishing management (OECD, 2001). Although the FAO data show aggregate landings of marine and freshwater areas, the SAU values are higher, because they include reconstructions of unreported landings. Landings for 2018 are estimated at around 520,000 tonnes by the SAU. FAO statistics include only what is officially reported by the countries themselves, excluding all IUU landings. Official statistics also often exclude statistics on subsistence fishing (Belhabib, Sumaila, and Pauly, 2015; Belhabib, Greer, and Pauly, 2018).

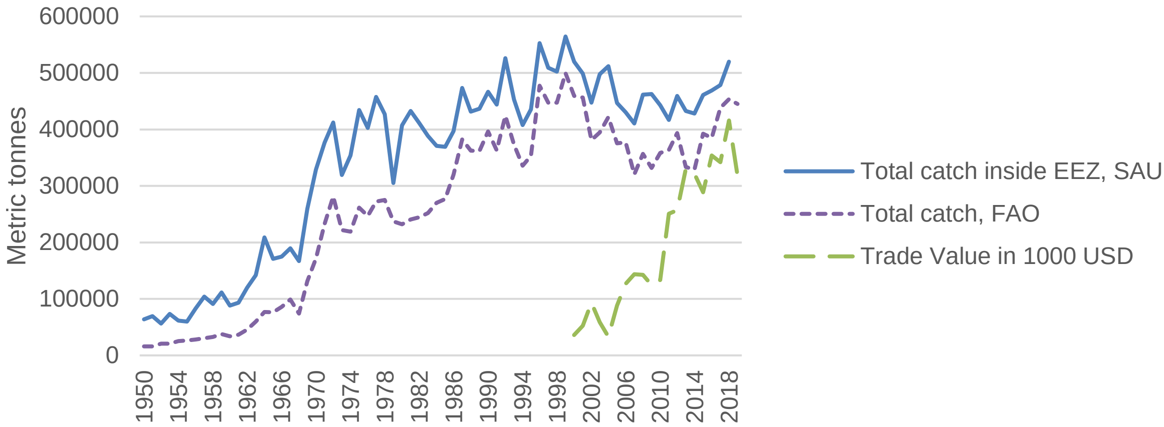

Figure 4. 1: Total fish landings and value of fish imports in Ghana

Notes: Total catch by SAU shows landings inside the exclusive economic zone (EEZ) in Ghana's marine area (Sea Around Us, 2021). Total catch by FAO includes marine and inland landings (FAO (FIGIS), 2021). Import trade value is given in 1000 USD (OEC, 2021).

Ghana's domestic production of marine fish declined between 2000 and 2015 (FAO (FIGIS), 2021; FAO, 2016) as did the fisheries' contribution to Ghana's GDP, which decreased from around 6 percent in 1993 to 4.5 percent in 2016 (FAO, 2016). The share of agriculture, forestry, and fishing put together decreased from over 28% in 2010 to only about 18% in 2020 (World Bank, 2021b), indicating that agriculture and fishing as economic activities have lost importance in the country over the years. Since around 2014/15 marine fish production has been slightly increasing again (Sea Around Us, 2021), which is mostly attributed to production growth of foreign companies whose landings do not support local fishers and food security (Nunoo et al., 2014; Alder and Sumaila, 2004).

A large part of the catch in the industrial fishing sector is fished by international or joint domestic and international companies, and it is commonly traded (Belhabib et al., 2020). In 2016, about 97% of industrial fishing in lower-income countries' EEZs was done by vessels owned by higher-income countries (McCauley et al., 2018), and historically only a small fraction of all Ghanaian fishermen and women are employed by the industrial sector (Atta-Mills, Alder, and Sumaila, 2004). This trend is also referred to as 'ocean grabbing' and is particularly worrying in countries with widespread food and nutrition insecurity (McCauley et al., 2018). To legally fish in West African EEZs, foreign vessels need to operate under certain access agreements. The value of these agreements often lies way below the value of the estimated actual catch by those foreign fleets (Okafor-Yarwood, 2019; Belhabib et al., 2015), thereby discriminating against the coastal states. Because these foreign industrial landings are not destined for domestic markets, they do not benefit the region economically or socially (Belhabib et al., 2020; Belhabib et al., 2015; Lam et al., 2012; Srinivasan, Watson, and Rashid Sumaila, 2012; Alder and Sumaila, 2004; Atta-Mills, Alder, and Sumaila, 2004).

Foreign industrial fleets have also repeatedly been criticized for their illegal fishing activities, including fishing in near-shore no-fishing zones, under-reporting of landings, and fishing above limits of official agreements (Belhabib et al., 2020; Merem et al., 2019; McCauley et al., 2018; Belhabib et al., 2015; Pala, 2013). Common practices that undermine sustainable fisheries management, enable IUU fishing, and make it difficult to trace back the origin of the catch include trans-shipment, the offloading of catch from fishing vessels to transportation vessels, discharging vessels outside of West Africa, and regular changes in vessel color, name, and flag state (Belhabib et al., 2020; Belhabib and Le Billon, 2020; Okafor-Yarwood, 2019; Boerder, Miller, and Worm, 2018). Figures 4.2 and 4.3 show catch separated by reporting status and fishing sector. Figure 4.2 indicates that the share of unreported catch in Ghana's EEZ has been slowly increasing over the years. Figure 4.3 reveals the share of marine catch by different sectors: The subsistence sector is responsible for a relatively constant and small part of total landings, while the industrial and artisanal sectors land bigger volumes of fish. The recreational sector is almost negligible in the size of its landings. The subsistence sector describes small-scale non-commercial fishing for consumption of the fishers' own families. The artisanal sector contains small-scale commercial fisheries. They assumably operate only in the inshore fishing areas of their home countries, close to the shore in shallow waters. If artisanal boats give away fish to their crew, this is counted towards subsistence fishing. The third small-scale sector is the recreational sector. It is also non-commercial and summarizes all fishing done for non-food purposes, such as sports. The industrial sector is defined as large-scale and commercial. It considers all large motorized vessels operating either domestically or in other countries' EEZs and the high seas (Pauly and Zeller, 2015).

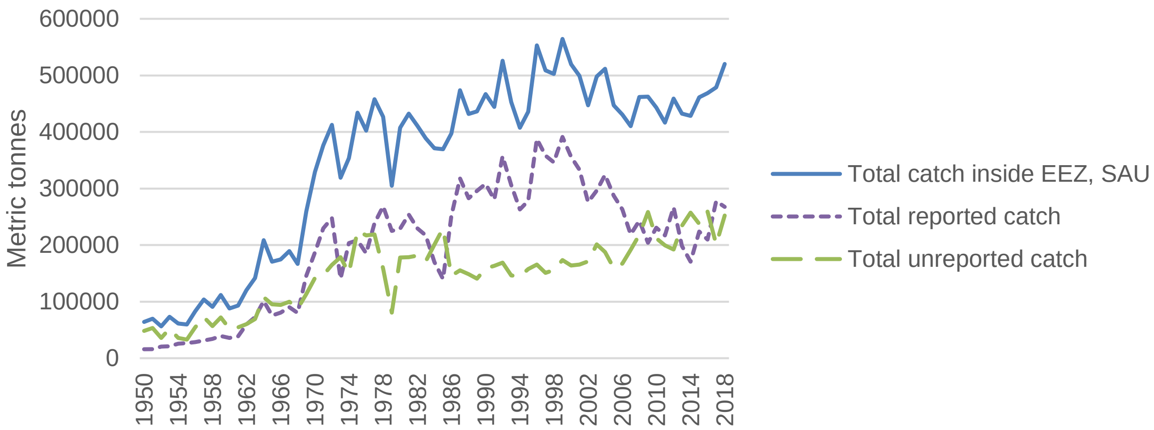

Figure 4. 2: Marine fish landings in Ghana by reporting status

Note: All values show landings inside the exclusive economic zone (EEZ) in Ghana's marine area (Sea Around Us, 2021).

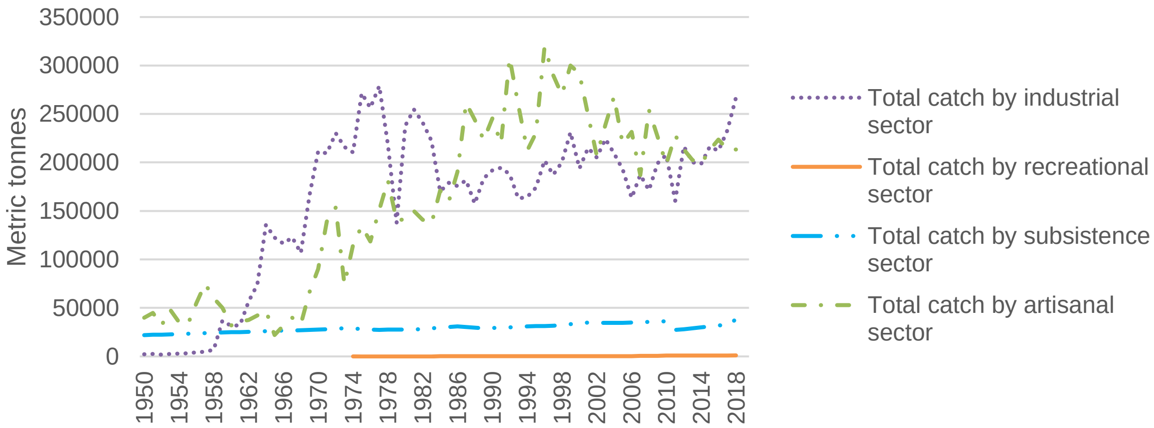

Figure 4. 3: Marine fish landings in Ghana by fishing sector

Note: All values show landings inside the exclusive economic zone (EEZ) in Ghana's marine area (Sea Around Us, 2021).

Tuna is the only wild fish species that can currently sustain further expansion in Ghana, and its industrial production recently increased slightly (see Figure 4.4) (Ashitey, 2019). However, the basis of small-scale fishers' livelihood are small pelagic fish species like mackerel, sardines, and anchovies (FAO, 2016), which are estimated to be mostly overexploited or approaching critical levels (Ashitey, 2019). Figure 4.4 shows the drop in small pelagic catch between 1996 and 2018.

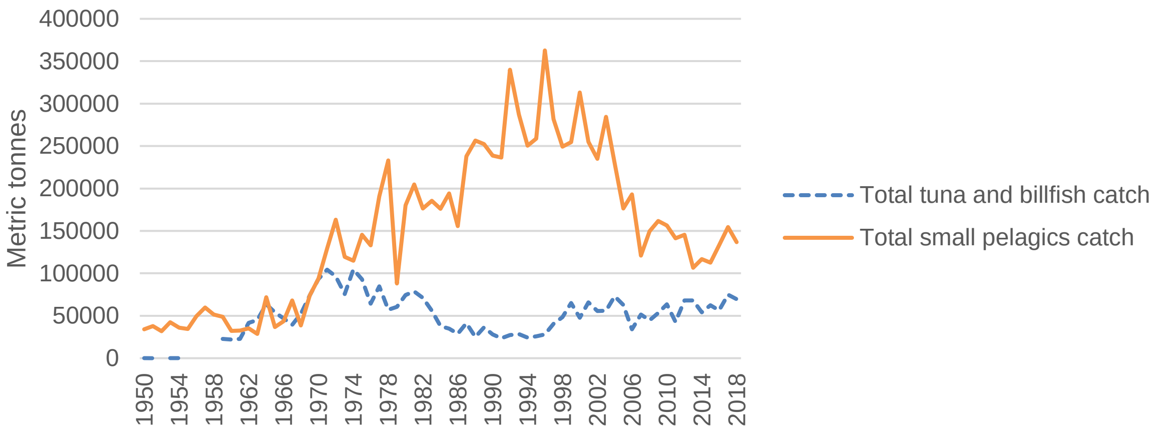

Figure 4. 4: Landings of tuna and small pelagic fish in Ghana

Note: All values show landings inside the exclusive economic zone (EEZ) in Ghana's marine area (Sea Around Us, 2021).

Fishing and related sectors are the basis for the livelihoods of about 10% of the population in Ghana – as many as 2.6 million people. This includes not only the 135,000 fishers that are directly employed in marine capture fisheries but also families of those fishers and employees of related sectors (UNCTAD, 2021; Hasselberg et al., 2020; FAO, 2016). The fishery value chain is known for its gender balance, and many women are involved in marketing and the sale of fish products (FAO, 2016). It is well established in the literature that income controlled by women tends to have positive effects on food security and nutrition of their households (Ogutu, Gödecke, and Qaim, 2020; Fischer and Qaim, 2012a; Hoddinott and Haddad, 1995). That strengthens the importance of the fishing sector for not only the provision of food but also financial reasons.

However, over the last years, small-scale fishery communities experienced income losses of up to 40% per canoe due to declining catch and overexploitation (Owusu and Andriesse, 2020; Belhabib et al., 2020). Decreasing returns due to low fish supply, increasing competition for resources between industrial and artisanal vessels, and higher input costs make it hard for small-scale fisheries to generate profits or even sustain their livelihoods (Belhabib et al., 2020; Hasselberg et al., 2020; FAO, 2016; Pauly and Zeller, 2016; Asiedu and Nunoo, 2015). The Ministry of Fisheries and Aquaculture Development (MoFAD) in Ghana published a report stating the decrease in the number of fishers to be 22.7%, with almost 140,000 fishers in 2013 and less than 110,000 only three years later (Owusu and Andriesse, 2020).

While domestic production is facing problems, consumption of fish and seafood products in Ghana is rising. Ghana's annual per capita fish consumption lies at around 26-28 kg (Hasselberg et al., 2020; Ashitey, 2019; FAO, 2016), though sources on this figure vary. It is, however, higher than the average consumption both in Africa (around 10 kg in 2017) and worldwide (just above 20 kg in 2017) (FAO, 2020). Being the cheapest source of animal protein in Ghana, it is consumed in many different ways (e.g. fresh, smoked, dried, canned, or grilled) and makes up about two-thirds of total animal protein consumed (Hasselberg et al., 2020; Ashitey, 2019; FAO, 2016; Pauly and Zeller, 2016). In order to meet the demand, imports have increased over the last decades and currently make up about 50% of Ghana's fish consumption (Hasselberg et al., 2020; Onumah et al., 2020; FAO, 2016).

Since about 2000, the African share of the global fish import volume has increased up to 11%, with the ECOWAS being responsible for about two-thirds of that increase. Because imports mostly consist of cheap small pelagic fish, the overall trade values are relatively low (FAO, 2022). Imports to Ghana mainly come from China, Morocco, and to a lesser extent from Indonesia, Thailand, and other Asian countries. The share of European imports has decreased to less than 1% in 2019 (OEC, 2021), and at the same time, Europe's participation in fishing in coastal waters off most West African countries drastically decreased and has been replaced by China, too (Tickler et al., 2018; Belhabib et al., 2015; Pala, 2013).

To reduce dependence on imports and strengthen their own fishing sector, the Ghanaian government follows different strategies, including the promotion of aquaculture and the introduction of closed seasons. By restricting access to the marine territory for a certain period, fish stocks should get the chance to recover from overexploitation. In the long run, this should lead to an increase in landings and secure livelihoods of those depending on fishing (Owusu and Andriesse, 2020). This strategy is relatively new, with a first 'trial' closed season in 2018, and two closed seasons in 2019: One for artisanal fisheries, the other for industrial trawlers only (Ashitey, 2019). Due to the Covid-19 pandemic, Ghana did not observe closed seasons in 2020 but reintroduced them one year later. Both, aquaculture and closed seasons, can have negative side effects. Since fish farming requires fish as feed, fish meal imports have been increasing with the importance of aquaculture (Hasselberg et al., 2020; Ashitey, 2019). The resources used as fish feed are also consumed directly by the Ghanaian population, and the costs of adopting aquaculture are relatively high for fishers. The overall sustainability and benefits of that strategy are therefore still ambiguous (Bogmans and Soest, 2021; Changing Markets Foundation and Compassion in World Farming, 2019). Closed seasons can also lead to adverse effects, and because of their novelty, the effects on fishers have not been thoroughly analyzed. If fishermen and women do not engage in alternative economic activities during the closed season or struggle to generate sufficient income thereafter, occurrences of illegal fishing might increase – even though illegal fishing adds to the problem of overfishing, decreasing catch, and diminishing returns in the first place (Owusu and Andriesse, 2020). Mkuna and Baiyegunhi (2020) found that fishers who overfished had higher financial returns than those who fished according to regulations. If returns decrease, fishers also tend to take greater risks in fishing methods and increase the areas they fish in. By traveling further to offshore waters, fishers increase their chances of bigger catch but also increase the risk of getting injured or lost on sea (Hasselberg et al., 2020).

4.3 Conceptual framework and methods

The last section highlighted how overfishing can negatively affect consumption and the generation of income of households who depend on fish for both: Because it leads to decreasing catch rates, fishing gets more expensive and time-intensive. To generate the same output, fishers have to put in higher effort. Thereby, overall profits decrease, especially for small-scale fisheries. Lower income coupled with decreasing landings limit the availability of domestically produced fish for consumption. Thus, overfishing is expected to be negatively linked to households through more than one channel. First, incentives to fish are lower and fewer households might engage in fishing. Second, household fish consumption might decrease if less fish is consumed through the subsistence channel and less income is generated through fishing.

To follow up on these assumptions, a number of variables related to fishing activity and fish consumption at the household level are used for comparative analysis and evaluation over time. To measure overfishing, several indicators are introduced: Because overfishing is difficult to measure exactly without a variety of sophisticated marine-biological indicators, production is used as the main proxy. Additionally, fishing effort and catch rate variables are constructed and analyzed. Fishing effort measures the fishing intensity – the amount of fishing done in a certain area – whereas catch rates reflect the state of overfishing of a certain fish population by indicating how much fish is caught per unit of effort (FAO, 2003; OECD, 2003). Details on the construction of these indicators are given in the next section. In line with the literature, increasing overall production, simultaneous high fishing efforts, and decreasing catch rates indicate overfishing (Link et al., 2020; Belhabib, Greer, and Pauly, 2018). We analyze these indicators for each sector and examine the relationships among themselves. Lastly, simple regression models are applied to analyze the relationship between households and indicators of overfishing. Because the data show that subsistence consumption is significantly higher for poor households, the results differentiate between poor and non-poor households. Landings by different fishing sectors are expected to be linked to households differently: While all catch from the subsistence sector and most of the artisanal landings is utilized by the local population, this is less true for fish caught in the industrial sector. Import trade value of fish and seafood items is included in the analysis as well, as it is strongly linked to overall production and makes up a large part of consumption in Ghana.

The rest of this chapter starts by introducing the data used for the analysis, then talks about the household outcome variables of the study, and explains the methodological approach and its limitations.

4.3.1 Data

At the household level, we utilize living standard survey data as provided by the Ghana Statistical Service and include the three last waves: GLSS5, 6, and 7 from the years 2005, 2012, and 2017 (Ghana Statistical Service, 2021). In 2005, over 9,000 households were included in the survey. In 2012, almost 17,000 households were interviewed, and in 2017, around 14,000 households participated. All waves are nationally representative and include a wide range of data on household economic activities as well as food and non-food expenditures. Household questionnaires for waves 6 and 7 are very similar and could be merged easily. Food consumption expenditures were collected over the course of 12 months through multiple household visits. In each visit, households were asked to report consumption over a five-day recall period. In 2005, the questionnaire was much shorter, less detailed, and did not include multiple household visits but one single recall period. Many variables exist only as binary indicators for that year, which results in some missing observations for variables in 2005. Information on fish landings in Ghana's EEZ and fish imports for the years 2005, 2012, and 2017 are merged into the household information using data from Sea Around Us (2021) and the Observatory of Economic Complexity (OEC, 2021), as shown in Figures 4.1-4,. For robustness checks, we run the analysis also using FAO data (FAO (FIGIS), 2021).

Table 4.1 gives an overview of the catch statistics used in this study, including landings for tuna and small pelagic fish. A third of all industrial catch is tuna for export purposes.

Table 4. 1: Catch statistics as provided by the FAO and the SAU project (FAO (FIGIS), 2021; Sea Around Us, 2021)

	(1) 2005 mean	(2) 2012 mean	(4) 2017 mean
SAU production (marine landings inside EEZ)			
Total annual catch	446.92	459.13	478.72
Total reported catch	287.39	267.22	277.76
Total unreported catch	159.52	191.91	200.96
Total catch by industrial sector	193.05	216.72	233.35
Share of unreported catch in industrial sector	0.617	0.564	0.585
Total catch by artisanal sector	218.87	213.45	213.55
Share of unreported catch in artisanal sector	0.025	0.191	0 .153
Total catch by subsistence sector	34.74	28.13	30.93
Share of unreported catch in subsistence sector	1	1	1
Total catch by recreational sector	0.25	0.82	0.89
Total small pelagic catch	176.34	145.40	154.66
Total tuna and billfish catch	62.96	68.15	74.75
Imports			
Total trade value of imported fish products	99.75	200.08	283.20
FAO production (marine landings inside EEZ and freshwater catch)			
Total annual catch	375.14	393.49	438.51
Total annual freshwater landings	76.15	117.45	147.40
Total annual marine landings	298.98	276.04	291.10

Notes: Catch is given in 1000 metric tonnes. Share of unreported catch in subsistence sector is 100%, as subsistence landings are not included in official statistics. Trade value of imported fish products given in 1 million USD.

4.3.2 Outcome variables

Several variables are included to measure household fish consumption and fishing activity. Binary variables available for all three waves include a fishing indicator, stating whether a household engaged in fishing over the past three months or not; a fish sales variable, indicating whether a household sold any fish during the past 12 months; a fish consumption variable, indicating whether a household consumed any fish; and an additional indicator of whether the household consumed any fish that has been farmed or caught themselves (own fish). Variables that are only available for 2012 and 2017 include the total value of the fish caught or farmed in the past 12 months; whether the household spent anything on fishing in the past 12 months; and the amount spent in cash or in-kind on fishing in the past 12 months. Additionally, a simple count variable that measures consumption diversity within the category fish is constructed. The 6th GLSS wave includes eight different fish categories: crustaceans, fresh/frozen, dried, smoked, fried, canned, salted fish, and other fish/seafood items. The 7th GLSS wave includes 48 different fish items, containing 13 different brands for canned fish, different local fish species, and different preparation styles (smoked, fried, dried, etc.). To be able to compare the two waves, we sorted items from the 7th wave according to the categories from the 6th wave, ending up with eight groups of items. This diversity variable does not precisely indicate consumption diversity of fish species and nutrients, but it is plausible to assume the various items consumed in different preparation styles and brands to include a variety of fish species, because of the complex marketing channels, consumer preferences, and price differences in fish species and preparation styles across Ghana (Foli, Awuni, and Amponsah, 2020; Hasselberg et al., 2020; Ashitey, 2019; Doku et al., 2018; Alhassan, Boateng, and Ndaigo, 2013). Lastly, to capture the regularity of fish consumption over time, the number of recall periods in the survey phase in which fish was consumed and a variable indicating the number of months in which the household consumed own fish were calculated.

4.3.3 Methodological approach

To examine the relationship between households and possible overfishing, the analysis starts by firstly comparing descriptive statistics of household characteristics over time to identify possible trends in consumption and engagement in fishing as an economic activity. Second, the indicators for overfishing and the relationship among themselves are examined. These indicators are fish production, fishing effort, and catch rate, each calculated per fishing sector. Production is indicated by total landings per fishing sector in metric tonnes (see equation 1), as shown in Table 4.1. The European Union defines fishing effort as fleet capacity multiplied by days at sea (OECD, 2003), other studies use the number of boats and/or power of the engines as proxies (Belhabib, Greer, and Pauly, 2018). The SAU data does not include an exact number of vessels, their capacity, or hours fished, but it disaggregates catch by country, fishing sector, species caught, and gear type used. Therefore, the number of observations per gear type used/species/sector/country constitutes the proxy for fishing effort in this analysis (see equation 2). It is useful to analyze whether countries raised the intensity of their fishing by increasing the number of vessels, gear type, or species caught. Because multiple gear types can be used per fishing vessel, and more than one species can be caught by one boat (multi-gear fisheries initially catch a high number of species and discard unwanted ones afterwards (Allan et al., 2005)), fishing effort does not represent the number of fishing vessels but is an indicator of fishing intensity. Catch rates generally indicate catch per vessel, area, or unit of effort (e.g. hours fished or energy used). We use fishing effort as constructed for this analysis as the unit to calculate a catch-per-unit (CPU) variable, dividing production (metric tonnes of fish caught) per sector through the respective number of observations in that sector (fishing effort). The

CPU variable therefore measures the tonnes caught per sector and gear type and fish species (see equation 3).

$$Production_{sector} = Total\ fish\ caught\ in\ metric\ tonnes_{sector} \tag{1}$$

$$Fishing\ effort_{sector} = Number\ of\ units\ per\ country, fishing\ gear\ and\ fish\ species\ caught_{sector} \tag{2}$$

$$Catch - per - unit\ of\ effort\ (CPU)_{sector} = \frac{Production_{\ sector}}{Fishing\ effort_{sector}} \tag{3}$$

Changes of these variables over time are analyzed, and links between the CPU variable with overall production and household fishing activity are examined. If fishing efforts increase while catch rates decrease, it is a sign of overexploitation of the fish population in an area.

Lastly, the links between production, the main indicator of overexploitation, and household consumption and fish sales are analyzed using simple OLS regression models. For binary outcome variables, Probit models are used. The regression models look as follows:

$$y_i = \beta_0 + \beta_1 x_s + \beta_2 H_i + \beta_3 R_i + \beta_4 P_i + \beta_5 year + \varepsilon_i, \tag{4}$$

where *y* are household outcome variables per household i. These variables include a binary fish consumption variable, a binary own fish consumption variable, the consumption diversity and regularity variables, and a binary fish sales variable. *x* are production volumes or total import trade value. *s* denotes the subsector, as regressions are run separately, using production values for subsistence, artisanal and industrial sectors, as well as total production. The recreational sector is neglected due to its minor significance on consumption. Because household fishing activity is endogenous to landings, especially in the subsistence sector, and would cause simultaneous causality bias, it is not included as an outcome variable in the models regressing on production, but only in the regression on import trade value. H_i is a vector of household characteristics, including e.g. household size and daily per capita food expenditures. Depending on the outcome variable, the models also control for fish consumption and fishing. R_i is a vector containing regional specifics, e.g. whether the household lives in a rural or urban area, and whether the region is close to water. Because proximity to water might increase a household's likelihood to fish, regions with access to marine areas or Lake Volta were grouped and controlled for. The following regions are considered as being close to water: Western, Central, Greater Accra, Volta, Eastern, Brong Ahafo, and Northern region. Smaller inland water sources were neglected. P_i is a binary poverty indicator and *year* is a categorical year variable, controlling for the year of the survey. We use poverty thresholds as defined by the Ghana Statistical Service in the data for waves 6 and 7. These are consumption-based measures, adjusted to the current Ghanaian society. A household is defined as poor if expenditures are insufficient for a minimum consumption basket.[9] Poverty statuses for wave 5 were reconstructed using food expenditures and information from the Ghana Statistical Service (2018). ε_i is the error term. Additional to including the total sample, the models are run separately for poor and non-poor households, then excluding the poverty indicator in the regression. As robustness checks to the regressions, all models are run using FAO data.

4.3.4 Limitations

Linking aggregate yearly catch data on a national level to household-level consumption and fish sales has some major drawbacks: With only two to three data points in time for the household variables, regression models only include production values for 2005, 2012, and 2017. Production data are aggregates that are constant per year and have zero variation across households. They work as time-fixed effects, almost perfectly correlated to the year variables, and are indistinguishable from other time effects that might be relevant. Because of that collinearity, marginal effects for the year categories could not be estimated. Nevertheless, production is different from a general time trend. As shown in Table 4.2 and Figures 4.1 and 4.3, catch values do not linearly increase or decrease but fluctuate. We control for the year of the survey to minimize the issue.

Considering the limitations of household and catch data, the approach still offers valuable insights into the relationship between national production data and households that have not been sufficiently looked at in the literature. Regression outcomes should, however, not be interpreted as causal relationships, and effect sizes may not be reliable. The primary feature of this study is analyzing the direction of the links between household behavior and national catch data, and the discussion of the results will therefore focus on the signs of coefficients.

4.4 Results

This section starts by presenting descriptive statistics and the comparative analysis of household characteristics between the different waves. Then, the different indicators of overfishing are evaluated, before regression results are discussed.

[9] In 2016/17 the upper poverty line was calculated to be GHS 1,760.8 per adult equivalent per year and the extreme or food poverty line was GHS 982.2 per adult equivalent per year (Ghana Statistical Service, 2018).

4.4.1 Descriptive statistics

Table 4.2 gives an overview of the variables described above for 2005, 2012, and 2017. To examine variables across all three waves, we pairwise compared means with equal variances, using Tukey's method. To estimate differences between variables that only exist for two waves, we applied simple t-tests. Results are indicated in the right column of Table 4.2, with complete results of the pairwise comparison are given in Table A3.1 in the Appendix.

Compared to 2005, households are less likely to be poor and spend more money on food in 2017. The share of households that engage in fishing in 2017 has decreased compared to earlier years, and so did fish sales from 2005 on. The value of fish sales has more than doubled between 2012 and 2017, while at the same time the costs of fishing increased almost threefold.

Fish consumption is now significantly higher than in 2005 but peaked in 2012 and then decreased slightly in 2017. Fish consumption diversity, periods in which fish was consumed, subsistence consumption, and own fish consumption regularity all decreased between their earliest wave and 2017. Table A3.2 in the Appendix shows the same descriptive statistics for households separated by their poverty status. While levels of fishing activity are higher and fish consumption is a bit lower for poor households, the general developments observed in the total sample also appear in the separate poverty groups.

Table 4. 2: Summary of household fish consumption and fishing activity per wave

	(1) 2005 mean/sd	(2) 2012 mean/sd	(3) 2017 mean/sd	(4) Mean comparison Diff/ two-tailed p-value
Household size	4.173 (2.978)	4.264 (2.783)	4.200 (2.866)	2005 different to 2012
Rural household 1/0	0.683 (0.465)	0.556 (0.497)	0.570 (0.495)	Difference between all years
Total daily per capita food expenditures	1.690 (5.566)	2.920 (3.135)	4.723 (4.659)	Difference between all years
Poverty status 1/0	0.338 (0.472)	0.239 (0.426)	0.256 (0.436)	Difference between all years
Fishing 1/0	0.027 (0.161)	0.023 (0.150)	0.017 (0.130)	2017 different to other years
Fish sales 1/0	0.019 (0.135)	0.013 (0.114)	0.011 (0.106)	2005 different to other years
Total value of caught and farmed fish	. (.)	20.902 (306.956)	59.748 (1456.896)	38.845 (0.000)
Household spend anything on fishing 1/0	. (.)	0.009 (0.094)	0.008 (0.089)	-0.00075 (0.4702)
Amount spent in cash/in-kind on fishing	. (.)	6.755 (148.573)	10.706 (274.621)	3.950 (0.109)
Fish consumption 1/0	0.895 (0.307)	0.950 (0.218)	0.935 (0.246)	Difference between all years
Consumption diversity	. (.)	1.605 (1.084)	1.173 (0.771)	-0.4317 (0.000)
Number of periods in which fish was consumed	. (.)	4.957 (1.727)	4.597 (1.855)	-0.359 (0.000)
Own fish consumption 1/0	0.052 (0.221)	0.019 (0.136)	0.024 (0.153)	Difference between all years
Number of months household consumed own fish	. (.)	0.193 (1.454)	0.085 (0.702)	-0.107 (0.000)
Observations	9292	16772	14009	

Notes: Expenditures and values given in Ghanaian cedi (GHS). Consumption diversity measures number of different fish items consumed during survey period (max eight). Number of periods in which fish was consumed has maximum of six. Food expenditures and value of sold fish deflated using FAO Food Price Indices (FAO, 2021a). Amount spent on fishing deflated using Consumer Price Indices provided by the Ghana Statistical Service (2017). Mean comparison between two years done by t-test, pairwise comparison of means by Tukey's method done for variables available for all years. Complete results shown in Table A3.1 in the Appendix.

4.4.2 Indicators of overfishing

This section explores the trends of the overfishing indicators and their relations between themselves and household fishing activity. The first indicators of overfishing, overall production and production by fishing sector, have been presented in Figure 4. 3. The next indicator, fishing effort per sector and year, is shown in Figure 4.5. Overall fishing effort increases. That is mostly attributed to an increase in industrial effort, while artisanal and subsistence efforts have been constant. The increase in effort traces back to a raise in the number of species caught and gear types used. The number of species caught increased constantly from only 30 in 1950 to over 120 in 2018. Similarly, in 1950 only 15 different types of gear were used. In 2018, the number increased up to 26. This leads to increased fishing intensity and stress on the marine ecosystem and is one sign of overexploitation.

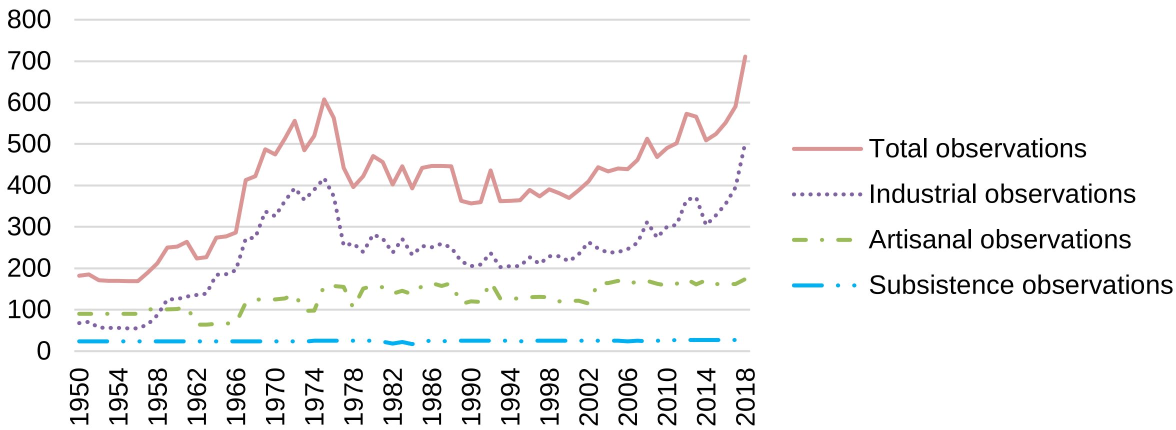

Figure 4. 5: Fishing effort

Notes: Number of observations per country/species/gear type (Sea Around Us, 2021)

Figure 4.6 shows the development of the CPU variable over time. The fact that the CPU indicator in this study is lowest for industrial vessels is because it indicates the number of species caught per gear type, not catch per vessel or input (see equation 3). Industrial vessels are likely to use multiple gear types and catch a variety of species. The number of gear types and species per vessel is lower for artisanal and subsistence fisheries, therefore their catch rate per these categories is higher. For that reason, it is not suitable to compare CPUs between sectors, but rather compare CPU within sectors over time: While peaking around the year 1978 and then again in 2000, we observe a decrease in CPU for both artisanal and industrial sectors afterwards. That means the amount of fish per sector that each country caught per gear type used and fish species caught decreased. While the decrease in artisanal CPU was drastic in the early 2000s, industrial CPU decreases more slowly. By increasing their fishing effort – expanding the number of species caught and using an increased number of gear types – industrial vessels can outbalance the effect of diminishing fish stocks on their catch rates, while small-scale fishing vessels struggle to do so. Increasing efforts and decreasing catch rates are a sign of Malthusian overfishing, a specific form of overfishing where excess labor is rewarded most (Belhabib, Greer, and Pauly, 2018; Pauly, 2006).

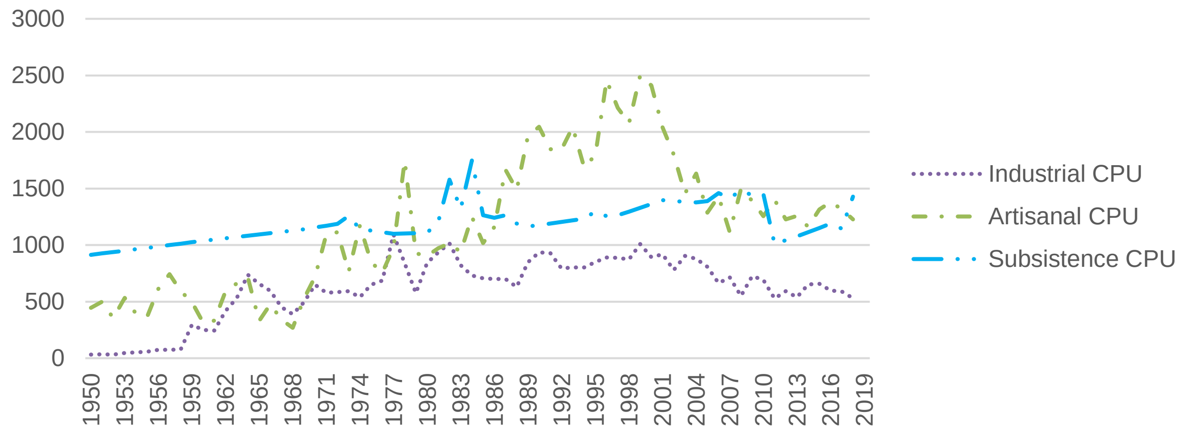

Figure 4. 6: Catch rates

Note: Mean CPU per sector (catch per fishing effort) (Sea Around Us, 2021)

To examine the relationship among these indicators and connect them with household fishing activity, Table 4.3 shows pairwise correlations between fish production in metric tonnes, CPU variables of different fishing sectors, and the variable indicating whether a household engages in fishing, using mean values across all three waves of the household survey. Fishing effort is not included, because the CPU indicator is a direct computation of production values and fishing effort and therefore closely correlated.

Industrial catch and industrial CPU are negatively correlated, while artisanal and subsistence catch are positively related to their respective CPU variables. This is in line with the results shown in Figures 4.5 and 4.6 and confirms the observation of increasing efforts and decreasing catch rates in the industrial sector. As discussed above, these are signs of overfishing. Total industrial catch is strongly and positively correlated with total catch, tuna catch, and unreported catch, suggesting a strong overlap between them. Artisanal catch is negatively correlated with total catch, and positively with subsistence and small pelagic fish catch. Subsistence catch relates similarly to other variables as artisanal catch. That indicates that total catch is developing in the opposite direction of artisanal and subsistence catch. As shown in Figures 4.1 and 4.3, total and industrial catch are still increasing, while artisanal and subsistence landings are stagnating or even decreasing. As expected, tuna landings are negatively and small pelagic fish landings are positively related to household fishing, because household consumption is largely made up of small cheap pelagic fish. Household fishing is negatively correlated to total and industrial catch but has a positive relationship with artisanal and subsistence landings, although the latter is not significant. Most Ghanaian fishers are employed in the artisanal fishing sector or engage in subsistence fishing and compete with industrial vessels for resources.

Table 4. 3: Pairwise correlation between catch types, all years

Variables	Household fishing	Total annual catch	Industrial catch	Industrial CPU	Artisanal catch	Artisanal CPU	Subsistence catch	Subsistence CPU	Tuna catch	Small pelagic catch	Reported catch	Unreported catch
Household fishing	1.000											
Total annual catch	-0.025***	1.000										
Industrial catch	-0.024***	0.966***	1.000									
Industrial CPU	0.018***	-0.732***	-0.821***	1.000								
Artisanal catch	0.018***	-0.708***	-0.210***	0.532***	1.000							
Artisanal CPU	-0.014***	0.536***	0.323***	0.203***	0.491***	1.000						
Subsistence catch	0.007	-0.305***	-0.508***	0.869***	0.459***	0.570***	1.000					
Subsistence CPU	0.011**	-0.448***	-0.635***	0.932***	0.456***	0.452***	0.987***	1.000				
Tuna catch	-0.025***	0.998***	0.971***	-0.738***	-0.286***	0.407***	-0.351***	-0.490***	1.000			
Small pelagic catch	0.011**	-0.446***	-0.568***	0.918***	0.622***	0.560***	0.955***	0.963***	-0.470***	1.000		
Reported catch	0.004	-0.188***	-0.217***	0.712***	0.796***	0.758***	0.845***	0.802***	-0.142***	0.887***	1.000	
Unreported catch	-0.022***	0.871***	0.963***	-0.932***	-0.308***	0.097***	-0.709***	-0.809***	0.886***	-0.751***	-0.441***	1.000

*** p<0.01, ** p<0.05, * p<0.1

4.4.3 Regressions

Regression results as shown in Table 4.4 help to understand what implications signs of overfishing and trends in fish production have on household fish consumption and fishing activity. First, results for the total sample are discussed, then the results for poor and non-poor households are looked at. The results for the total sample indicate that fish consumption is positively associated with total production, industrial production and imports. There is a negative association with subsistence and artisanal catch. The relationship between fish production in the different sectors and own fish consumption is the exact opposite: Overall fish consumption and own fish consumption react adversatively, and overall fish consumption is positively affected by variables that are negatively related to own fish consumption. It is, however, important to stress that overall fish consumption refers to the whole sample whereas own fish consumption refers to roughly 2% of households only (see Table 4.2). Most fish consumed is purchased at markets and therefore positively associated with imports and total production, which is strongly correlated with imports. Consumption diversity and consumption regularity (number of periods in which fish was consumed) are negatively associated with all sectors' production values, but the strongest connection exists with catch from subsistence and artisanal sectors. There are no significant links with fish sales for the whole sample.

Looking at poor and non-poor households separately, it can be observed that non-poor households' overall fish consumption is neither significantly associated with catch from any sector, nor with imports. Poor households' overall fish consumption is significantly and positively associated with total production, industrial production, and imports, but has a negative relationship with production from the subsistence and artisanal sector. It seems that results for fish consumption of the overall sample are mainly driven by the poor share of the households. The link between production from all sectors and own fish consumption, consumption diversity, and regularity of fish intake, however, is stronger for non-poor households than for the poor. The same is true for the association with imports. Because poor households rely more on own fish and have lower diversity and regularity of fish consumption, they might be less able to adjust their consumption to fluctuations in price and availability of fish. The positive link between subsistence and artisanal fishing and own fish consumption is in line with the assumption that both sectors support local subsistence consumption. However, the negative relationship to overall fish consumption is surprising, as the literature suggested that most of the domestic consumption stems from the artisanal sector. One possible explanation is that the models applied here were not able to sufficiently extract the time effect from the equation. As seen in Table 4.2, fish consumption has been fluctuating up and down between 2005 and 2017, while artisanal fish production wavered, too, but in the opposite direction, explaining the negative association. Fish sales are only significantly associated with catch and imports for the non-poor sample. They have a negative relationship with total production, industrial production, and imports and a positive relationship with production from the subsistence and artisanal sectors. It is interesting that only non-poor households' fish sales are significantly associated with changes in fish production, although more poor households sell fish (see Table A3.2 in the Appendix) and might depend on it for income.

Table A3.16-18 in the Appendix show full model results for import values and include household fishing as an additional outcome variable. Household fishing is negatively associated with imports, with a stronger relationship observed for poor households. This again relates only to about 2% of all households and about 3% of poor households. Because total and industrial landings are strongly correlated with imports, it makes sense that they also affect overall consumption positively. It is plausible to assume, that total and industrial fish production would also be negatively associated with household fishing activities. The robustness check, using FAO values as sown in Table A3.15 for the same models, offers similar results. Results change slightly in scope, but the direction of the relationships stays the same.

Full model results, as seen in Tables A3.3-18 in the Appendix, indicate rural households and households in regions close to water are more likely to engage in fishing activities and to consume fish, from both purchases and subsistence fishing. At the same time, households that fish are more likely to consume own fish, but less likely to consume fish at all. Fishing households might rely majorly on own fish for nutrition and thus not regularly consume purchased fish items. Other factors might also play a role: Fishing households tend to be poorer, live in more rural areas, and have bigger household sizes. If households who engage in fishing increase only their intake of fresh fish, that increase would not be displayed in the diversity indicator used here. This explanation is supported by the results of a two-sample t-test between households consuming own fish and those who do not.

Table 4. 4: Marginal effects of fish landings, Probit and OLS models

	(1) Fish consumption 1/0	(2) Own fish consumption 1/0	(3) Consumption diversity	(4) Number of periods in which fish was consumed	(5) Fish sales 1/0
Total catch inside Ghanaian EEZ					
Total sample	0.00118***	-0.000397***	-0.0231***	-0.0151***	-0.0000282
	(0.000109)	(0.0000641)	(0.000546)	(0.000795)	(0.0000334)
Poor	0.00225***	-0.000311*	-0.0124***	-0.0103***	0.0000972
	(0.000267)	(0.000187)	(0.000694)	(0.00170)	(0.0000891)
Non-poor	0.000150	-0.000426***	-0.0283***	-0.0199***	-0.0000847**
	(0.000134)	(0.0000720)	(0.000735)	(0.000917)	(0.0000365)
Catch by industrial sector					
Total sample	0.000930***	-0.000314***	-0.0273***	-0.0178***	-0.0000222
	(0.0000858)	(0.0000506)	(0.000644)	(0.000937)	(0.0000263)
Poor	0.00178***	-0.000245*	-0.0146***	-0.0121***	0.0000768
	(0.000211)	(0.000148)	(0.000818)	(0.00200)	(0.0000704)
Non-poor	0.000118	-0.000336***	-0.0334***	-0.0234***	-0.0000668**
	(0.000106)	(0.0000568)	(0.000866)	(0.00108)	(0.0000288)
Catch by subsistence sector					
Total sample	-0.00983***	0.00331***	-0.162***	-0.106***	0.000235
	(0.000906)	(0.000535)	(0.00383)	(0.00557)	(0.000278)
Poor	-0.0188***	0.00259*	-0.0871***	-0.0719***	-0.000811
	(0.00223)	(0.00156)	(0.00486)	(0.0119)	(0.000743)
Non-poor	-0.00125	0.00355***	-0.199***	-0.139***	0.000706**
	(0.00112)	(0.000600)	(0.00515)	(0.00642)	(0.000305)
Catch by artisanal sector					
Total sample	-0.00705***	0.00238***	-4.419***	-2.876***	0.000169
	(0.000650)	(0.000384)	(0.104)	(0.152)	(0.000200)
Poor	-0.0135***	0.00186*	-2.372***	-1.957***	-0.000582
	(0.00160)	(0.00112)	(0.133)	(0.324)	(0.000533)
Non-poor	-0.000895	0.00255***	-5.411***	-3.795***	0.000506**
	(0.000803)	(0.000431)	(0.140)	(0.175)	(0.000219)
Imports					
Total sample	0.000204***	-0.0000689***	-0.00546***	-0.00355***	-0.00000489
	(0.0000189)	(0.0000111)	(0.000129)	(0.000187)	(0.00000579)
Poor	0.000391***	-0.0000538*	-0.00293***	-0.00242***	0.0000169
	(0.0000463)	(0.0000324)	(0.000164)	(0.000401)	(0.0000155)
Non-poor	0.0000259	-0.0000738***	-0.00668***	-0.00469***	-0.0000147**
	(0.0000233)	(0.0000125)	(0.000173)	(0.000216)	(0.00000634)

Notes: Standard errors in parentheses, * $p<0.10$, ** $p<0.05$, *** $p<0.01$. All catch variables show results for SAU statistics. Catch is shown in 1000 metric tonnes/year. Imports are shown in 1 million USD. Separate models were estimated for each sector's catch variable and for poor and non-poor households as shown in Tables A3.3-14 in the Appendix. Probit specifications were used for binary outcome variables in model 1, 2, and 5. Models 3 and 4 are run for years 2012 and 2017 only using OLS regression. All results show marginal effects.

4.5 Conclusion and discussion

This article analyzed recent trends in the Ghanaian fishing sector and whether they indicate overfishing. It also examined the link between fish production in different fishing sectors, imports, and household fish consumption and production in Ghana. After an extensive literature review, three waves of GLSS data were used and combined with yearly aggregate fish production and import data on a national level. This last section summarizes and discusses the results of the analysis.

First, a comparative analysis of household statistics was done for the years 2005, 2012, and 2017. It revealed that since 2005, fish consumption increased among all households, while diversity and regularity of fish consumption decreased. This might indicate that, while almost all households do consume fish in general, they consume it irregularly and may be financially or locally restricted in their choices.

Second, different indicators of overfishing were analyzed: Total fish production is still increasing in all fishing sectors in Ghana, with the industrial sector being responsible for the majority of the recent growth. Fishing effort is also increasing for industrial fishing, while efforts in artisanal and subsistence sectors seem to stagnate. As a third indicator, the catch rate (CPU) uncovers decreasing returns for the artisanal and industrial fishing sectors. That means less fish is caught per unit of effort in each sector. The findings suggest overfishing and are in line with the literature on marine ecosystem overfishing, stating that while efforts still increase, catch-per-unit rates are decreasing (Belhabib, Greer, and Pauly, 2018; Allan et al., 2005; Alder and Sumaila, 2004).

Third, overall household fish consumption is positively associated with production in the industrial sector, assumable through its high correlation with imports, whereas own fish consumption is positively linked to the subsistence and artisanal fishing sectors. Household fishing is negatively associated with imports, which are also negatively linked to household fish sales. These results are in line with the hypothesis of intensive commercial and industrial fishing efforts fostering overexploitation in the Ghanaian marine area and negatively impacting fishing households and those relying on subsistence consumption. However, not all households are affected in the same way and there are differences between poor and non-poor households: Poor households' fish consumption is more strongly linked to changes in fish production or imports, whereas non-poor household's consumption diversity, regularity, and fish sales are associated more strongly with production and import changes.

While the analysis finds evidence for overfishing in Ghana, its relationship to households seems to be more complex. Domestic production cannot keep up with the demand and the gap in fish supply is currently filled with imports. Consumption seems to be positively related to imports, but imports also reduce the likelihood of households engaging in and generating income through fishing. While the fraction of fishing households is only about 2%, the literature suggests a much larger share of the population depends on the whole fisheries value chain for income. If the share of domestically produced fish on Ghanaian markets further decreases, it could have severe consequences for these people. The positive relationship between artisanal and subsistence catch with fish sales of non-poor households indicates that strengthening these two sectors has the potential to offset some of the negative developments. While the Ghanaian government tries to protect marine biodiversity and foster fish stocks by introducing closed seasons, restricting entry also for small-scale and subsistence fishers might worsen their situation further.

Both, evidence from the literature as well as the indicators for overfishing from this study suggest a high correlation between industrial fishing efforts and overfishing. Since a majority of industrial landings do not support local income generation nor provide fish for local consumption, small- and medium-scale fisheries will likely increase their fishing efforts as well, and thus hamper efforts to stop overfishing.

5
General conclusion

The three essays of this dissertation highlighted different aspects of the interlinkages between trade and local food production and the essential role that both play in the improvement of living standards and well-being of local households. Trade and local food production are important for sufficient supply of food and the generation of income and growth, but the dynamics that link them to living standards are complex. There are some trade-offs that policymakers should be aware of if aiming to improve the situation for the poor and most vulnerable.

Each study shed light on a different aspect of the subject and provided new insights into a complex topic. The following sections shortly summarize the main findings of all three essays, highlight their limitations, and give recommendations for policymaking and further research.

5.1 Main findings and policy implications

The second chapter looked at the effects of Fairtrade certification on farm household living standards and food security using survey data from the cocoa sector in Côte d'Ivoire. The study found that Fairtrade certification increases aggregate living standards measured in terms of per capita household consumption expenditures of participating households. These effects are larger for poor than non-poor households, indicating that Fairtrade works as a pro-poor rural development instrument and can reduce poverty. Food security and food consumption expenditures are, however, not affected by certification, and non-cocoa income proves to be more relevant for food purchases. Reasons could be gender dimensions of control over income from cash crops and seasonal income patterns. Lastly, the analysis looked at different categories of consumption expenditures and found different effects between poor and non-poor households: Poor households increase consumption in the category of basic living expenditures, including housing and clothing, whereas non-poor households increase expenditures for education and transport. The essay concluded that Fairtrade improves living standards of farm households if aggregate consumption expenditures are looked at, but it does affect poor and non-poor households unevenly. Certification schemes like Fairtrade can be an effective tool in strengthening producers of export crops and increasing their living standards. However, to specifically target issues like food security, higher incomes alone are not sufficient, and complex consumption dynamics need to be considered when aiming to improve certain areas of wellbeing. Special training and workshops, that are already in place in some contexts, can help to enlarge the scope of improvements achieved by Fairtrade and other certification programs.

The third chapter analyzed whether import restrictions on chicken in Ghana are a pro-poor policy instrument. Some countries have imposed stricter import policies, e.g. high import tariffs or complete import bans, to protect local producers from global competition. Adding to the controversial debate around the advantages and disadvantages of protectionist trade policies, the analysis of our study simulated two hypothetical scenarios of import restrictions and estimated their effects on consumption, production, and overall welfare. In these scenarios, both, a higher import tariff and an import ban would lead to increased market prices for domestic producers and thereby raise their production output and incomes. However, the same increase in prices would have negative effects on consumption levels, especially in the case of a complete import ban. With the exception of very poor rural households, most households in Ghana are net consumers of chicken and would experience overall welfare losses in consequence of tightened import restrictions. Very poor rural households make up about 10% of the population and therefore, the majority of people, including very poor urban and moderately poor rural and urban households, would be negatively affected. Additional import restrictions can thus not be considered a pro-poor policy. To support very poor rural households, other measures like targeted income support or technical assistance in agricultural subsectors might be better suited. By strengthening infrastructure, technology, and local institutions, improvements across all producers and consumers and a more sustainable development of the sectors can be achieved, compared to using restrictive policies that shield the domestic economy from global competition.

The last essay in chapter four looked at the link between overfishing, fish production in small- and large-scale fishing sectors, fish imports, and household fish consumption and production in Ghana. The results showed that overall fish consumption increased over the past years and so did total fish production in Ghana's EEZ. Most of the growth can be traced back to the industrial sector, while production in the small-scale subsistence and artisanal sectors stagnates. The analysis used several indicators to check for overexploitation of marine sources and found a strong correlation between industrial fish production and the occurrence of overfishing. This phenomenon is not only a threat to marine ecosystems but has strong socio-economic implications, too. An extensive literature review unfolded that, first, decreasing fish stocks lead to diminishing returns for fishers and others, who rely on related sectors for their income. Second, reduced domestic production limits the availability of fish in the country; a gap that is currently filled with imports. The analysis of the study linked aggregated yearly fish production and import statistics to nationally representative household data and found a positive association between fish production/imports and fish consumption but a negative relationship between imports and household fishing activity/fish sales. Hence, while imports seem to be important for consumption, high industrial fish production and import shares are negatively linked to subsistence production and domestic producers' income from fishing. The analysis found the strongest link between overfishing and production of the industrial sector. The industrial sector is also dominated by foreign fleets whose catch is not directed towards Ghanaian consumers. Thus, production in that sector is also strongly associated with increasing fish imports. The interference of multiple global players in West African marine areas is fostering ecosystem overfishing which makes fishing unprofitable for many of the small-scale fishermen and women in the area. Without economic alternatives, people who formerly relied on fishing for their income will continue to struggle. Policies aiming at conserving marine areas should not discriminate against small-scale fisheries or offer economic alternatives in addition.

In conclusion, trade and local food production are linked in complex ways and affect living standards of people in West Africa variegated. While the results of the studies presented in this dissertation strengthen the importance of international trade to meet the demand for food products, consumers and producers are affected differently and so are poor and non-poor households. Essay two and three analyzed the poultry and fish sectors in Ghana and showed that imports are negatively associated with local production, especially small-scale and subsistence production. Industrialized countries from the Global North, e.g. European countries or the USA, have long had an advantage in production that enables them to provide cheaper products. In the case of chicken imports to Ghana, this advantage is further strengthened through subsidies that are indirectly supporting European producers (e.g. through export subsidies). In the case of fish, foreign producers are strongly involved in illegal and unreported fishing activities, take more fish out of the sea than their fishing agreements would allow them to, and thereby exhaust West African marine resources. In turn, domestic production stagnates or even decreases due to overexploitation, and the country resorts to importing fish from these very countries to meet local demand.

At the same time, the results proved the importance of trade and imports for consumers. Both case studies from Ghana showed that only a minority of households engage in chicken or fish production, and most people are net consumers of these products. Imports provide access to affordable food that is important in a context where food insecurity and malnutrition are still widespread and nutritious alternatives are difficult to access. The analysis of the Ghanaian chicken sector shows that the benefits received on the consumption side outweigh the negative effects of imports on producers. Such examinations are important to base decisions over trade policies on and lead development initiatives that aim to improve the living standards of the most vulnerable people.

Instead of restricting trade, producers should be endorsed in their production processes through e.g. technical or infrastructural support. The first study of this thesis presented an instrument that specifically targets producers of high value export crops and achieves to improve their living standards: the Fairtrade certification scheme. Our analysis showed that by linking farmers to lucrative export markets, supporting them in sustainable production, and paying an appropriate minimum price for their products, income and living standards of participating farmers improve. The standard works as a pro-poor development instrument across participating farmers. Sustainability standards like Fairtrade are hence a valuable measure in supporting producers of cocoa and other tropical export crops, and they can help to improve living standards across countries of the Global South.

5.2 Limitations and directions for future research

The analyzes in this dissertation help making more informed decisions when it comes to trade and local food production and highlight some commonly overlooked aspects. Nevertheless, some limitations need to be mentioned:

The first essay uses data that includes 500 farmers, with half of them being certified under the Fairtrade scheme. While this survey is among the largest ones across studies on sustainability standards, it might not include the poorest of the poor. Because only farmers who produce at a certain level and have access to information about certification can get involved, a certain share of farms is not eligible. The study was also unable to further evaluate the gender aspect on household welfare because the number of female-headed households in the data was too small. Future research should broaden the scope of the household surveys to include both, female-headed households and the most vulnerable ones.

The second essay simulated changes in price after two hypothetical import restriction policies, building on pre-existing estimates of price elasticities as found in the relevant literature. Because of data availability, the results are based on a simple demand-supply model using a few simplified assumptions. Those assumptions include a homogeneous market for domestic and imported chicken products, the separability of markets and household decisions, and a zero price-elasticity of demand for chicken from own production. Future research should aim to improve the quality of the data such that more sophisticated economic models can be used to analyze also short- and long-term effects of trade policies.

In the last essay, the relationship of yearly aggregated national fish production and import statistics with household behavior was analyzed. The study is also limited by the availability of data, enabling only the analysis of correlations without establishing causal relationships. Disaggregated production and import statistics, as well as yearly household data, would allow for a more detailed analysis and more advanced econometric models. Improved monitoring techniques would also enhance the availability of more detailed data on fish production. That way future research could further specify the dynamics of the link between overfishing and households.

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Appendices

A.1 Appendix of Chapter 2

Validity of the instruments used in the IV regression models

We use two instruments to address possible endogeneity of Fairtrade certification in the regression models in equation (1) and thus reduce issues of non-random selection bias. The first instrument is the share of Fairtrade-certified farmers in a 5 km radius around the respective farmer's household, assuming that information about Fairtrade spreads from farmer to farmer in the same neighborhood. The second instrument is a dummy variable that takes a value of one if the mobile phone network provider of the cooperative leader is the company 'Orange', and zero if the leader uses other local network providers such as MTN or Moov. As phone calls and text messages within the same mobile network are cheaper than across networks, more intensive within-network communication can be expected. In our data, we observe a significant positive relationship between a cooperative being certified and a cooperative leader using the network provider 'Orange', implying that within the 'Orange' network information about Fairtrade is likely exchanged more frequently than in the other mobile phone networks.

Table A1.1 with first-stage IV regression results shows that both instruments are significantly associated with Fairtrade certification of the individual farmer for the total sample with all households included. The instruments perform reasonably well also for the two subsamples of poor and non-poor households (Table A1.2). At the same time, the two instruments do not influence household living standards (consumption expenditures) through other channels. As both instruments also capture regional differences (market access etc.), which could potentially influence household welfare in multiple ways, one could have expected a correlation between the instruments and consumption expenditures. However, after controlling for other regional factors, the instruments are not significantly associated with the outcome variables (Table A1.1). That the instruments do not influence any of the outcome variables directly is also confirmed in Table A1.3, which shows correlations between the outcome variables and the instruments for the subsample of non-certified households. None of the outcome variables is significantly correlated with the instruments.

Table A1.4 shows results of additional identification tests. Column (1) tests the null hypothesis that the equations are under-identified, which is rejected in all cases, meaning that the instruments are relevant. Column (2) tests for weak instruments, showing Kleinbergen-Paap rk Wald F statistics and Stock-Yogo critical values. Since all the F statistics are larger than the critical values, the null hypothesis of weak instruments can be rejected. The over-identification tests in column (3) test the null hypothesis that the instruments are uncorrelated with the error term. This hypothesis cannot be rejected at the 5% level. Based on the different tests, we conclude that our instruments are valid and that the IV models lead to unbiased estimates of the effects of Fairtrade certification on household living standards.

Table A1. 1: First-stage IV regression and instrument falsification tests

	(1) Fairtrade certified	(2) Consumption expenditures	(3) Non-food expenditures	(4) Food expenditures
Share of certified farmers in 5km radius	0.822*** (0.03)	0.0488 (0.11)	0.138 (0.16)	-0.0291 (0.12)
Network of coop leader is Orange (1/0)	0.0657*** (0.02)	0.0878 (0.06)	0.100 (0.09)	0.0764 (0.07)
Age of household head	-0.00157 (0.00)	0.00145 (0.00)	-0.00209 (0.00)	0.00206 (0.00)
Female head (1/0)	0.173*** (0.04)	0.334** (0.13)	0.296 (0.19)	0.324*** (0.12)
Education of head (years)	-0.000136 (0.00)	-0.00191 (0.00)	0.00106 (0.00)	-0.00359 (0.01)
Experience in growing cocoa (years)	-0.00121 (0.00)	0.00109 (0.00)	0.00339 (0.00)	-0.000987 (0.00)
Household size	0.00131 (0.00)	-0.0734*** (0.01)	-0.0802*** (0.01)	-0.0623*** (0.01)
Non-cocoa income (million CFA)	0.00609 (0.00)	0.0578*** (0.01)	0.0646*** (0.02)	0.0584*** (0.02)
Value of assets 10 years ago (million CFA)	-0.00305 (0.00)	0 .00393 (0.02)	0.0204 (0.03)	-0.00824 (0.01)
Akan ethnicity (1/0)	-0.00692 (0.02)	-0.0260 (0.06)	-0.0604 (0.08)	-0.00741 (0.07)
Land owned (ha)	0.000800 (0.00)	0.0105** (0.00)	0.0127*** (0.00)	0.00853** (0.00)
Good soil quality (1/0)	0.0471* (0.02)	-0.0351 (0.06)	-0.177** (0.07)	0.0494 (0.07)
Steep slope (1/0)	0.00502 (0.02)	-0.0959** (0.05)	-0.110* (0.06)	-0.0784 (0.05)
Distance to water source (km)	-0.0000140 (0.00)	0.00229 (0.00)	0.00124 (0.00)	0.00301 (0.00)
Distance to tarmac road (km)	-0.0000552 (0.00)	-0.00462*** (0.00)	-0.00464*** (0.00)	-0.00444*** (0.00)
Distance to primary school (1/0)	0.0000659 (0.00)	0.000663 (0.00)	-0.000591 (0.00)	0.00158*** (0.00)
Cooperative age (years)	0.00895*** (0.00)	-0.0115* (0.01)	-0.0172** (0.01)	-0.00572 (0.01)
Cooperative leader education (years)	0.000706 (0.00)	0.0144 (0.01)	0.0218* (0.01)	0.0122 (0.01)
Share of coop democratic decisions	-0.0592 (0.09)	-0.374* (0.21)	-0.244 (0.28)	-0.286 (0.24)
Cooperative size (before certification)	0.000172*** (0.00)	-0.0000789 (0.00)	-0.000158* (0.00)	-0.00000722 (0.00)
Cooperative leader grows cocoa (1/0)	-0.114*** (0.03)	0.0319 (0.07)	0.117 (0.09)	0.0138 (0.07)
Number of trainings provided by cooperative	0.00869 (0.01)	0.0307 (0.02)	0.0895*** (0.03)	-0.0101 (0.03)
Number of vehicles the cooperative owns	0.0110*** (0.00)	0.00115 (0.01)	-0.00495 (0.01)	0.00415 (0.01)
Fairtrade certified (1/0)		0.0849 (0.11)	0.168 (0.15)	0.0171 (0.11)
Constant	-0.0287 (0.09)	8.004*** (0.25)	7.084*** (0.31)	7.311*** (0.27)
Wald test on instruments (chi2/F)	857.87***	1.07	1.11	0.63
Observations	500	500	500	500

Notes: Coefficient estimates are shown with robust standard errors in parentheses. Expenditure variables in columns (2) to (4) are IHS-transformed. * p<0.10, ** p<0.05, *** p<0.01

Table A1. 2: Test of instrument significance on certification status for subsamples

	(1) Fairtrade certified (total sample)	(3) Fairtrade certified (poor households)	(2) Fairtrade certified (non-poor households)
Share of certified cooperatives in 5km radius	0.822***	0.807***	0.852***
	(0.03)	(0.04)	(0.05)
Phone operator of cooperative leader is Orange (1/0)	0.0657***	0.0872**	0.0325
	(0.02)	(0.04)	(0.03)
Observations	500	262	238

Notes: Standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01

Table A1. 3: Pairwise correlations between instruments and outcome variables for subsample of non-certified households

	Total sample		Poor households		Non-poor households	
Outcome Variables	(1) IV 1	(2) IV 2	(1) IV 1	(2) IV 2	(1) IV 1	(2) IV 2
(1) IV1: Share of cert. coop. in 5km radius	1.000		1.000		1.000	
(2) IV2: Phone operator of coop. leader is Orange	0.162	1.000	0.169	1.000	0.153	1.000
(3) Food expenditures	-0.031	-0.002	0.047	0.032	-0.095	-0.019
(4) Non-food expenditures	0.092	-0.030	0.196	0.035	0.032	-0.082
(5) Total expenditures	0.034	-0.021	0.147	0.028	-0.039	-0.050
(6) Living expenditures	0.082	0.020	0.163	0.044	0.029	0.018
(7) Social expenditures	0.041	0.007	0.146	0.075	-0.058	-0.050
(8) Health expenditures	0.092	0.027	0.212	0.049	-0.036	0.021
(9) Education expenditures	0.116	-0.040	0.144	0.046	0.097	-0.113
(10) Other expenditures	-0.009	0.050	0.014	0.128	-0.025	-0.022
(11) Transport expenditures	0.057	-0.059	0.033	-0.012	0.105	-0.110
(12) HDDS	0.106	0.106	0.101	0.158	0.129	0.059
(13) FCS	0.085	0.082	0.119	0.138	0.054	0.027
(14) Undernourished (1/0)	0.043	-0.026	0.037	-0.049	0.045	-0.005

Note: None of the correlation coefficients is statistically significant.

Table A1. 4: Identification tests, total sample

	(1) Kleinbergen-Paap rk LM Statistic	(2) Kleinbergen-Paap rk Wald F Statistic	(3) Hansen J. statistic
Total Sample			
Total expenditures	183.697	408.348	1.741
	(0.000)	(19.93)	(0.1871)
Total non-food expenditures	183.697	408.348	1.084
	(0.000)	(19.93)	(0.2979)
Total food expenditures	183.697	408.348	1.281
	(0.000)	(19.93)	(0.2577)
Poor households			
Total expenditures	91.391	244.984	0.062
	(0.000)	(19.93)	(0.802)
Total non-food expenditures	91.391	244.984	1.133
	(0.000)	(19.93)	(0.2872)
Total food expenditures	91.391	244.984	0.079
	(0.000)	(19.93)	(0.7783)
Non-poor households			
Total expenditures	90.712	162.015	2.235
	(0.000)	(19.93)	(0.1349)
Total non-food expenditures	90.712	162.015	0.009
	(0.000)	(19.93)	(0.9245)
Total food expenditures	90.712	162.015	3.655
	(0.000)	(19.93)	(0.0559)

Notes: In columns (1) and (3), chi-square statistics are shown with *p*-values in parentheses. In column (2), Stock-Yogo weak ID test critical values at 10% max IV size are shown in parentheses.

Table A1. 5: Poverty rates among Fairtrade-certified and non-certified households

	Certified households	Non-certified households	Mean difference
Income below $1.90 PPP	0.304	0.272	0.032
Income below $3.20 PPP	0.508	0.54	-0.032
Income below $5.50 PPP	0.752	0.8	-0.048
Observations	250	250	

Table A1. 6: Effects of Fairtrade certification on daily per capita consumption expenditures (full results of OLS models)

	(1) Total expenditures	(2) Food expenditures	(3) Non-food expenditures	(4) Basic living expenditures	(5) Health expenditures	(6) Education expenditures	(7) Transport expenditures	(8) Social expenditures	(9) Financial expenditures	(10) Missellan. expenditures
Fairtrade certified	0.139**	0.0103	0.292***	0.131	0.0208	0.487**	0.417*	0.214*	0.286**	-0.0222
	(0.07)	(0.07)	(0.09)	(0.10)	(0.11)	(0.22)	(0.23)	(0.12)	(0.13)	(0.24)
Age of household head	0.00163	0.00212	-0.00177	-0.00234	0.00865**	0.0117	-0.0228**	-0.0148***	-0.00307	-0.00252
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
Female household head	0.321**	0.321***	0.272	0.308	0.170	0.455	-0.289	0.0705	0.540	0.150
	(0.13)	(0.12)	(0.19)	(0.19)	(0.18)	(0.50)	(0.51)	(0.25)	(0.51)	(0.39)
Education of household head	-0.00166	-0.00342	0.00139	0.0138***	-0.0151	-0.00583	-0.00207	-0.000532	-0.00200	0.00864
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)
Experience in growing cocoa	0.00119	-0.000929	0.00353	-0.00113	-0.00806*	0.000952	0.00330	0.00693	0.00429	-0.0106
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
Size of household	-0.0725***	-0.0617***	-0.0790***	-0.0736***	-0.0645***	-0.0103	-0.0566**	-0.0757***	0.00366	-0.0776***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)
Non-cocoa income	0.0588***	0.0595***	0.0656***	0.0895***	0.101***	0.0747**	0.0888**	0.0694**	-0.0211	0.136**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.04)	(0.03)	(0.01)	(0.05)
Value of assets 10 years ago	0.00401	-0.00816	0.0204	0.00241	0.0285	0.0170	0.0487	0.0421	0.00725	0.0543**
	(0.02)	(0.01)	(0.03)	(0.03)	(0.03)	(0.02)	(0.06)	(0.05)	(0.01)	(0.02)
Akan ethnicity	-0.0371	-0.0160	-0.0743	-0.130*	0.0862	0.194	-0.107	-0.0662	0.155*	-0.478**
	(0.06)	(0.06)	(0.07)	(0.08)	(0.10)	(0.20)	(0.20)	(0.10)	(0.09)	(0.22)
Land owned (ha)	0.0101**	0.00821**	0.0121**	0.00985**	0.00886	-0.00122	0.0280***	0.0192***	0.00454	0.0244***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Good soil quality	-0.0370	0.0477	-0.180**	0.101	-0.266***	-0.256	-0.299	-0.295***	-0.142	-0.142
	(0.06)	(0.07)	(0.07)	(0.08)	(0.09)	(0.20)	(0.20)	(0.10)	(0.12)	(0.21)
Steep slope	-0.0989**	-0.0799	-0.115*	-0.0714	-0.0898	-0.172	-0.479***	-0.0963	-0.0379	0.247
	(0.05)	(0.05)	(0.06)	(0.07)	(0.08)	(0.16)	(0.18)	(0.08)	(0.08)	(0.18)
Distance to water source	0.00231	0.00309	0.00118	0.000363	-0.00195	0.00190	-0.00994	-0.00114	0.00574*	-0.00109
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
Distance to tarmac road	-0.00457***	-0.00450***	-0.00445**	-0.00735***	-0.00460*	0.00364	0.000652	-0.00475*	-0.00268	-0.00193
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)
Distance to primary school	0.000695	0.00159***	-0.000531	0.000670	0.00254***	-0.00962***	-0.000805	-0.000422	-0.000564	-0.000829
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Age of cooperative	-0.0136**	-0.00724	-0.0201***	0.000230	-0.0376***	0.00497	-0.0603***	-0.0167	-0.00534	-0.0237
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)
Education of coop leader	0.0129	0.00973	0.0215*	0.0124	0.0220	0.0667**	-0.00116	0.00963	-0.00796	0.0389
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.04)	(0.02)	(0.01)	(0.04)

Coop democratic decisions	-0.365*	-0.277	-0.236	-0.307	-0.112	-0.702	-0.949	0.224	-0.448	0.797
	(0.21)	(0.24)	(0.28)	(0.34)	(0.33)	(0.70)	(0.66)	(0.37)	(0.54)	(0.67)
Cooperative size before certif.	-0.0000785	0.00000649	-0.000173**	-0.000148*	-0.000205**	-0.000142	-0.0000710	-0.0000768	-0.0000947	-0.000484**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Coop leader grows cocoa	0.0381	0.0151	0.129	0.156*	0.125	0.0912	0.217	0.0667	-0.0989	-0.105
	(0.07)	(0.07)	(0.09)	(0.09)	(0.11)	(0.22)	(0.24)	(0.12)	(0.13)	(0.23)
Trainings by cooperative	0.0273	-0.0147	0.0874***	0.00113	0.120***	-0.0551	0.249***	0.111***	0.0279	0.195**
	(0.02)	(0.03)	(0.03)	(0.03)	(0.04)	(0.08)	(0.09)	(0.04)	(0.04)	(0.08)
Vehicles coop owns	0.00298	0.00592	-0.00308	0.0132	0.0201*	0.000589	-0.00593	-0.00798	-0.0123	-0.0139
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)
Constant	8.090***	7.394***	7.171***	5.588***	4.663***	3.326***	6.029***	5.709***	0.436	3.602***
	(0.24)	(0.26)	(0.28)	(0.31)	(0.39)	(0.78)	(0.76)	(0.42)	(0.45)	(0.79)
Observations	500	500	500	500	500	500	500	500	500	500

Notes: Coefficient estimates shown with standard errors in parentheses. All dependent variables are IHS-transformed. * *p*<0.10; ** *p*<0.05; *** *p*<0.01

Table A1. 7: Effects of Fairtrade certification on daily per capita consumption expenditures (full results of IV models)

	(1) Total expenditures	(2) Food expenditures	(3) Non-food expenditures	(4) Basic living expenditures	(5) Health expenditures	(6) Education expenditures	(7) Transport expenditures	(8) Social expenditures	(9) Financial expenditures	(10) Miscellan. expenditures
Fairtrade certified	0.171**	0.00638	0.364***	0.223*	0.120	0.659**	0.564**	0.243*	0.376**	-0.243
	(0.08)	(0.09)	(0.10)	(0.12)	(0.15)	(0.27)	(0.28)	(0.15)	(0.18)	(0.30)
Age of household head	0.00166	0.00212	-0.00170	-0.00225	0.00874**	0.0119	-0.0227**	-0.0148***	-0.00299	-0.00273
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
Female household head	0.315**	0.322***	0.257	0.289	0.150	0.420	-0.319	0.0647	0.522	0.194
	(0.12)	(0.11)	(0.18)	(0.19)	(0.17)	(0.49)	(0.50)	(0.25)	(0.49)	(0.39)
Education of household head	-0.00170	-0.00342	0.00129	0.0137***	-0.0152	-0.00606	-0.00227	-0.000571	-0.00212	0.00893
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)
Experience in growing cocoa	0.00126	-0.000939	0.00370	-0.000911	-0.00783*	0.00136	0.00365	0.00700	0.00451	-0.0111
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
Household size	-0.0728***	-0.0616***	-0.0797***	-0.0745***	-0.0654***	-0.0119	-0.0580**	-0.0759***	0.00282	-0.0756***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)
Non-cocoa income	0.0584***	0.0595***	0.0646***	0.0883***	0.0995***	0.0725**	0.0868**	0.0690**	-0.0223	0.139***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.04)	(0.03)	(0.01)	(0.05)
Value of assets 10 years ago	0.00428	-0.00819	0.0211	0.00322	0.0294	0.0185	0.0500	0.0424	8.04e-09	0.0524**
	(0.02)	(0.01)	(0.03)	(0.03)	(0.03)	(0.02)	(0.06)	(0.05)	(0.00)	(0.02)
Akan ethnicity	-0.0349	-0.0163	-0.0690	-0.123	0.0934	0.206	-0.0958	-0.0641	0.162*	-0.494**
	(0.06)	(0.06)	(0.07)	(0.08)	(0.10)	(0.19)	(0.20)	(0.10)	(0.09)	(0.22)

Land owned (ha)	0.0101**	0.00821**	0.0121**	0.00986**	0.00886	-0.00121	0.0280***	0.0192***	0.00455	0.0244***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Good soil quality	-0.0410	0.0482	-0.189***	0.0894	-0.278***	-0.278	-0.318	-0.298***	-0.154	-0.114
	(0.06)	(0.06)	(0.07)	(0.08)	(0.09)	(0.20)	(0.20)	(0.09)	(0.12)	(0.21)
Steep slope	-0.0981**	-0.0800	-0.113*	-0.0689	-0.0872	-0.168	-0.476***	-0.0955	-0.0355	0.241
	(0.05)	(0.05)	(0.06)	(0.07)	(0.08)	(0.16)	(0.18)	(0.08)	(0.08)	(0.17)
Distance to water source	0.00237	0.00309	0.00133	0.000552	-0.00175	0.00226	-0.00964	-0.00108	0.00593*	-0.00154
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
Distance to tarmac road	-0.00467***	-0.00448***	-0.00468***	-0.00765***	-0.00491*	0.00309	0.000186	-0.00484*	-0.00296	-0.00123
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)
Distance to primary school	0.000668	0.00159***	-0.000593	0.000590	0.00246***	-0.00977***	-0.000932	-0.000447	-0.000642	-0.000638
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Age of cooperative	-0.0139**	-0.00720	-0.0207***	-0.000593	-0.0385***	0.00343	-0.0616***	-0.0170*	-0.00614	-0.0218
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)
Education of coop leader	0.0118	0.00987	0.0190*	0.00920	0.0186	0.0608**	-0.00623	0.00863	-0.0111	0.0465
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.04)	(0.02)	(0.01)	(0.03)
Democratic coop decisions	-0.360*	-0.278	-0.223	-0.290	-0.0937	-0.671	-0.923	0.230	-0.432	0.757
	(0.21)	(0.24)	(0.27)	(0.33)	(0.33)	(0.68)	(0.65)	(0.36)	(0.52)	(0.66)
Coop size before certification	-0.0000807	0.00000677	-0.000178**	-0.000155*	-0.000212**	-0.000154	-0.0000815	-0.0000788	-0.000101	-0.000468*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Coop leader grows cocoa	0.0436	0.0144	0.141*	0.173*	0.143	0.121	0.243	0.0718	-0.0830	-0.144
	(0.06)	(0.07)	(0.08)	(0.09)	(0.11)	(0.22)	(0.23)	(0.11)	(0.13)	(0.22)
Trainings provided by coop	0.0252	-0.0144	0.0828***	-0.00479	0.114***	-0.0661	0.240***	0.109***	0.0221	0.209**
	(0.02)	(0.03)	(0.03)	(0.03)	(0.04)	(0.08)	(0.09)	(0.04)	(0.03)	(0.08)
Vehicles coop owns	0.00209	0.00603	-0.00511	0.0106	0.0173	-0.00426	-0.0101	-0.00880	-0.0148	-0.00764
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)
Constant	8.096***	7.394***	7.184***	5.605***	4.681***	3.357***	6.055***	5.714***	0.453	3.562***
	(0.23)	(0.25)	(0.28)	(0.30)	(0.38)	(0.77)	(0.74)	(0.41)	(0.44)	(0.77)
Observations	500	500	500	500	500	500	500	500	500	500

Notes: Coefficient estimates shown with standard errors in parentheses. All dependent variables are IHS-transformed. * p<0.10; ** p<0.05; *** p<0.01

Table A1. 8: Effects of Fairtrade certification on food security indicators for full sample and poor and non-poor subsamples (full results)

	Total sample						Poor			Non-poor		
	HDDS (OLS)	FCS (OLS)	Under-nourished (probit)	HDDS (IV)	FCS (IV)	Under-nourished (IV probit)	HDDS (IV)	FCS (IV)	Under-nourished (IV probit)	HDDS (IV)	FCS (IV)	Under-nourished (IV probit)
Fairtrade certified	-0.0676	-0.544	0.136	0.0781	0.409	0.162	0.376	0.819	0.0670	-0.0494	0.681	0.167
	(0.18)	(1.24)	(0.16)	(0.22)	(1.46)	(0.21)	(0.28)	(1.81)	(0.30)	(0.33)	(2.20)	(0.31)
Age of household head	0.00169	0.00998	-0.0141**	0.00182	0.0109	-0.0141**	-0.00527	-0.0579	-0.0233**	0.00979	0.0776	-0.00629
	(0.01)	(0.04)	(0.01)	(0.01)	(0.04)	(0.01)	(0.01)	(0.06)	(0.01)	(0.01)	(0.06)	(0.01)
Female household head	0.626***	6.762***	-0.515	0.597**	6.569***	-0.521	0.377	7.296***	0.453	0.408	4.848**	-0.738*
	(0.24)	(1.76)	(0.33)	(0.24)	(1.74)	(0.32)	(0.51)	(2.26)	(0.70)	(0.27)	(2.18)	(0.41)
Education of household head	-0.00973	-0.0624*	0.0137*	-0.00992	-0.0637*	0.0136	-0.0148*	-0.0890*	0.0167	-0.000621	-0.0258	0.0247
	(0.01)	(0.04)	(0.01)	(0.01)	(0.03)	(0.02)	(0.01)	(0.05)	(0.02)	(0.01)	(0.04)	(0.03)
Experience in growing cocoa	-0.000941	0.0199	0.00374	-0.000596	0.0222	0.00380	-0.00699	-0.00853	0.00730	0.00256	0.0344	0.00522
	(0.01)	(0.04)	(0.01)	(0.01)	(0.04)	(0.01)	(0.01)	(0.05)	(0.01)	(0.01)	(0.07)	(0.01)
Household size	0.0157	0.263**	0.0465***	0.0143	0.254*	0.0463***	0.0309	0.384**	0.0467*	0.00517	0.194	0.117***
	(0.02)	(0.13)	(0.02)	(0.02)	(0.13)	(0.02)	(0.03)	(0.18)	(0.03)	(0.03)	(0.22)	(0.04)
Non-cocoa income	0.139***	1.211***	0.0258	0.137***	1.198***	0.0256	1.246***	9.085***	-0.349	0.0745*	0.751***	0.0200
	(0.05)	(0.33)	(0.04)	(0.05)	(0.33)	(0.04)	(0.34)	(2.45)	(0.32)	(0.04)	(0.24)	(0.04)
Value of assets 10 years ago	-0.0125	-0.109	0.0984*	-0.0113	-0.100	0.0981	-0.0356**	-0.275***	0.109	0.0861	0.534	0.0736
	(0.04)	(0.25)	(0.05)	(0.04)	(0.25)	(0.06)	(0.01)	(0.08)	(0.24)	(0.05)	(0.38)	(0.08)
Akan ethnicity	-0.378**	-1.298	0.222	-0.367**	-1.229	0.224	-0.326	-1.246	0.353*	-0.369	-0.626	0.0543
	(0.16)	(0.96)	(0.14)	(0.16)	(0.94)	(0.14)	(0.22)	(1.33)	(0.20)	(0.23)	(1.38)	(0.22)
Land owned (ha)	0.00984	0.0698	-0.0150**	0.00984	0.0698	-0.0150**	-0.0123	-0.0986	-0.0271*	0.00305	0.0654	-0.00362
	(0.01)	(0.07)	(0.01)	(0.01)	(0.07)	(0.01)	(0.01)	(0.09)	(0.02)	(0.01)	(0.07)	(0.01)
Good soil quality	-0.0649	-0.302	-0.0267	-0.0832	-0.422	-0.0305	0.0210	0.360	-0.316	-0.156	-0.435	0.350
	(0.16)	(1.03)	(0.14)	(0.16)	(1.01)	(0.14)	(0.21)	(1.32)	(0.21)	(0.24)	(1.56)	(0.23)
Steep slopes	-0.373***	-3.053***	0.102	-0.369***	-3.027***	0.103	-0.240	-2.734**	0.0575	-0.396**	-2.662**	0.143
	(0.14)	(0.85)	(0.12)	(0.13)	(0.83)	(0.12)	(0.18)	(1.10)	(0.17)	(0.19)	(1.18)	(0.18)
Distance to water source	-0.00478	0.0212	-0.00495	-0.00448	0.0232	-0.00489	-0.000445	0.0354	-0.00721	-0.00510	0.0243	-0.00226
	(0.01)	(0.03)	(0.00)	(0.01)	(0.03)	(0.00)	(0.01)	(0.04)	(0.01)	(0.01)	(0.05)	(0.01)
Distance to tarmac road	-0.00686*	-0.0307	0.00291	-0.00732*	-0.0338	0.00282	-0.00824	-0.0292	-0.00221	-0.00821	-0.0455	0.00751
	(0.00)	(0.02)	(0.00)	(0.00)	(0.02)	(0.00)	(0.01)	(0.03)	(0.01)	(0.01)	(0.03)	(0.01)
Distance to primary school	0.00209**	0.00786	-0.0119	0.00196**	0.00704	-0.0119	0.0143	0.135	-0.0438*	0.00144	0.00518	-0.00190
	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.02)	(0.14)	(0.02)	(0.00)	(0.01)	(0.01)
Age of cooperative	-0.00791	-0.0857	0.0140	-0.00921	-0.0942	0.0138	-0.00375	-0.0800	-0.0158	-0.0117	-0.0654	0.0399*
	(0.01)	(0.09)	(0.01)	(0.01)	(0.09)	(0.01)	(0.02)	(0.11)	(0.02)	(0.03)	(0.17)	(0.02)
Education of coop leader	-0.0254	-0.241	-0.00678	-0.0304	-0.274*	-0.00770	-0.0283	-0.347	0.0232	-0.0398	-0.350	-0.0195
	(0.03)	(0.16)	(0.02)	(0.03)	(0.16)	(0.02)	(0.04)	(0.24)	(0.04)	(0.03)	(0.24)	(0.04)

Coop democratic decisions	1.149*	3.014	0.303	1.175**	3.186	0.309	1.667**	2.953	0.328	0.750	2.914	0.575
	(0.59)	(3.64)	(0.46)	(0.58)	(3.57)	(0.47)	(0.83)	(4.83)	(0.70)	(0.78)	(5.19)	(0.72)
Members of coop before certification	-0.00029	-0.0020**	0.00038**	-0.00031*	-0.0021**	0.00038**	-0.00050**	-0.0026**	0.00028	0.000083	0.00015	0.00063**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Coop leader grows cocoa	0.253	0.291	-0.115	0.279	0.459	-0.111	0.359	-0.389	-0.115	0.325	1.715	0.0207
	(0.18)	(1.12)	(0.16)	(0.18)	(1.10)	(0.16)	(0.24)	(1.46)	(0.24)	(0.27)	(1.69)	(0.25)
Trainings provided by cooperative	0.0760	0.413	0.133**	0.0666	0.352	0.131**	0.131	0.378	0.255***	0.000873	0.192	0.0754
	(0.06)	(0.44)	(0.06)	(0.06)	(0.44)	(0.06)	(0.09)	(0.59)	(0.09)	(0.09)	(0.62)	(0.08)
Vehicles cooperative owns	0.0162	0.212*	-0.0540***	0.0121	0.185	-0.0547***	-0.00734	0.237	-0.0809***	0.0215	0.0842	-0.0439*
	(0.02)	(0.11)	(0.01)	(0.02)	(0.11)	(0.02)	(0.02)	(0.16)	(0.02)	(0.03)	(0.17)	(0.02)
Constant	8.581***	26.52***	-0.0686	8.607***	26.70***	-0.0639	8.181***	28.75***	0.600	8.803***	24.17***	-1.629**
	(0.63)	(3.98)	(0.54)	(0.62)	(3.89)	(0.53)	(0.92)	(5.53)	(0.82)	(0.83)	(5.40)	(0.81)
Observations	500	500	500	500	500	500	500	500	500	500		

Notes: Coefficient estimates shown with standard errors in parentheses. Non-poor households are those with incomes of more than 3.20 PPP dollars per capita and day; poor households are those with incomes of less than 3.20 PPP dollars per capita and day. A household is defined as undernourished when daily calorie consumption is below 2400 kcal per male adult equivalent. * *p*<0.10; ** *p*<0.05; *** *p*<0.01

Table A1. 9: Effects of Fairtrade certification on consumption expenditures controlling for double and triple certification

	(1) Total expenditures	(2) Food expenditures	(3) Non-food expenditures	(4) Basic living expenditures	(5) Health expenditures	(6) Education expenditures	(7) Transport expenditures	(8) Social expenditures	(9) Financial expenditures	(10) Miscellan. expenditures
OLS models										
Fairtrade certified	0.122*	-0.00870	0.273***	0.116	-0.0184	0.470**	0.384	0.182	0.322**	-0.0671
	(0.07)	(0.08)	(0.09)	(0.10)	(0.12)	(0.23)	(0.24)	(0.13)	(0.15)	(0.25)
Certified under UTZ/RA	0.0726	0.0812	0.0819	0.0666	0.168	0.0744	0.139	0.135	-0.152	0.192
	(0.08)	(0.08)	(0.10)	(0.10)	(0.13)	(0.23)	(0.25)	(0.13)	(0.16)	(0.25)
IV models										
Fairtrade certified	0.156*	-0.0122	0.350***	0.213*	0.0875	0.652**	0.541*	0.214	0.416**	-0.299
	(0.08)	(0.09)	(0.11)	(0.13)	(0.16)	(0.28)	(0.29)	(0.16)	(0.20)	(0.31)
Certified under UTZ/RA	0.0644	0.0820	0.0634	0.0429	0.142	0.0304	0.101	0.128	-0.175	0.248
	(0.08)	(0.08)	(0.10)	(0.10)	(0.12)	(0.23)	(0.25)	(0.13)	(0.16)	(0.24)
Observations	500	500	500	500	500	500	500	500	500	500

Notes: Coefficient estimates shown with standard errors in parentheses. All dependent variables are IHS-transformed. RA, Rainforest Alliance. * *p*<0.10; ** *p*<0.05; *** *p*<0.01

Table A1. 10: Cocoa yields, prices, and incomes among Fairtrade certified and non-certified households by poverty status

	Poor households (below 3.20 PPP dollars)		Non-poor households (above 3.20 PPP dollars)	
	Certified	Non-certified	Certified	Non-certified
Cocoa yield (kg/ha)	507.72	465.41	641.58	555.90
	(21.66)	(20.49)	(24.42)	(19.60)
Cocoa prices (CFA/kg)	727.54	703.80	734.68	702.50
	(3.70)	(2.39)	(4.55)	(2.08)
Cocoa income (1000 CFA/year)	1812.83	1073.95	2771.87	2256.98
	(616.50)	(696.87)	(189.73)	(186.94)
Observations	127	135	123	115

Notes: Mean values are shown with standard errors in parentheses.

Table A1. 11: Effects of Fairtrade certification on daily per capita consumption expenditures of poor households (full results of IV models)

	(1) Total expenditures	(2) Food expenditures	(3) Non-food expenditures	(4) Basic living expenditures	(5) Health expenditures	(6) Education expenditures	(7) Transport expenditures	(8) Social expenditures	(9) Financial expenditures	(10) Missellan. expenditures
Fairtrade certified	0.271***	0.0784	0.456***	0.274*	0.306	0.507	0.347	0.213	0.292	-0.0414
	(0.10)	(0.11)	(0.15)	(0.15)	(0.20)	(0.36)	(0.40)	(0.21)	(0.28)	(0.40)
Age of household head	0.00344	0.00341	-0.00126	-0.000597	0.00458	0.0143	-0.0306***	-0.0169***	-0.00411	-0.0153
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Female household head	0.0115	0.0693	0.0484	0.679***	-0.197	0.251	-0.653	-0.548	1.052	0.501
	(0.20)	(0.20)	(0.28)	(0.23)	(0.34)	(0.53)	(0.62)	(0.57)	(1.25)	(0.78)
Education of household head	-0.00999***	-0.0137***	-0.00257	0.0118**	-0.0354***	-0.00684	-0.0148	-0.00993*	-0.00592	0.0145
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Experience in growing cocoa	-0.000203	0.000976	-0.00120	-0.00389	-0.0138**	0.000439	-0.00976	0.000412	0.00804	-0.0119
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Household size	-0.0424***	-0.0364***	-0.0419***	-0.0475***	-0.0238*	-0.0305	0.0430	-0.0265*	-0.0121	-0.0110
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.04)	(0.02)	(0.01)	(0.03)
Non-cocoa income	0.00227	-0.0330	0.0406	0.157	0.257	-0.331	-0.456	0.387**	-0.121	0.0942
	(0.10)	(0.11)	(0.13)	(0.15)	(0.19)	(0.36)	(0.45)	(0.17)	(0.15)	(0.41)
Value of assets 10 years ago	-0.0103	-0.0143***	-0.000764	-0.0139	0.0194*	-0.00724	0.0194	0.000252	0.0144*	0.0546***
	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)	(0.02)
Akan ethnicity	0.0113	-0.0101	0.0151	-0.129	0.347***	-0.0638	0.133	-0.00173	0.152	-0.616**
	(0.07)	(0.08)	(0.09)	(0.10)	(0.13)	(0.22)	(0.26)	(0.13)	(0.14)	(0.26)
Land owned (ha)	0.00448	0.00430	0.00448	0.00374	-0.00164	0.0121	0.0136	0.00697	0.0144	0.0192
	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)

Good soil quality	-0.0201	0.116	-0.219**	0.125	-0.309**	-0.546**	-0.324	-0.249**	-0.0674	0.000147
	(0.07)	(0.08)	(0.09)	(0.10)	(0.12)	(0.21)	(0.27)	(0.12)	(0.17)	(0.27)
Steep slopes	-0.0530	-0.0417	-0.0847	-0.0754	-0.00929	-0.286	-0.818***	-0.0669	-0.0502	0.281
	(0.06)	(0.06)	(0.08)	(0.08)	(0.11)	(0.19)	(0.24)	(0.11)	(0.11)	(0.23)
Distance to water	0.00226	0.00213	0.00130	-0.00405	0.000549	0.0140**	0.00336	-0.00424	0.00244	-0.00887
source	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
Distance to tarmac	-0.00135	-0.00140	-0.00162	-0.00480*	0.00184	0.00584	0.0113	-0.00433	0.000213	-0.00718
road	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
Distance to	0.000526	0.00733	-0.00819	-0.00310	0.0177*	0.00271	-0.0286	-0.0104	-0.0125	-0.0308
primary school	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)	(0.02)	(0.01)	(0.03)
Age of cooperative	-0.00705	-0.00127	-0.0146	0.00452	-0.0282**	0.00375	-0.0429	-0.0175	-0.00386	-0.0298
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)	(0.01)	(0.02)	(0.03)
Education of coop	0.0104	-0.00272	0.0366**	0.0165	0.0154	0.103***	0.0308	0.0232	-0.00380	0.0941*
leader	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.04)	(0.06)	(0.02)	(0.02)	(0.05)
Coop democratic	-0.638**	-0.436	-0.496	-0.584	-0.251	0.236	-2.086***	-0.750	-0.942	0.919
decisions	(0.28)	(0.30)	(0.38)	(0.37)	(0.48)	(0.74)	(0.81)	(0.52)	(0.84)	(0.88)
Members of coop	-0.000107	-0.0000170	-0.000206*	-0.0000862	-0.000239	0.0000330	-0.000331	-0.000105	-0.000141	-0.000607**
before certif.	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Coop leader grows	0.0580	-0.0103	0.209*	0.110	0.0678	0.342	0.122	0.134	-0.147	0.259
cocoa	(0.09)	(0.09)	(0.12)	(0.11)	(0.16)	(0.28)	(0.36)	(0.17)	(0.15)	(0.31)
Trainings provided	-0.0265	-0.0865***	0.0747*	-0.0532	0.0563	0.0722	0.169	0.0911	0.00691	0.301**
by coop	(0.03)	(0.03)	(0.04)	(0.04)	(0.06)	(0.09)	(0.14)	(0.06)	(0.06)	(0.12)
Vehicles coop	0.00200	0.0129	-0.0114	0.0117	0.00762	-0.0413	0.00130	-0.000389	-0.00552	-0.00255
owns	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.03)	(0.01)	(0.01)	(0.03)
Constant	7.748***	7.210***	6.596***	5.313***	4.439***	2.437***	5.793***	5.496***	0.641	2.570**
	(0.30)	(0.31)	(0.40)	(0.37)	(0.56)	(0.92)	(1.14)	(0.63)	(0.66)	(1.09)
Observations	262	262	262	262	262	262	262	262	262	262

Notes: Coefficient estimates shown with standard errors in parentheses. All dependent variables are IHS-transformed. Poor households are those with incomes of less than 3.20 PPP dollars per capita and day. * $p<0.10$; ** $p<0.05$; *** $p<0.01$

Table A1. 12: Effects of Fairtrade certification on daily per capita consumption expenditures of non-poor households (full results of IV models)

	(1) Total expenditures	(2) Total food expenditures	(3) Total non-food expenditures	(4) Basic living expenditures	(5) Health expenditures	(6) Education expenditures	(7) Transport expenditures	(8) Social expenditures	(9) Financial expenditures	(10) Miscellan. expenditures
Fairtrade certified	0.00842	-0.151	0.237*	0.0571	-0.0961	1.017**	0.776**	0.186	0.303	-0.539
	(0.10)	(0.14)	(0.12)	(0.18)	(0.20)	(0.40)	(0.36)	(0.16)	(0.19)	(0.44)
Age of household head	-0.000868	-0.000178	-0.00265	-0.00576	0.0123**	0.00614	-0.0186	-0.0129**	-0.0000366	0.00890
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.00)	(0.02)
Female household head	0.255*	0.266*	0.154	0.0325	0.0787	0.343	-0.432	-0.0130	0.440	-0.0571
	(0.15)	(0.14)	(0.21)	(0.24)	(0.18)	(0.68)	(0.54)	(0.25)	(0.48)	(0.46)
Education of household head	-0.000336	0.000598	-0.000793	0.00925***	-0.00168	-0.0115	-0.00540	0.00467	-0.00358	0.00823
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
Experience in growing cocoa	-0.00119	-0.00644	0.00397	-0.00165	-0.00545	0.00576	0.0146	0.00592	-0.000617	-0.0210
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)
Household size	-0.111***	-0.0925***	-0.121***	-0.107***	-0.111***	0.0732	-0.154***	-0.130***	-0.000425	-0.156***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.05)	(0.04)	(0.02)	(0.02)	(0.05)
Non-cocoa income	0.0419***	0.0519***	0.0379**	0.0705***	0.0704***	0.0401	0.0269	0.0255	-0.000470	0.132***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.04)	(0.03)	(0.03)	(0.01)	(0.04)
Value of assets 10 years ago	0.0828***	0.0271	0.134***	0.0964***	0.0998**	0.0269	0.183***	0.263***	0.0306	0.120*
	(0.03)	(0.03)	(0.04)	(0.03)	(0.05)	(0.07)	(0.07)	(0.05)	(0.05)	(0.07)
Akan ethnicity	-0.0832	-0.0282	-0.163	-0.129	-0.168	0.614*	-0.315	-0.160	0.0779	-0.490
	(0.08)	(0.10)	(0.10)	(0.11)	(0.13)	(0.33)	(0.27)	(0.14)	(0.08)	(0.37)
Land owned (ha)	0.00764**	0.00809**	0.00737	0.00435	0.00878	-0.0156	0.0407***	0.00274	-0.00514	0.0137
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.00)	(0.01)
Good soil quality	-0.132*	-0.0885	-0.227**	0.0131	-0.332**	0.00174	-0.472*	-0.363***	-0.275*	-0.376
	(0.08)	(0.10)	(0.09)	(0.12)	(0.13)	(0.33)	(0.27)	(0.12)	(0.16)	(0.32)
Steep slopes	-0.129*	-0.105	-0.120	-0.0377	-0.159	-0.157	-0.148	-0.0155	-0.0286	0.294
	(0.07)	(0.08)	(0.09)	(0.10)	(0.10)	(0.26)	(0.23)	(0.10)	(0.08)	(0.27)
Distance to water source	0.000960	0.00288	-0.000136	0.00382	-0.00475*	-0.00508	-0.0282**	0.00116	0.00910	0.00335
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Distance to tarmac road	-0.00548***	-0.00517**	-0.00596***	-0.00907***	-0.00757***	0.000183	-0.00574	-0.00189	-0.00462	0.000962
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
Distance to primary school	-0.000166	0.000841*	-0.00145**	-0.000175	0.00119	-0.00956***	-0.00235**	-0.00139*	-0.000503	-0.00138
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Age of cooperative	-0.0116	-0.00382	-0.0171*	0.00375	-0.0396***	0.0130	-0.0654**	0.00351	-0.00926	0.00914
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.03)	(0.01)	(0.01)	(0.03)

Education of coop leader	0.00571	0.0145	-0.00214	0.000858	0.00582	0.0286	-0.0797**	-0.0142	-0.00496	0.0165
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.04)	(0.04)	(0.02)	(0.01)	(0.05)
Coop democratic decisions	-0.0754	-0.308	0.253	0.0974	0.0767	-1.564	0.777	1.295***	0.130	0.960
	(0.30)	(0.37)	(0.38)	(0.55)	(0.41)	(1.21)	(1.01)	(0.44)	(0.51)	(1.05)
Members of coop before certification	-0.000123*	-0.0000403	-0.000185*	-0.000240**	-0.000167	-0.000352	0.000275	-0.0000895	-0.0000889	-0.000371
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Coop leader grows cocoa	-0.123	-0.156	-0.00144	0.135	0.0668	0.0411	0.246	-0.124	-0.0116	-0.603*
	(0.09)	(0.11)	(0.12)	(0.15)	(0.16)	(0.38)	(0.30)	(0.14)	(0.16)	(0.34)
Trainings provided by cooperative	0.0288	0.0128	0.0507	-0.00664	0.112**	-0.205	0.222**	0.0549	0.0253	0.114
	(0.03)	(0.04)	(0.04)	(0.04)	(0.05)	(0.13)	(0.11)	(0.05)	(0.04)	(0.11)
Vehicles cooperative owns	0.00559	0.00356	0.00144	0.0150	0.0308*	0.0171	-0.0238	-0.0160	-0.0166	-0.0206
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)	(0.02)	(0.01)	(0.01)	(0.03)
Constant	8.906***	8.135***	8.036***	6.240***	5.356***	3.798***	6.894***	6.355***	0.307	4.866***
	(0.33)	(0.39)	(0.37)	(0.44)	(0.50)	(1.23)	(0.97)	(0.47)	(0.40)	(1.11)
Observations	238	238	238	238	238	238	238	238	238	238

Notes: Coefficient estimates shown with standard errors in parentheses. All dependent variables are IHS-transformed. Non-poor households are those with incomes of more than 3.20 PPP dollars per capita and day. * $p<0.10$; ** $p<0.05$; *** $p<0.01$

Table A1. 13: Effects of Fairtrade certification on consumption expenditures of different income segments (quantile regressions)

		Quantiles (0.25, 0.5, 0.75)		
	OLS	0.25	0.5	0.75
Total expenditures	0.139**	0.155*	0.118*	0.0899
	(0.07)	(0.08)	(0.07)	(0.07)
Food expenditures	0.0103	0.0764	0.0195	0.00188
	(0.07)	(0.08)	(0.08)	(0.10)
Non-food expenditures	0.292***	0.315***	0.307***	0.333***
	(0.09)	(0.10)	(0.09)	(0.09)
Observations	500	500	500	500

Notes: Coefficient estimates shown with standard errors in parentheses. * $p<0.10$; ** $p<0.05$; *** $p<0.01$

A.2 Appendix of Chapter 3

Table A2. 1: Consumption patterns of households that consumed any chicken

		Total		Urban		Rural	
	Total sample mean/sd	Poor mean/sd	Non-poor mean/sd	Poor mean/sd	Non-poor mean/sd	Poor mean/sd	Non-poor mean/sd
Consumption of chicken							
Any chicken (1/0)	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Frozen chicken (1/0)	0.793	0.546	0.845	0.880	0.894	0.506	0.791
	(0.405)	(0.498)	(0.362)	(0.327)	(0.308)	(0.500)	(0.407)
Consumption quantity of frozen chicken	10.091	2.688	11.660	3.821	12.702	2.554	10.505
	(15.632)	(4.605)	(16.661)	(4.962)	(17.386)	(4.546)	(15.742)
Expenditures for frozen chicken	99.714	24.475	115.654	34.144	127.029	23.334	103.056
	(173.678)	(41.364)	(186.387)	(41.796)	(191.810)	(41.188)	(179.395)
Fresh/live chicken (1/0)	0.134	0.100	0.141	0.080	0.148	0.103	0.133
	(0.341)	(0.301)	(0.348)	(0.273)	(0.355)	(0.304)	(0.340)
Consumption quantity of fresh/live chicken	2.263	0.989	2.532	1.931	2.567	0.878	2.495
	(8.845)	(6.139)	(9.297)	(14.652)	(8.680)	(4.111)	(9.937)
Expenditures for fresh/live chicken	30.796	6.501	35.944	4.580	43.199	6.728	27.908
	(121.924)	(31.452)	(132.870)	(17.196)	(152.866)	(32.727)	(105.887)
Own produced chicken (1/0)	0.191	0.463	0.134	0.100	0.043	0.505	0.234
	(0.393)	(0.499)	(0.340)	(0.302)	(0.203)	(0.500)	(0.423)
Consumption quantity of own produced chicken	0.795	1.340	0.680	0.388	0.370	1.452	1.023
	(3.506)	(2.482)	(3.676)	(1.709)	(4.375)	(2.535)	(2.659)
Value of own produced chicken consumed	36.265	54.991	32.297	16.380	17.462	59.549	48.728
	(179.074)	(195.134)	(175.250)	(63.279)	(202.079)	(204.726)	(137.844)
Observations	5417	947	4470	100	2349	847	2121

Note: Own calculations based on GLSS7.

Table A2. 2: Production statistics for households that produced any chicken

		Total		Urban		Rural	
	All who sold mean/sd	Poor mean/sd	Non-poor mean/sd	Poor mean/sd	Total sample mean/sd	Poor mean/sd	Non-poor mean/sd
Chicken sold (1/0)	1.000	0.173	0.057	0.020	0.016	0.191	0.104
	(0.000)	(0.379)	(0.233)	(0.141)	(0.125)	(0.394)	(0.305)
Quantity of chicken sold	15.401	2.068	0.677	0.220	0.301	2.286	1.093
	(65.508)	(7.995)	(5.240)	(1.703)	(5.492)	(8.408)	(4.914)
Value of chicken sold	111.628	18.080	8.030	24.450	4.280	17.328	12.183
	(222.175)	(95.816)	(85.720)	(239.997)	(105.562)	(59.333)	(55.811)
Observations	951	947	4470	100	2349	847	2121

Note: Own calculations based on GLSS7.

Table A2. 3: Change in production through higher import tariffs among households that sold any chicken, PES=0.8

	Total sample mean/sd	Rural households mean/sd	Urban households mean/sd
Current production of chicken	15.388	12.620	44.095
	(65.371)	(35.873)	(186.320)
Current income from chicken	111.160	98.677	240.595
	(221.826)	(111.698)	(645.146)
Average percentage change in domestic production at a 50% import tariff		5.490	
Production of chicken at a 50% import tariff	16.233	13.313	46.516
	(68.960)	(37.843)	(196.549)
Income from chicken at a 50% import tariff	140.424	127.810	271.222
	(516.423)	(490.072)	(727.269)
Average percentage change in production at a prohibitive import tariff		29.631	
Production of chicken at a prohibitive import tariff	19.948	16.359	57.161
	(84.742)	(46.503)	(241.528)
Income from chicken at a prohibitive import tariff	221.288	201.410	427.405
	(813.806)	(772.281)	(1146.068)
Observations	951	867	84

Note: These results correspond to those in Table 5 of the main paper, only that a higher own-price elasticity of supply (PES) of 0.8 was used for the calculations.

Table A2. 4: Welfare effects of higher import tariffs for chicken in Ghana (all households)

		Total		Urban		Rural	
	Total sample mean/sd	Poor mean/sd	Non-poor mean/sd	Poor mean/sd	Non-poor mean/sd	Poor mean/sd	Non-poor mean/sd
50% import tariff							
Consumption change (GHS)	-3.467	-0.565	-4.464	-0.716	-4.865	-0.548	-3.991
	(9.892)	(1.994)	(11.234)	(1.904)	(11.932)	(2.004)	(10.331)
Production change (GHS)	0.249	0.280	0.238	0.100	0.113	0.301	0.385
	(2.761)	(1.260)	(3.114)	(0.972)	(3.510)	(1.287)	(2.562)
Total welfare effect relative to food expenditure (%)	-0.113	-0.019	-0.145	-0.094	-0.151	-0.010	-0.139
	(0.392)	(0.431)	(0.373)	(0.371)	(0.386)	(0.437)	(0.356)
Prohibitive import tariff							
Consumption change (GHS)	-18.715	-3.052	-24.095	-3.866	-26.256	-2.958	-21.543
	(53.388)	(10.763)	(60.634)	(10.275)	(64.398)	(10.816)	(55.759)
Production change (GHS)	1.450	1.616	1.393	0.594	0.667	1.734	2.251
	(16.268)	(7.005)	(18.404)	(5.762)	(20.809)	(7.127)	(15.034)
Total welfare effect relative to food expenditure (%)	-0.601	-0.081	-0.779	-0.496	-0.811	-0.033	-0.742
	(2.139)	(2.344)	(2.034)	(2.064)	(2.110)	(2.370)	(1.939)
Observations	14009	67	304	5647	1455	1756	4780

Table A2. 5: Welfare effects only for those households that consumed or produced chicken

		Total		Urban		Rural	
	Total sample mean/sd	Poor mean/sd	Non-poor mean/sd	Poor mean/sd	Non-poor mean/sd	Poor mean/sd	Non-poor mean/sd
50% import tariff							
Consumption change (GHS)	-8.926	-1.994	-10.497	-2.531	-11.701	-1.932	-9.143
	(14.261)	(3.341)	(15.284)	(2.873)	(16.208)	(3.387)	(14.055)
Production change (GHS)	0.634	0.964	0.560	0.354	0.271	1.035	0.884
	(4.391)	(2.068)	(4.760)	(1.808)	(5.445)	(2.086)	(3.822)
Total welfare effect relative to food expenditure (%)	-0.292	-0.073	-0.342	-0.331	-0.363	-0.043	-0.319
	(0.576)	(0.771)	(0.509)	(0.640)	(0.531)	(0.780)	(0.483)
Prohibitive import tariff							
Consumption change (GHS)	-48.173	-10.764	-56.653	-13.660	-63.154	-10.426	-49.345
	(76.969)	(18.032)	(82.490)	(15.508)	(87.476)	(18.282)	(75.857)
Production change (GHS)	3.730	5.712	3.281	2.098	1.608	6.134	5.161
	(25.956)	(12.259)	(28.130)	(10.720)	(32.279)	(12.363)	(22.434)
Total welfare effect relative to food expenditure (%)	-1.546	-0.279	-1.833	-1.752	-1.951	-0.107	-1.700
	(3.205)	(4.382)	(2.793)	(3.596)	(2.916)	(4.434)	(2.644)
Observations	5433	1004	4429	105	2344	899	2085

Table A2. 6: Welfare effects of higher import tariffs for chicken in Ghana (all households), PES=0.8

		Total		Urban		Rural	
	Total sample mean/sd	Poor mean/sd	Non-poor mean/sd	Poor mean/sd	Non-poor mean/sd	Poor mean/sd	Non-poor mean/sd
50% import tariff							
Consumption change (GHS)	-3.467	-0.565	-4.464	-0.716	-4.865	-0.548	-3.991
	(9.892)	(1.994)	(11.234)	(1.904)	(11.932)	(2.004)	(10.331)
Production change (GHS)	0.300	0.337	0.287	0.121	0.136	0.362	0.465
	(3.332)	(1.494)	(3.761)	(1.175)	(4.244)	(1.525)	(3.087)
Total welfare effect relative to food expenditure (%)	-0.108	-0.006	-0.143	-0.090	-0.150	-0.004	-0.135
	(0.414)	(0.475)	(0.384)	(0.397)	(0.397)	(0.483)	(0.368)
Prohibitive import tariff							
Consumption change (GHS)	-18.715	-3.052	-24.095	-3.866	-26.256	-2.958	-21.543
	(53.388)	(10.763)	(60.634)	(10.275)	(64.398)	(10.816)	(55.759)
Production change (GHS)	1.803	2.008	1.733	0.738	0.830	2.154	2.799
	(20.235)	(8.706)	(22.893)	(7.167)	(25.885)	(8.856)	(18.699)
Total welfare effect relative to food expenditure (%)	-0.564	0.008	-0.760	-0.469	-0.802	-0.063	-0.711
	(2.298)	(2.671)	(2.119)	(2.255)	(2.193)	(2.710)	(2.028)
Observations	14009	3582	10427	371	5647	3211	4780

Table A2. 7: Welfare effects of higher import tariffs for chicken in Ghana with further disaggregation of poor households (all households included), PES=0.5

		Urban households			Rural households		
	Total sample mean/sd	Very poor mean/sd	Poor mean/sd	Non-poor mean/sd	Very poor mean/sd	Poor mean/sd	Non-poor mean/sd
50% import tariff							
Consumption change (GHS)	-3.467	-0.636	-0.734	-4.865	-0.180	-0.853	-3.991
	(9.892)	(1.683)	(1.951)	(11.932)	(0.847)	(2.558)	(10.331)
Production change (GHS)	0.249	0.062	0.109	0.113	0.258	0.337	0.385
	(2.761)	(0.357)	(1.061)	(3.510)	(1.133)	(1.402)	(2.562)
Total welfare effect relative to food expenditure (%)	-0.113	-0.137	-0.084	-0.151	0.041	-0.053	-0.139
	(0.392)	(0.414)	(0.360)	(0.386)	(0.466)	(0.407)	(0.356)
Prohibitive import tariff							
Consumption change (GHS)	-18.715	-3.432	-3.962	-26.256	-0.973	-4.602	-21.543
	(53.388)	(9.082)	(10.531)	(64.398)	(4.574)	(13.808)	(55.759)
Production change (GHS)	1.450	0.365	0.644	0.667	1.453	1.967	2.251
	(16.268)	(2.117)	(6.288)	(20.809)	(5.613)	(8.165)	(15.034)
Total welfare effect relative to food expenditure (%)	-0.601	-0.731	-0.444	-0.811	0.245	-0.264	-0.742
	(2.139)	(2.250)	(2.021)	(2.110)	(2.499)	(2.232)	(1.939)
Observations	14009	67	304	5647	1455	1756	4780

A.3 Appendix of Chapter 4

Table A3. 1: Results for pairwise comparisons of means with equal variances using Tukey's method

Household size		2005	2012	2017
	2005	.	0.091 (0.036)	0.027 (0.757)
	2012	0.091 (0.036)	.	-0.064 (0.123)
	2017	0.027 (0.757)	-0.064 (0.123)	.
Rural household		2005	2012	2017
	2005	.	-0.127 (0.000)	-0.113 (0.000)
	2012	-0.127 (0.000)	.	0.0143 (0.028)
	2017	-0.113 (0.000)	0.0143 (0.028)	.
Total daily food expenditures per capita, deflated		2005	2012	2017
	2005	.	1.230 (0.000)	3.033 (0.0001)
	2012	1.230 (0.000)	.	1.802 (0.000)
	2017	3.033 (0.000)	1.802 (0.000)	.
Poverty Status (1/0)		2005	2012	2017
	2005	.	-0.098 (0.000)	-0.082 (0.000)
	2012	-0.098 (0.000)	.	0.016 (0.003)
	2017	-0.082 (0.000)	0.016 (0.003)	.
Any household member participated in fishing activities in past 3 months		2005	2012	2017
	2005	.	-0.004 (0.144)	-0.009 (0.000)
	2012	-0.004 (0.144)	.	-0.006 (0.001)
	2017	-0.009 (0.000)	-0.006 (0.001)	.
Was any fish sold during the last 12 months?		2005	2012	2017
	2005	.	-0.005 (0.001)	-0-007 (0.000)
	2012	-0.005 (0.001)	.	-0.002 (0.405)
	2017	-0-007 (0.000)	-0.002 (0.405)	.
Fish consumption 1/0		2005	2012	2017
	2005	.	0.055 (0.000)	0.040 (0.000)
	2012	0.055 (0.000)	.	-0.015 (0.000)
	2017	0.040 (0.000)	-0.015 (0.000)	.
Household consumed any own produced fish/shellfish		2005	2012	2017
	2005	.	0.032 (0.000)	-0.028 (0.000)
	2012	0.032 (0.000)	.	0.005 (0.024)
	2017	-0.028 (0.000)	0.005 (0.024)	.

Note: p-values in parentheses.

Table A3. 2: Summary of households by poverty status, 2005-2017

	Poor households			Non-poor households		
	2005	2012	2017	2005	2012	2017
	mean/sd	mean/sd	mean/sd	mean/sd	mean/sd	mean/sd
Household size	5.595	6.029	5.989	3.448	3.709	3.586
	(3.266)	(3.084)	(3.209)	(2.531)	(2.430)	(2.456)
Rural household 1/0	0.884	0.845	0.896	0.581	0.465	0.458
	(0.320)	(0.362)	(0.305)	(0.493)	(0.499)	(0.498)
Total daily per capita food expenditures	0.473	0.875	1.201	2.313	3.564	5.933
	(0.235)	(0.379)	(0.655)	(6.758)	(3.339)	(4.826)
Fishing 1/0	0.033	0.031	0.023	0.024	0.021	0.015
	(0.178)	(0.174)	(0.150)	(0.152)	(0.142)	(0.122)
Fish sales 1/0	0.018	0.020	0.016	0.019	0.011	0.010
	(0.132)	(0.141)	(0.126)	(0.136)	(0.103)	(0.098)
Total value of caught and farmed fish	.	26.511	49.046	0.000	19.137	63.424
	(.)	(255.959)	(840.695)	(0.000)	(321.320)	(1615.231)
Household spend anything on fishing 1/0	.	0.014	0.010	.	0.007	0.007
	(.)	(0.116)	(0.101)	(.)	(0.085)	(0.085)
Amount spent in cash/in-kind on fishing	.	8.013	9.651	.	6.359	11.068
	(.)	(126.998)	(300.498)	(.)	(154.742)	(265.164)
Fish consumption 1/0	0.850	0.943	0.963	0.918	0.953	0.926
	(0.357)	(0.232)	(0.189)	(0.275)	(0.213)	(0.262)
Consumption diversity	.	1.116	0.944	.	1.758	1.251
	(.)	(0.768)	(0.485)	(.)	(1.122)	(0.833)
Number of periods in which fish was consumed	.	4.674	4.720	.	5.045	4.555
	(.)	(1.858)	(1.668)	(.)	(1.674)	(1.913)
Own fish consumption 1/0	0.060	0.020	0.034	0.047	0.019	0.020
	(0.237)	(0.139)	(0.182)	(0.213)	(0.136)	(0.141)
Number of months household consumed own fish	.	0.191	0.116	.	0.193	0.075
	(.)	(1.429)	(0.797)	(.)	(1.462)	(0.665)
Observations	3139	4014	3582	6153	12758	10427

Notes: Expenditures and values given in Ghanaian cedi (GHS). Consumption diversity measures number of different fish items consumed during survey period (max eight). Number of periods in which fish was consumed has maximum of six. Food expenditures and value of sold fish deflated using FAO Food Price Indices (FAO, 2021a). Amount spent on fishing deflated using Consumer Price Indices provided by the Ghanaian Statistical Service (Ghana Statistical Service, 2017).

Table A3. 3: Marginal effects of total catch (SAU), Probit and OLS models

	(1) Fish consumption 1/0	(2) Own fish consumption 1/0	(3) Consumption diversity	(4) Number of periods in which fish was consumed	(5) Fish sales 1/0
Total annual catch inside Ghanaian EEZ	0.00118***	-0.000397***	-0.0231***	-0.0151***	-0.0000282
	(0.000109)	(0.0000641)	(0.000546)	(0.000795)	(0.0000334)
Household size	0.0197***	0.000699***	0.0593***	0.103***	0.000526***
	(0.000959)	(0.000266)	(0.00230)	(0.00333)	(0.000143)
Region with access to marine area or Lake Volta	0.0219***	0.0344***	0.219***	0.231***	0.00512***
	(0.00275)	(0.00293)	(0.0106)	(0.0168)	(0.00132)
Rural household 1/0	0.0446***	0.0252***	0.00433	0.194***	0.00168*
	(0.00270)	(0.00211)	(0.0111)	(0.0159)	(0.000958)
Poverty status (1/0)	-0.0584***	0.000982	-0.475***	-0.388***	-0.00110
	(0.00332)	(0.00195)	(0.0130)	(0.0205)	(0.00104)
Daily per capita food expenditures, deflated	0.00113***	0.000103	0.0333***	0.0131***	-0.000293*
	(0.000418)	(0.000103)	(0.00298)	(0.00246)	(0.000153)
Fishing 1/0	-0.0736***	0.0705***	-0.290***	-0.837***	0.0398***
	(0.0103)	(0.00433)	(0.0452)	(0.0959)	(0.00139)
Fish sales 1/0	-0.0142	0.0468***	-0.202***	-0.706***	
	(0.0129)	(0.00532)	(0.0582)	(0.135)	
Year=2005	0	0			0
	(.)	(.)			(.)
Year=2012	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Year=2017	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Fish consumption 1/0		0	1.357***	4.788***	-0.00432***
		(.)	(0.0105)	(0.0151)	(0.00131)
Own fish consumption 1/0			-0.351***	-1.115***	0.0124***
			(0.0379)	(0.0835)	(0.00124)
Observations	40053	37340	30781	30781	40053

Notes: Standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01. All variables show results for SAU statistics. Catch shown in 1000 metric tonnes/year. Probit specifications were used for binary outcome variables in model 1, 2, and 5. Models 3 and 4 are run for years 2012 and 2017 only using OLS regression. All results show marginal effects. Marginal effects for categorical year variable not estimable because of collinearity with catch.

Table A3. 4: Marginal effects of total catch (SAU) on poor households, Probit and OLS models

	(1) Fish consumption 1/0	(2) Own fish consumption 1/0	(3) Consumption diversity	(4) Number of periods in which fish was consumed	(5) Fish sales 1/0
Total annual catch inside Ghanaian EEZ	0.00225***	-0.000311*	-0.0124***	-0.0103***	0.0000972
	(0.000267)	(0.000187)	(0.000694)	(0.00170)	(0.0000891)
Household size	0.0155***	0.000715	0.0239***	0.0873***	0.000716***
	(0.00134)	(0.000529)	(0.00215)	(0.00549)	(0.000229)
Region with access to marine area or Lake Volta	0.0152***	0.0527***	0.270***	0.217***	0.0113***
	(0.00583)	(0.00642)	(0.0135)	(0.0326)	(0.00275)
Rural household 1/0	0.0499***	0.0240***	-0.0464**	0.148***	0.00743**
	(0.00635)	(0.00705)	(0.0230)	(0.0467)	(0.00341)
Daily per capita food expenditures, deflated	0.0479***	0.00152	0.232***	0.533***	0.00143
	(0.00795)	(0.00467)	(0.0127)	(0.0334)	(0.00173)
Fishing 1/0	-0.0509***	0.0710***	-0.239***	-0.947***	0.0490***
	(0.0172)	(0.00926)	(0.0557)	(0.169)	(0.00290)
Fish sales 1/0	-0.0838***	0.0668***	-0.314***	-1.033***	
	(0.0202)	(0.0111)	(0.0616)	(0.211)	
Year=2005	0	0			0
	(.)	(.)			(.)
Year=2012	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Year=2017	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Fish consumption 1/0		0	0.978***	4.514***	-0.0117***
		(.)	(0.0164)	(0.0403)	(0.00241)
Own fish consumption 1/0			-0.350***	-1.352***	0.0149***
			(0.0439)	(0.140)	(0.00232)
Observations	10735	9902	7596	7596	10735

Notes: Standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01. All variables show results for SAU statistics. Catch shown in 1000 metric tonnes/year. Probit specifications were used for binary outcome variables in model 1, 2, and 5. Models 3 and 4 are run for years 2012 and 2017 only using OLS regression. All results show marginal effects. Marginal effects for categorical year variable are not estimable because of collinearity with catch.

Table A3. 5: Marginal effects of total catch (SAU) on non-poor households, Probit and OLS models

	(1) Fish consumption 1/0	(2) Own fish consumption 1/0	(3) Consumption diversity	(4) Number of periods in which fish was consumed	(5) Fish sales 1/0
Total annual catch inside Ghanaian EEZ	0.000150	-0.000426***	-0.0283***	-0.0199***	-0.0000847**
	(0.000134)	(0.0000720)	(0.000735)	(0.000917)	(0.0000365)
Household size	0.0256***	0.000693**	0.0887***	0.126***	0.000489***
	(0.00137)	(0.000322)	(0.00371)	(0.00427)	(0.000186)
Region with access to marine area or lake Volta	0.0266***	0.0269***	0.187***	0.194***	0.00267*
	(0.00310)	(0.00326)	(0.0138)	(0.0196)	(0.00141)
Rural household 1/0	0.0416***	0.0230***	0.0119	0.200***	0.000758
	(0.00294)	(0.00206)	(0.0124)	(0.0168)	(0.000953)
Daily per capita food expenditures, deflated	0.00299***	0.000120	0.0415***	0.0184***	-0.000237*
	(0.000492)	(0.0000998)	(0.00378)	(0.00273)	(0.000141)
Fishing 1/0	-0.0913***	0.0695***	-0.345***	-0.825***	0.0361***
	(0.0133)	(0.00483)	(0.0597)	(0.116)	(0.00157)
Fish sales 1/0	0.0305*	0.0400***	-0.168**	-0.523***	
	(0.0182)	(0.00598)	(0.0814)	(0.171)	
Year=2005	0	0			0
	(.)	(.)			(.)
Year=2012	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Year=2017	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Fish consumption 1/0		0	1.407***	4.795***	-0.000543
		(.)	(0.0120)	(0.0171)	(0.00179)
Own fish consumption 1/0			-0.369***	-1.047***	0.0116***
			(0.0510)	(0.102)	(0.00143)
Observations	29318	27438	23185	23185	29318

Notes: Standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01. All variables show results for SAU statistics. Catch shown in 1000 metric tonnes/year. Probit specifications were used for binary outcome variables in model 1, 2, and 5. Models 3 and 4 are run for years 2012 and 2017 only using OLS regression. All results show marginal effects. Marginal effects for categorical year variable are not estimable because of collinearity with catch.

Table A3. 6: Marginal effects of industrial catch (SAU), Probit and OLS models

	(1) Fish consumption 1/0	(2) Own fish consumption 1/0	(3) Consumption diversity	(4) Number of periods in which fish was consumed	(5) Fish sales 1/0
Total annual catch inside Ghanaian EEZ	0.000930***	-0.000314***	-0.0273***	-0.0178***	-0.0000222
	(0.0000858)	(0.0000506)	(0.000644)	(0.000937)	(0.0000263)
Household size	0.0197***	0.000699***	0.0593***	0.103***	0.000526***
	(0.000959)	(0.000266)	(0.00230)	(0.00333)	(0.000143)
Region with access to marine area or Lake Volta	0.0219***	0.0344***	0.219***	0.231***	0.00512***
	(0.00275)	(0.00293)	(0.0106)	(0.0168)	(0.00132)
Rural household 1/0	0.0446***	0.0252***	0.00433	0.194***	0.00168*
	(0.00270)	(0.00211)	(0.0111)	(0.0159)	(0.000958)
Poverty status (1/0)	-0.0584***	0.000982	-0.475***	-0.388***	-0.00110
	(0.00332)	(0.00195)	(0.0130)	(0.0205)	(0.00104)
Daily per capita food expenditures, deflated	0.00113***	0.000103	0.0333***	0.0131***	-0.000293*
	(0.000418)	(0.000103)	(0.00298)	(0.00246)	(0.000153)
Fishing 1/0	-0.0736***	0.0705***	-0.290***	-0.837***	0.0398***
	(0.0103)	(0.00433)	(0.0452)	(0.0959)	(0.00139)
Fish sales 1/0	-0.0142	0.0468***	-0.202***	-0.706***	
	(0.0129)	(0.00532)	(0.0582)	(0.135)	
Year=2005	0	0			0
	(.)	(.)			(.)
Year=2012	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Year=2017	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Fish consumption 1/0		0	1.357***	4.788***	-0.00432***
		(.)	(0.0105)	(0.0151)	(0.00131)
Own fish consumption 1/0			-0.351***	-1.115***	0.0124***
			(0.0379)	(0.0835)	(0.00124)
Observations	40053	37340	30781	30781	40053

Notes: Standard errors in parentheses, * $p<0.10$, ** $p<0.05$, *** $p<0.01$. All variables show results for SAU statistics. Catch shown in 1000 metric tonnes/year. Probit specifications were used for binary outcome variables in model 1, 2, and 5. Models 3 and 4 are run for years 2012 and 2017 only using OLS regression. All results show marginal effects. Marginal effects for categorical year variable are not estimable because of collinearity with catch.

Table A3. 7: Marginal effects of industrial catch (SAU) on poor households, Probit and OLS models

	(1) Fish consumption 1/0	(2) Own fish consumption 1/0	(3) Consumption diversity	(4) Number of periods in which fish was consumed	(5) Fish sales 1/0
Total annual catch inside Ghanaian EEZ	0.00178***	-0.000245*	-0.0146***	-0.0121***	0.0000768
	(0.000211)	(0.000148)	(0.000818)	(0.00200)	(0.0000704)
Household size	0.0155***	0.000715	0.0239***	0.0873***	0.000716***
	(0.00134)	(0.000529)	(0.00215)	(0.00549)	(0.000229)
Region with access to marine area or Lake Volta	0.0152***	0.0527***	0.270***	0.217***	0.0113***
	(0.00583)	(0.00642)	(0.0135)	(0.0326)	(0.00275)
Rural household 1/0	0.0499***	0.0240***	-0.0464**	0.148***	0.00743**
	(0.00635)	(0.00705)	(0.0230)	(0.0467)	(0.00341)
Daily per capita food expenditures, deflated	0.0479***	0.00152	0.232***	0.533***	0.00143
	(0.00795)	(0.00467)	(0.0127)	(0.0334)	(0.00173)
Fishing 1/0	-0.0509***	0.0710***	-0.239***	-0.947***	0.0490***
	(0.0172)	(0.00926)	(0.0557)	(0.169)	(0.00290)
Fish sales 1/0	-0.0838***	0.0668***	-0.314***	-1.033***	
	(0.0202)	(0.0111)	(0.0616)	(0.211)	
Year=2005	0	0			0
	(.)	(.)			(.)
Year=2012	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Year=2017	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Fish consumption 1/0		0	0.978***	4.514***	-0.0117***
		(.)	(0.0164)	(0.0403)	(0.00241)
Own fish consumption 1/0			-0.350***	-1.352***	0.0149***
			(0.0439)	(0.140)	(0.00232)
Observations	10735	9902	7596	7596	10735

Notes: Standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01. All variables show results for SAU statistics. Catch shown in 1000 metric tonnes/year. Probit specifications were used for binary outcome variables in model 1, 2, and 5. Models 3 and 4 are run for years 2012 and 2017 only using OLS regression. All results show marginal effects. Marginal effects for categorical year variable are not estimable because of collinearity with catch.

Table A3. 8: Marginal effects of industrial catch (SAU) on non-poor households, Probit and OLS models

	(1) Fish consumption 1/0	(2) Own fish consumption 1/0	(3) Consumption diversity	(4) Number of periods in which fish was consumed	(5) Fish sales 1/0
Total annual catch inside Ghanaian EEZ	0.000118	-0.000336***	-0.0334***	-0.0234***	-0.0000668**
	(0.000106)	(0.0000568)	(0.000866)	(0.00108)	(0.0000288)
Household size	0.0256***	0.000693**	0.0887***	0.126***	0.000489***
	(0.00137)	(0.000322)	(0.00371)	(0.00427)	(0.000186)
Region with access to marine area or Lake Volta	0.0266***	0.0269***	0.187***	0.194***	0.00267*
	(0.00310)	(0.00326)	(0.0138)	(0.0196)	(0.00141)
Rural household 1/0	0.0416***	0.0230***	0.0119	0.200***	0.000758
	(0.00294)	(0.00206)	(0.0124)	(0.0168)	(0.000953)
Daily per capita food expenditures, deflated	0.00299***	0.000120	0.0415***	0.0184***	-0.000237*
	(0.000492)	(0.0000998)	(0.00378)	(0.00273)	(0.000141)
Fishing 1/0	-0.0913***	0.0695***	-0.345***	-0.825***	0.0361***
	(0.0133)	(0.00483)	(0.0597)	(0.116)	(0.00157)
Fish sales 1/0	0.0305*	0.0400***	-0.168**	-0.523***	
	(0.0182)	(0.00598)	(0.0814)	(0.171)	
Year=2005	0	0			0
	(.)	(.)			(.)
Year=2012	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Year=2017	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Fish consumption 1/0		0	1.407***	4.795***	-0.000543
		(.)	(0.0120)	(0.0171)	(0.00179)
Own fish consumption 1/0			-0.369***	-1.047***	0.0116***
			(0.0510)	(0.102)	(0.00143)
Observations	29318	27438	23185	23185	29318

Notes: Standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01. All variables show results for SAU statistics. Catch shown in 1000 metric tonnes/year. Probit specifications were used for binary outcome variables in model 1, 2, and 5. Models 3 and 4 are run for years 2012 and 2017 only using OLS regression. All results show marginal effects. Marginal effects for categorical year variable are not estimable because of collinearity with catch.

Table A3. 9: Marginal effects of subsistence catch (SAU), Probit and OLS models

	(1) Fish consumption 1/0	(2) Own fish consumption 1/0	(3) Consumption diversity	(4) Number of periods in which fish was consumed	(5) Fish sales 1/0
Total annual catch inside Ghanaian EEZ	-0.00983***	0.00331***	-0.162***	-0.106***	0.000235
	(0.000906)	(0.000535)	(0.00383)	(0.00557)	(0.000278)
Household size	0.0197***	0.000699***	0.0593***	0.103***	0.000526***
	(0.000959)	(0.000266)	(0.00230)	(0.00333)	(0.000143)
Region with access to marine area or Lake Volta	0.0219***	0.0344***	0.219***	0.231***	0.00512***
	(0.00275)	(0.00293)	(0.0106)	(0.0168)	(0.00132)
Rural household 1/0	0.0446***	0.0252***	0.00433	0.194***	0.00168*
	(0.00270)	(0.00211)	(0.0111)	(0.0159)	(0.000958)
Poverty status (1/0)	-0.0584***	0.000982	-0.475***	-0.388***	-0.00110
	(0.00332)	(0.00195)	(0.0130)	(0.0205)	(0.00104)
Daily per capita food expenditures, deflated	0.00113***	0.000103	0.0333***	0.0131***	-0.000293*
	(0.000418)	(0.000103)	(0.00298)	(0.00246)	(0.000153)
Fishing 1/0	-0.0736***	0.0705***	-0.290***	-0.837***	0.0398***
	(0.0103)	(0.00433)	(0.0452)	(0.0959)	(0.00139)
Fish sales 1/0	-0.0142	0.0468***	-0.202***	-0.706***	
	(0.0129)	(0.00532)	(0.0582)	(0.135)	
Year=2005	0	0			0
	(.)	(.)			(.)
Year=2012	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Year=2017	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Fish consumption 1/0		0	1.357***	4.788***	-0.00432***
		(.)	(0.0105)	(0.0151)	(0.00131)
Own fish consumption 1/0			-0.351***	-1.115***	0.0124***
			(0.0379)	(0.0835)	(0.00124)
Observations	40053	37340	30781	30781	40053

Notes: Standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01. All variables show results for SAU statistics. Catch shown in 1000 metric tonnes/year. Probit specifications were used for binary outcome variables in model 1, 2, and 5. Models 3 and 4 are run for years 2012 and 2017 only using OLS regression. All results show marginal effects. Marginal effects for categorical year variable are not estimable because of collinearity with catch.

Table A3. 10: Marginal effects of subsistence catch (SAU) on poor households, Probit and OLS models

	(1) Fish consumption 1/0	(2) Own fish consumption 1/0	(3) Consumption diversity	(4) Number of periods in which fish was consumed	(5) Fish sales 1/0
Total annual catch inside Ghanaian EEZ	-0.0188***	0.00259*	-0.0871***	-0.0719***	-0.000811
	(0.00223)	(0.00156)	(0.00486)	(0.0119)	(0.000743)
Household size	0.0155***	0.000715	0.0239***	0.0873***	0.000716***
	(0.00134)	(0.000529)	(0.00215)	(0.00549)	(0.000229)
Region with access to marine area or Lake Volta	0.0152***	0.0527***	0.270***	0.217***	0.0113***
	(0.00583)	(0.00642)	(0.0135)	(0.0326)	(0.00275)
Rural household 1/0	0.0499***	0.0240***	-0.0464**	0.148***	0.00743**
	(0.00635)	(0.00705)	(0.0230)	(0.0467)	(0.00341)
Daily per capita food expenditures, deflated	0.0479***	0.00152	0.232***	0.533***	0.00143
	(0.00795)	(0.00467)	(0.0127)	(0.0334)	(0.00173)
Fishing 1/0	-0.0509***	0.0710***	-0.239***	-0.947***	0.0490***
	(0.0172)	(0.00926)	(0.0557)	(0.169)	(0.00290)
Fish sales 1/0	-0.0838***	0.0668***	-0.314***	-1.033***	
	(0.0202)	(0.0111)	(0.0616)	(0.211)	
Year=2005	0	0			0
	(.)	(.)			(.)
Year=2012	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Year=2017	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Fish consumption 1/0		0	0.978***	4.514***	-0.0117***
		(.)	(0.0164)	(0.0403)	(0.00241)
Own fish consumption 1/0			-0.350***	-1.352***	0.0149***
			(0.0439)	(0.140)	(0.00232)
Observations	10735	9902	7596	7596	10735

Notes: Standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01. All variables show results for SAU statistics. Catch shown in 1000 metric tonnes/year. Probit specifications were used for binary outcome variables in model 1, 2, and 5. Models 3 and 4 are run for years 2012 and 2017 only using OLS regression. All results show marginal effects. Marginal effects for categorical year variable are not estimable because of collinearity with catch.

Table A3. 11: Marginal effects of subsistence catch (SAU) on non-poor households, Probit and OLS models

	(1) Fish consumption 1/0	(2) Own fish consumption 1/0	(3) Consumption diversity	(4) Number of periods in which fish was consumed	(5) Fish sales 1/0
Total annual catch inside Ghanaian EEZ	-0.00125	0.00355***	-0.199***	-0.139***	0.000706**
	(0.00112)	(0.000600)	(0.00515)	(0.00642)	(0.000305)
Household size	0.0256***	0.000693**	0.0887***	0.126***	0.000489***
	(0.00137)	(0.000322)	(0.00371)	(0.00427)	(0.000186)
Region with access to marine area or Lake Volta	0.0266***	0.0269***	0.187***	0.194***	0.00267*
	(0.00310)	(0.00326)	(0.0138)	(0.0196)	(0.00141)
Rural household 1/0	0.0416***	0.0230***	0.0119	0.200***	0.000758
	(0.00294)	(0.00206)	(0.0124)	(0.0168)	(0.000953)
Daily per capita food expenditures, deflated	0.00299***	0.000120	0.0415***	0.0184***	-0.000237*
	(0.000492)	(0.0000998)	(0.00378)	(0.00273)	(0.000141)
Fishing 1/0	-0.0913***	0.0695***	-0.345***	-0.825***	0.0361***
	(0.0133)	(0.00483)	(0.0597)	(0.116)	(0.00157)
Fish sales 1/0	0.0305*	0.0400***	-0.168**	-0.523***	
	(0.0182)	(0.00598)	(0.0814)	(0.171)	
Year=2005	0	0			0
	(.)	(.)			(.)
Year=2012	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Year=2017	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Fish consumption 1/0		0	1.407***	4.795***	-0.000543
		(.)	(0.0120)	(0.0171)	(0.00179)
Own fish consumption 1/0			-0.369***	-1.047***	0.0116***
			(0.0510)	(0.102)	(0.00143)
Observations	29318	27438	23185	23185	29318

Notes: Standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01. All variables show results for SAU statistics. Catch shown in 1000 metric tonnes/year. Probit specifications were used for binary outcome variables in model 1, 2, and 5. Models 3 and 4 are run for years 2012 and 2017 only using OLS regression. All results show marginal effects. Marginal effects for categorical year variable are not estimable because of collinearity with catch.

Table A3. 12: Marginal effects of artisanal catch (SAU), Probit and OLS models

	(1) Fish consumption 1/0	(2) Own fish consumption 1/0	(3) Consumption diversity	(4) Number of periods in which fish was consumed	(5) Fish sales 1/0
Total annual catch inside Ghanaian EEZ	-0.00705***	0.00238***	-4.419***	-2.876***	0.000169
	(0.000650)	(0.000384)	(0.104)	(0.152)	(0.000200)
Household size	0.0197***	0.000699***	0.0593***	0.103***	0.000526***
	(0.000959)	(0.000266)	(0.00230)	(0.00333)	(0.000143)
Region with access to marine area or Lake Volta	0.0219***	0.0344***	0.219***	0.231***	0.00512***
	(0.00275)	(0.00293)	(0.0106)	(0.0168)	(0.00132)
Rural household 1/0	0.0446***	0.0252***	0.00433	0.194***	0.00168*
	(0.00270)	(0.00211)	(0.0111)	(0.0159)	(0.000958)
Poverty status (1/0)	-0.0584***	0.000982	-0.475***	-0.388***	-0.00110
	(0.00332)	(0.00195)	(0.0130)	(0.0205)	(0.00104)
Daily per capita food expenditures, deflated	0.00113***	0.000103	0.0333***	0.0131***	-0.000293*
	(0.000418)	(0.000103)	(0.00298)	(0.00246)	(0.000153)
Fishing 1/0	-0.0736***	0.0705***	-0.290***	-0.837***	0.0398***
	(0.0103)	(0.00433)	(0.0452)	(0.0959)	(0.00139)
Fish sales 1/0	-0.0142	0.0468***	-0.202***	-0.706***	
	(0.0129)	(0.00532)	(0.0582)	(0.135)	
Year=2005	0	0			0
	(.)	(.)			(.)
Year=2012	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Year=2017	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Fish consumption 1/0		0	1.357***	4.788***	-0.00432***
		(.)	(0.0105)	(0.0151)	(0.00131)
Own fish consumption 1/0			-0.351***	-1.115***	0.0124***
			(0.0379)	(0.0835)	(0.00124)
Observations	40053	37340	30781	30781	40053

Notes: Standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01. All variables show results for SAU statistics. Catch shown in 1000 metric tonnes/year. Probit specifications were used for binary outcome variables in model 1, 2, and 5. Models 3 and 4 are run for years 2012 and 2017 only using OLS regression. All results show marginal effects. Marginal effects for categorical year variable are not estimable because of collinearity with catch.

Table A3. 13: Marginal effects of artisanal catch (SAU) on poor households, Probit and OLS models

	(1) Fish consumption 1/0	(2) Own fish consumption 1/0	(3) Consumption diversity	(4) Number of periods in which fish was consumed	(5) Fish sales 1/0
Total annual catch inside Ghanaian EEZ	-0.0135***	0.00186*	-2.372***	-1.957***	-0.000582
	(0.00160)	(0.00112)	(0.133)	(0.324)	(0.000533)
Household size	0.0155***	0.000715	0.0239***	0.0873***	0.000716***
	(0.00134)	(0.000529)	(0.00215)	(0.00549)	(0.000229)
Region with access to marine area or Lake Volta	0.0152***	0.0527***	0.270***	0.217***	0.0113***
	(0.00583)	(0.00642)	(0.0135)	(0.0326)	(0.00275)
Rural household 1/0	0.0499***	0.0240***	-0.0464**	0.148***	0.00743**
	(0.00635)	(0.00705)	(0.0230)	(0.0467)	(0.00341)
Daily per capita food expenditures, deflated	0.0479***	0.00152	0.232***	0.533***	0.00143
	(0.00795)	(0.00467)	(0.0127)	(0.0334)	(0.00173)
Fishing 1/0	-0.0509***	0.0710***	-0.239***	-0.947***	0.0490***
	(0.0172)	(0.00926)	(0.0557)	(0.169)	(0.00290)
Fish sales 1/0	-0.0838***	0.0668***	-0.314***	-1.033***	
	(0.0202)	(0.0111)	(0.0616)	(0.211)	
Year=2005	0	0			0
	(.)	(.)			(.)
Year=2012	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Year=2017	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Fish consumption 1/0		0	0.978***	4.514***	-0.0117***
		(.)	(0.0164)	(0.0403)	(0.00241)
Own fish consumption 1/0			-0.350***	-1.352***	0.0149***
			(0.0439)	(0.140)	(0.00232)
Observations	10735	9902	7596	7596	10735

Notes: Standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01. All variables show results for SAU statistics. Catch shown in 1000 metric tonnes/year. Probit specifications were used for binary outcome variables in model 1, 2, and 5. Models 3 and 4 are run for years 2012 and 2017 only using OLS regression. All results show marginal effects. Marginal effects for categorical year variable are not estimable because of collinearity with catch.

Table A3. 14: Marginal effects of artisanal catch (SAU) on non-poor households, Probit and OLS models

	(1) Fish consumption 1/0	(2) Own fish consumption 1/0	(3) Consumption diversity	(4) Number of periods in which fish was consumed	(5) Fish sales 1/0
Total annual catch inside Ghanaian EEZ	-0.000895	0.00255***	-5.411***	-3.795***	0.000506**
	(0.000803)	(0.000431)	(0.140)	(0.175)	(0.000219)
Household size	0.0256***	0.000693**	0.0887***	0.126***	0.000489***
	(0.00137)	(0.000322)	(0.00371)	(0.00427)	(0.000186)
Region with access to marine area or Lake Volta	0.0266***	0.0269***	0.187***	0.194***	0.00267*
	(0.00310)	(0.00326)	(0.0138)	(0.0196)	(0.00141)
Rural household 1/0	0.0416***	0.0230***	0.0119	0.200***	0.000758
	(0.00294)	(0.00206)	(0.0124)	(0.0168)	(0.000953)
Daily per capita food expenditures, deflated	0.00299***	0.000120	0.0415***	0.0184***	-0.000237*
	(0.000492)	(0.0000998)	(0.00378)	(0.00273)	(0.000141)
Fishing 1/0	-0.0913***	0.0695***	-0.345***	-0.825***	0.0361***
	(0.0133)	(0.00483)	(0.0597)	(0.116)	(0.00157)
Fish sales 1/0	0.0305*	0.0400***	-0.168**	-0.523***	
	(0.0182)	(0.00598)	(0.0814)	(0.171)	
Year=2005	0	0			0
	(.)	(.)			(.)
Year=2012	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Year=2017	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Fish consumption 1/0		0	1.407***	4.795***	-0.000543
		(.)	(0.0120)	(0.0171)	(0.00179)
Own fish consumption 1/0			-0.369***	-1.047***	0.0116***
			(0.0510)	(0.102)	(0.00143)
Observations	29318	27438	23185	23185	29318

Notes: Standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01. All variables show results for SAU statistics. Catch shown in 1000 metric tonnes/year. Probit specifications were used for binary outcome variables in model 1, 2, and 5. Models 3 and 4 are run for years 2012 and 2017 only using OLS regression. All results show marginal effects. Marginal effects for categorical year variable are not estimable because of collinearity with catch.

Table A3. 15: Marginal effects of total catch (FAO), Probit and OLS models

	(1) Fish consumption 1/0	(2) Own fish consumption 1/0	(3) Consumption diversity	(4) Number of periods in which fish was consumed	(5) Fish sales 1/0
Total annual catch inside Ghanaian EEZ	0.000592***	-0.000199***	-0.0101***	-0.00656***	-0.0000141
	(0.0000546)	(0.0000322)	(0.000238)	(0.000346)	(0.0000168)
Household size	0.0197***	0.000699***	0.0593***	0.103***	0.000526***
	(0.000959)	(0.000266)	(0.00230)	(0.00333)	(0.000143)
Region with access to marine area or Lake Volta	0.0219***	0.0344***	0.219***	0.231***	0.00512***
	(0.00275)	(0.00293)	(0.0106)	(0.0168)	(0.00132)
Rural household 1/0	0.0446***	0.0252***	0.00433	0.194***	0.00168*
	(0.00270)	(0.00211)	(0.0111)	(0.0159)	(0.000958)
Poverty status (1/0)	-0.0584***	0.000982	-0.475***	-0.388***	-0.00110
	(0.00332)	(0.00195)	(0.0130)	(0.0205)	(0.00104)
Daily per capita food expenditures, deflated	0.00113***	0.000103	0.0333***	0.0131***	-0.000293*
	(0.000418)	(0.000103)	(0.00298)	(0.00246)	(0.000153)
Fishing 1/0	-0.0736***	0.0705***	-0.290***	-0.837***	0.0398***
	(0.0103)	(0.00433)	(0.0452)	(0.0959)	(0.00139)
Fish sales 1/0	-0.0142	0.0468***	-0.202***	-0.706***	
	(0.0129)	(0.00532)	(0.0582)	(0.135)	
Year=2005	0	0			0
	(.)	(.)			(.)
Year=2012	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Year=2017	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)
Fish consumption 1/0		0	1.357***	4.788***	-0.00432***
		(.)	(0.0105)	(0.0151)	(0.00131)
Own fish consumption 1/0			-0.351***	-1.115***	0.0124***
			(0.0379)	(0.0835)	(0.00124)
Observations	40053	37340	30781	30781	40053

Notes: Standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01. Catch shown in 100 metric tonnes/year (FAO (FIGIS), 2021). Probit specifications were used for binary outcome variables in model 1, 2, and 5. Models 3 and 4 are run for years 2012 and 2017 only using OLS regression. All results show marginal effects. Marginal effects for categorical year variable are not estimable because of collinearity with catch.

Table A3. 16: Marginal effects of total trade value of fish imports, Probit and OLS models

	(1) Fishing 1/0	(2) Fish consumption 1/0	(3) Own fish consumption 1/0	(4) Consumption diversity	(5) Number of periods in which fish was consumed	(6) Fish sales 1/0
Imports	-0.0000217*	0.000204***	-0.0000689***	-0.00546***	-0.00355***	-0.00000489
	(0.0000115)	(0.0000189)	(0.0000111)	(0.000129)	(0.000187)	(0.00000579)
Household size	0.00197***	0.0197***	0.000699***	0.0593***	0.103***	0.000526***
	(0.000232)	(0.000959)	(0.000266)	(0.00230)	(0.00333)	(0.000143)
Region with access to marine area or Lake Volta	0.0247***	0.0219***	0.0344***	0.219***	0.231***	0.00512***
	(0.00231)	(0.00275)	(0.00293)	(0.0106)	(0.0168)	(0.00132)
Rural household 1/0	0.0193***	0.0446***	0.0252***	0.00433	0.194***	0.00168*
	(0.00184)	(0.00270)	(0.00211)	(0.0111)	(0.0159)	(0.000958)
Poverty status (1/0)	0.000371	-0.0584***	0.000982	-0.475***	-0.388***	-0.00110
	(0.00181)	(0.00332)	(0.00195)	(0.0130)	(0.0205)	(0.00104)
Daily per capita food expenditures, deflated	-0.0000916	0.00113***	0.000103	0.0333***	0.0131***	-0.000293*
	(0.000231)	(0.000418)	(0.000103)	(0.00298)	(0.00246)	(0.000153)
Fishing 1/0	0	0	0			0
	(.)	(.)	(.)			(.)
Fish sales 1/0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)
Year=2005	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)
Year=2012		-0.0736***	0.0705***	-0.290***	-0.837***	0.0398***
		(0.0103)	(0.00433)	(0.0452)	(0.0959)	(0.00139)
Year=2017		-0.0142	0.0468***	-0.202***	-0.706***	
		(0.0129)	(0.00532)	(0.0582)	(0.135)	
Fish consumption 1/0			0	1.357***	4.788***	-0.00432***
			(.)	(0.0105)	(0.0151)	(0.00131)
Own fish consumption 1/0				-0.351***	-1.115***	0.0124***
				(0.0379)	(0.0835)	(0.00124)
Observations	40053	40053	37340	30781	30781	40053

Notes: Standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01. Trade value shown in one million USD (OECD, 2001). Probit specifications were used for binary outcome variables in model 1-3, 6. Models 4 and 5 run for years 2012 and 2017 only using OLS regression. All results show marginal effects. Marginal effects for categorical year variable are not estimable because of collinearity with catch.

Table A3. 17: Marginal effects of total trade value of imports on poor households, Probit and OLS models

	(1) Fishing 1/0	(2) Fish consumption 1/0	(3) Own fish consumption 1/0	(4) Consumption diversity	(5) Number of periods in which fish was consumed	(6) Fish sales 1/0
Imports	-0.0000546*	0.000391***	-0.0000538*	-0.00293***	-0.00242***	0.0000169
	(0.0000297)	(0.0000463)	(0.0000324)	(0.000164)	(0.000401)	(0.0000155)
Household size	0.00175***	0.0155***	0.000715	0.0239***	0.0873***	0.000716***
	(0.000441)	(0.00134)	(0.000529)	(0.00215)	(0.00549)	(0.000229)
Region with access to marine area or Lake Volta	0.0286***	0.0152***	0.0527***	0.270***	0.217***	0.0113***
	(0.00462)	(0.00583)	(0.00642)	(0.0135)	(0.0326)	(0.00275)
Rural household 1/0	0.0106**	0.0499***	0.0240***	-0.0464**	0.148***	0.00743**
	(0.00528)	(0.00635)	(0.00705)	(0.0230)	(0.0467)	(0.00341)
Daily per capita food expenditures, deflated	0.00836**	0.0479***	0.00152	0.232***	0.533***	0.00143
	(0.00363)	(0.00795)	(0.00467)	(0.0127)	(0.0334)	(0.00173)
Fishing 1/0	0	0	0			0
	(.)	(.)	(.)			(.)
Fish sales 1/0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)
Year=2005	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)
Year=2012		-0.0509***	0.0710***	-0.239***	-0.947***	0.0490***
		(0.0172)	(0.00926)	(0.0557)	(0.169)	(0.00290)
Year=2017		-0.0838***	0.0668***	-0.314***	-1.033***	
		(0.0202)	(0.0111)	(0.0616)	(0.211)	
Fish consumption 1/0			0	0.978***	4.514***	-0.0117***
			(.)	(0.0164)	(0.0403)	(0.00241)
Own fish consumption 1/0				-0.350***	-1.352***	0.0149***
				(0.0439)	(0.140)	(0.00232)
Observations	10735	10735	9902	7596	7596	10735

Notes: Standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01. Trade value shown in one million USD (OECD, 2001). Probit specifications were used for binary outcome variables in model 1-3, 6. Models 4 and 5 run for years 2012 and 2017 only using OLS regression. All results show marginal effects. Marginal effects for categorical year variable are not estimable because of collinearity with catch.

Table A3. 18: Marginal effects of total trade value of imports on non-poor households, Probit and OLS models

	(1) Fishing 1/0	(2) Fish consumption 1/0	(3) Own fish consumption 1/0	(4) Consumption diversity	(5) Number of periods in which fish was consumed	(6) Fish sales 1/0
Imports	-0.0000258**	0.0000259	-0.0000738***	-0.00668***	-0.00469***	-0.0000147**
	(0.0000122)	(0.0000233)	(0.0000125)	(0.000173)	(0.000216)	(0.00000634)
Household size	0.00233***	0.0256***	0.000693**	0.0887***	0.126***	0.000489***
	(0.000273)	(0.00137)	(0.000322)	(0.00371)	(0.00427)	(0.000186)
Region with access to marine area or Lake Volta	0.0230***	0.0266***	0.0269***	0.187***	0.194***	0.00267*
	(0.00274)	(0.00310)	(0.00326)	(0.0138)	(0.0196)	(0.00141)
Rural household 1/0	0.0189***	0.0416***	0.0230***	0.0119	0.200***	0.000758
	(0.00180)	(0.00294)	(0.00206)	(0.0124)	(0.0168)	(0.000953)
Daily per capita food expenditures, deflated	-0.00000146	0.00299***	0.000120	0.0415***	0.0184***	-0.000237*
	(0.000111)	(0.000492)	(0.0000998)	(0.00378)	(0.00273)	(0.000141)
Fishing 1/0	0	0	0			0
	(.)	(.)	(.)			(.)
Fish sales 1/0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)
Year=2005	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)
Year=2012		-0.0913***	0.0695***	-0.345***	-0.825***	0.0361***
		(0.0133)	(0.00483)	(0.0597)	(0.116)	(0.00157)
Year=2017		0.0305*	0.0400***	-0.168**	-0.523***	
		(0.0182)	(0.00598)	(0.0814)	(0.171)	
Fish consumption 1/0			0	1.407***	4.795***	-0.000543
			(.)	(0.0120)	(0.0171)	(0.00179)
Own fish consumption 1/0				-0.369***	-1.047***	0.0116***
				(0.0510)	(0.102)	(0.00143)
Observations	29318	29318	27438	23185	23185	29318

Notes: Standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01. Trade value shown in one million USD (OECD, 2001). Probit specifications were used for binary outcome variables in model 1-3, 6. Models 4 and 5 run for years 2012 and 2017 only using OLS regression. All results show marginal effects. Marginal effects for categorical year variable are not estimable because of collinearity with catch.

A.4 Curriculum Vitae

Isabel Knößlsdorfer

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Place of birth:	Munich, Germany

Curriculum Vitae

<u>Research positions</u>

05/2019 – 05/2022	**Georg-August University of Göttingen** Scientific Associate of the Chair for 'International Food Economics and Rural Development'

<u>Education</u>

05/2019 – 05/2022	**Georg-August University of Göttingen** Ph.D. Student at the Chair for 'International Food Economics and Rural Development'
10/2016 - 03/2019	**University of Passau: M.A. in Development Studies** Focus: Development Economics
10/2011 - 08/2015	**University of Bayreuth: B.A. in Kultur und Gesellschaft Afrikas** Minor: Economics

<u>Research Interests</u>

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<u>Publications (March 2022)</u>

Knößlsdorfer, I., J. Sellare, M. Qaim (2021). Effects of Fairtrade on Farm Household Food Security and Living Standards: Insights from Côte d'Ivoire. Global Food Security, Vol. 29, 100535, https://doi.org/10.1016/j.gfs.2021.100535

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