RURAL DEVELOPMENT IN SUB-SAHARAN AFRICA:
ESSAYS ON FOOD SUPPLY CHAINS, LABOUR MARKETS AND FERTILITY

Kaat VAN HOYWEGHEN

Supervisors:
Prof. Miet Maertens
Prof. Goedele Van den Broeck

Members of the Examination Committee:
Prof. Marc Hendrickx (Chairman)
Prof. Liesbeth Colen
Prof. Johan Swinnen
Prof. Marijke Verpoorten
Prof. Liesbet Vranken

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Voor mijn ouders

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[1] I would be an extreme outlier when I would figure in any household survey database :-)

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Summary

Rural development can be a major welfare catalyst for rural Sub-Saharan African regions, as more than 80% of the poor live in rural areas and derive their livelihoods from a limited range of (on-farm) activities. Rural development – an umbrella term for all activities, programs and strategies that target to improve the livelihoods of rural households – comprises both agricultural and non-agricultural development, and can be triggered through macro-scale market interventions and micro-scale public interventions. In more recent rural development strategies, four pillars can be distinguished: the establishment of strong empowered local institutions for governance, the development of rural labour markets and education facilities, the introduction of social (safety net) programs and the development of resilient supply chains. In this dissertation I focus on the last three, and more specifically on resilient high value supply chain development, labour market development and rural fertility.

In chapter two I descriptively investigate the Covid-19 pandemic's early impact on the fresh fruits and vegetables supply chain in Senegal, using trade statistics and survey data collected through online questionnaires and telephone interviews with all relevant FFV supply chain actors. The results point to major differences in how Covid-19 and containment measures disrupt supply chains between the modern export-oriented supply chain and the more traditional domestic-oriented supply chain. The former shows to be more resilient to the Covid-19 shock. I show that both the modern and the traditional supply chain innovate to cope with the Covid-19 containment measures. While the study is subject to some limitations, the findings bring nuance in the debate on the resilience of food system to the pandemic, and have important policy and research implications toward international trade, social safety measures, and food and nutrition security.

In chapter three I asses conceptually and empirically the direct and indirect welfare effects of entry and continuation in different types of wage employment in the Senegal River Delta region in rural Senegal. I use panel data, fixed effects and first-difference estimation, and show substantial positive welfare and linkage effects. I find that

participation in wage employment increases per capita income by 143%, and reduces poverty, poverty gap and food insecurity by, respectively, 63%, 89% and 48%. While the direct effect on income is larger for non-agricultural and contractual wage employment, the indirect income effects through self-employment are more pronounced for agricultural and casual wage employment. The results imply that job creation is important for rural development, that wage employment in agriculture can lead to considerable growth multiplier effects, and that synergies exist between large-scale and small-scale agriculture.

In chapter four I use choice experimental data that values preferences with respect to fertility (the household's number of children) and child-raising (the education, nutrition and health care provisioning of the children), using a sample of married couples living in the SRD region in Senegal and the Mount Elgon region in Uganda. As the experiment was first implemented with both spouses separately, and repeated with the spouses jointly as couple, I am able to distinguish between individual and household choices, to analyse spouses' preferences on fertility and child-raising, and to calculate a decision-making coefficient. The results show that the assumptions of the basic unitary household model and the practice of traditional survey-based data collections should be used in a more considerate way and interpreted with more caution. Moreover, I find that a representative mix of husbands and wives cannot substitute for choices made at the household level. The results reveal that fertility and child-raising choices of spouses are highly country-specific. This study reveals the importance of considering the adequate decision-making unit when designing family planning and child-centred programs, and to use a country- or region-specific approach.

In chapter five I use the same choice experimental data collected in Senegal and Uganda, to add to the knowledge on rural fertility preferences and the existence of a quantity-quality trade-off between the number of children and child-raising quality. I include three socio-economic drivers of fertility to the analysis: education level, poverty level and polygamy status of the relation. The results show that rural households prefer to have many children, but non-poor and monogamous respondents demonstrate a lower preference for many children than poor and polygamous

respondents. I find that the quantity-quality trade-off is a two-sided story. On the one hand, for most of the quality attributes, I confirm the existence of a trade-off. On the other hand, quantity and quality are complementary when all children in the household can attain a lower secondary school diploma. The results imply that broadening the currently narrow focus on contraceptive uptake in family planning programs, and more specific targeting of such programs to people with low fertility preferences, could improve their effectiveness.

Overall this dissertation shows that an integrated approach to rural development must include both macro-scale market interventions and micro-scale public interventions. First, macro-scale market interventions are needed to incentivise overall economic growth and rural labour market expansion. These interventions need to target rural areas, the agricultural sector and unskilled labour to optimise the inclusion of the poor. Second, if rural population growth is to be reduced drastically in the coming decades in SSA – which is a highly necessary prerequisite for economic growth to contribute to rural development – well-targeted and well-defined micro-scale public interventions are needed in rural areas.

Samenvatting

Plattelandsontwikkeling kan een belangrijke welvaartskatalysator zijn voor rurale regio's in Sub-Sahara Afrika, aangezien meer dan 80% van de armen in rurale gebieden woont en hun levensonderhoud ontleent aan een beperkt aantal (landbouw-)activiteiten. Plattelandsontwikkeling – een overkoepelende term voor alle activiteiten, programma's en strategieën die gericht zijn op het verbeteren van het levensonderhoud van rurale gezinnen – omvat zowel agrarische als niet-agrarische ontwikkeling en kan worden ondersteund door zowel marktinterventies op macroschaal en overheidsinterventies op microschaal. In recente strategieën voor plattelandsontwikkeling kunnen vier pijlers onderscheiden worden: de oprichting en ondersteuning van sterke lokale besturen, de ontwikkeling van rurale arbeidsmarkten en onderwijsinstellingen, de introductie van sociale vangnetten en programma's, en de ontwikkeling van veerkrachtige toeleveringsketens. In dit proefschrift concentreer ik me op de laatste drie, en meer specifiek op de veerkrachtige ontwikkeling van hoogwaardige toeleveringsketens, rurale arbeidsmarktontwikkeling, en fertiliteit op het platteland.

In hoofdstuk twee implementeer ik een beschrijvend onderzoek naar de impact van de Covid-19-pandemie op de toeleveringsketen van verse groenten en fruit in Senegal. Ik gebruik handelsstatistieken en primaire data verzameld via online vragenlijsten en telefonische interviews. De resultaten wijzen op grote verschillen in hoe Covid-19 en de hieruit volgende inperkingsmaatregelen de toeleveringsketens hebben verstoord. De moderne exportgerichte toeleveringsketen blijkt beter bestand te zijn tegen de Covid-19 schok dan de traditionele binnenlands gerichte toeleveringsketen. Ik vind dat zowel de moderne als de traditionele toeleveringsketen innoveren om de Covid-19-inperkingsmaatregelen het hoofd te bieden. Hoewel de studie onderhevig is aan enkele beperkingen, brengen de bevindingen nuance in het debat over de veerkracht van het voedselsysteem tegen de pandemie, en hebben ze belangrijke beleids- en onderzoeks-implicaties met betrekking tot internationale handel, sociale veiligheidsmaatregelen en voedselzekerheid.

In hoofdstuk drie beoordeel ik conceptueel en empirisch de directe en indirecte welvaartseffecten van loonarbeid in verschillende sectoren op het Senegalese platteland. Ik maak gebruik van paneldata en “fixed effects” en “first-difference” regressies. Ik vind dat deelname aan loonarbeid het gezinsinkomen per persoon met 143% verhoogt en armoede, de armoedekloof en voedselonzekerheid met respectievelijk 63%, 89% en 48% vermindert. Terwijl het directe inkomenseffect groter is voor loonarbeid in de niet-landbouwsector en voor contractuele loonarbeid, zijn de indirecte inkomenseffecten (door een verhoging van het inkomen uit zelfstandige activiteiten) meer uitgesproken wanneer men werkt in de landbouwsector of met een tijdelijk contract. De resultaten impliceren dat het creëren van werkgelegenheid in loondienst belangrijk is voor plattelandsontwikkeling, dat loonwerk in de landbouw kan leiden tot multiplicatoreffecten, en dat er synergiën bestaan tussen grootschalige en kleinschalige landbouw.

In hoofdstuk vier gebruik ik een keuze experiment om de voorkeuren van koppels met betrekking tot fertiliteit (het aantal kinderen in een gezin) en opvoeding (het onderwijs, de voeding en de gezondheidszorg van de kinderen) te onderzoeken. De steekproef bestaat uit gehuwde koppels die op het platteland van Senegal en Oeganda wonen. Het experiment is eerst met beide echtgenoten afzonderlijk uitgevoerd, waarna het herhaald is met de echtgenoten tezamen. Hierdoor ben ik in staat onderscheid te maken tussen individuele en huishoudelijke keuzes, de voorkeuren van echtgenoten te analyseren met betrekking tot fertiliteit en de opvoeding van kinderen, en een coëfficiënt rond onderhandelingskracht te berekenen. De resultaten laten zien dat de assumpties van het unitaire huishoudmodel en de gewoonte van traditionele, op enquêtes gebaseerde, dataverzamelingen om één representatief lid van het gezin te interviewen, op een bedachtzame manier moeten worden gebruikt en met grotere voorzichtigheid moeten worden geïnterpreteerd. Bovendien vind ik dat een representatieve mix van echtgenoten geen substituut is voor keuzes die op het niveau van het huishouden worden genomen. De resultaten laten zien dat de preferenties van koppels over fertiliteit en opvoeding heel land-specifiek zijn. Deze studie laat het belang zien van het overwegen van de adequate besluitvormingseenheid bij het ontwerpen van gezinsplanning en andere sociale programma's, en van een land- of regio-specifieke aanpak te gebruiken.

In hoofdstuk vijf gebruik ik dezelfde experimentele data verzameld in rurale gebieden in Senegal en Oeganda, om de kennis over preferenties met betrekking tot fertiliteit en opvoeding, en het bestaan van een kwantiteit-kwaliteitsverhouding tussen het aantal kinderen en de kwaliteit van de opvoeding, te vergroten. Ik neem drie sociaaleconomische factoren van fertiliteit mee in de analyse: het opleidingsniveau van de respondent, het armoedeniveau van het huishouden en het al dan niet polygaam zijn van de relatie. De resultaten laten zien dat rurale gezinnen de voorkeur geven aan veel kinderen, maar dat niet-arme en monogame respondenten een lagere voorkeur hebben voor veel kinderen dan arme en polygame respondenten. Ik vind dat de afweging tussen kwantiteit en kwaliteit een tweezijdig verhaal is. Enerzijds bevestigen de resultaten het bestaan van een afweging tussen de meeste kwaliteitskenmerken en het aantal kinderen. Aan de andere kant zijn kwantiteit en kwaliteit complementair wanneer alle kinderen in het huishouden een diploma secundair onderwijs kunnen behalen. De resultaten impliceren dat programma's voor gezinsplanning hun momenteel beperkte focus op anticonceptie moeten verbreden, en dat deze zich meer specifiek zouden moeten richten op mensen met lage vruchtbaarheidsvoorkeuren. Dit zou hun effectiviteit verbeteren.

Dit proefschrift laat zien dat een geïntegreerde benadering van plattelandsontwikkeling zowel marktinterventies op macroschaal als overheidsinterventies op microschaal moet omvatten. Ten eerste zijn marktinterventies op macroschaal nodig om de algemene economische groei en de uitbreiding van de rurale arbeidsmarkten te stimuleren. Deze interventies moeten specifiek gericht zijn op rurale gebieden, de landbouwsector en ongeschoolde arbeidskrachten om de inclusie van de meest arme huishoudens te optimaliseren. Ten tweede, als de bevolkingsgroei op het platteland de komende decennia drastisch moet worden verminderd in SSA - wat een zeer noodzakelijke voorwaarde is opdat economische groei kan bijdragen aan plattelandsontwikkeling - zijn goed gerichte en goed gedefinieerde overheidsinterventies op microschaal.

List of Abbreviations and Acronyms

d-m	Decision-making
DCE	Discrete Choice Experiment
FANTA	Food and Nutrition Technical Assistance
FCFA	Franc Communauté Financière Africaine
FDI	Foreign Direct Investments
FFV	Fresh Fruits and Vegetables
GII	Gender Inequality Index
HFIAS	Household Food Insecurity Access Scale
IFAD	International Fund for Agricultural Development
MXL	Mixed Logit Model
OECD	Organisation for Economic Co-operation and Development
pp	Percentage points
Q-Q	Quantity-Quality
SANA	Stated Attribute Non-Attendance
SRD	Senegal River Delta
SSA	Sub-Saharan Africa
TFR	Total Fertility Rate
USAID	United States Agency for International Development

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Chapter 1

General introduction

1. Setting the scene

Despite (slow) reductions in relative poverty indicators such as the poverty headcount ratio and the poverty gap[2], the increasing population growth in Sub-Saharan Africa (SSA) causes (in part) that the absolute number of people living in extreme poverty continues to increase (figure 1). Forecasts indicate that by 2030, 9 out of 10 extreme poor people will live in SSA (Wadhwa, 2018). As more than 80% of the poor live in rural areas (Beegle, Christiaensen, Dabalen, & Gaddis, 2016) and derive their livelihoods from a limited range of (on-farm) activities (B. Davis, Di Giuseppe, & Zezza, 2017), rural development can be a major welfare catalyst for rural SSA regions.

[2] The headcount ratio is defined as the share of people living below the international poverty line ($1.90 a day in 2011 PPP). The extreme poverty gap is defined as the mean shortfall in income (or consumption) from the same poverty line, expressed as a percentage of the poverty line. The non-poor are counted as having zero shortfall.

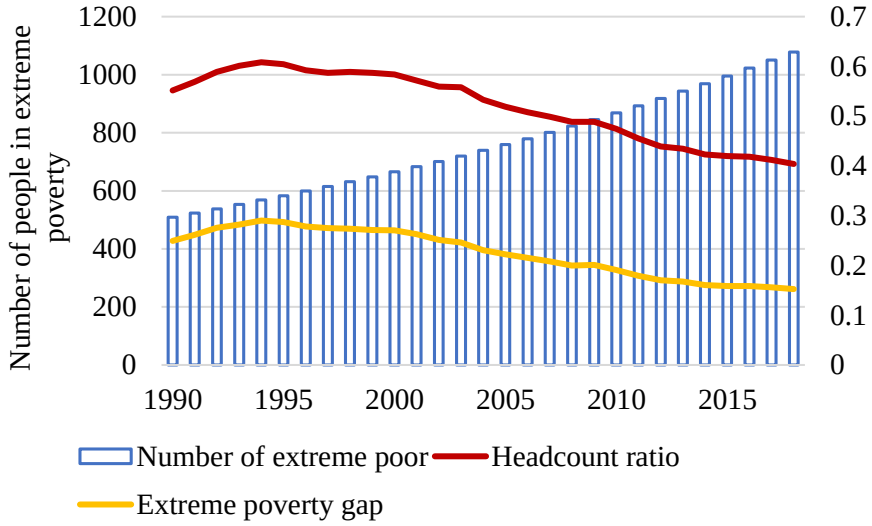

Figure 1: Poverty trends in Sub-Saharan Africa. (Source: World Bank).

Rural development – an umbrella term for all activities, programs and strategies that target to improve the livelihoods of rural households – comprises both agricultural and non-agricultural development, and includes topics such as household income, resource allocation, access to technology, family planning, health care and education (De Janvry & Sadoulet, 2001; Dethier & Effenberger, 2012). In the past, rural development has taken different identities, with varying degrees of success. Between the 1950's and 1970's development programs were mainly micro-interventions in rural areas, focusing on improving access to basic needs such as education and health care, or increasing agricultural efficiency and productivity. During the 1980's rural development approaches shifted towards more integrated market-oriented solutions (Dethier & Effenberger, 2012). Micro-scale public interventions mainly failed because of a lack of resource provisioning to the targeted communities, the incapacity of programs to account for traditional power structures and incorporate local expertise and institutions, and the high cost of the programs (Dethier & Effenberger, 2012; Lele, 1976). Macro-scale market interventions often destabilised supply chains and failed to reach smallholder farmers because of market failures such as missing credit and insurance

markets, coordination failure, and weak institutions present in SSA (Dorward, Kydd, & Poulton, 2005).

Dethier & Effenberger (2012) distinguish four pillars in more recent rural development strategies: the establishment of strong empowered local institutions for governance, the development of rural labour markets and education facilities, the introduction of social (safety net) programs and the development of resilient supply chains. In this dissertation I focus on the last three, and more specifically on resilient high value supply chain development, labour market development and rural fertility. In the next sections, I will discuss the importance of these three topics for rural development.

1.1. High value food supply chains

High value food supply chains encompass all activities required to bring high value farm products to consumers. It includes the agricultural production, processing, storage, marketing, distribution, and consumption of high value products such as fruits and vegetables, and meat and dairy products. Especially in SSA, production and exports of fresh fruits and vegetables (FFV) have boomed in recent decades. Feyaerts, Van den Broeck & Maertens (2020) calculate that FFV exports from East- and West-Africa have grown with more than 600% between 1997 and 2016. The cause and consequence of this export boom is the global transformation and modernisation of food supply chains in recent decades, triggered by income and population growth, changes in consumer preferences, urbanization and globalisation, amongst other factors (Reardon et al., 2019). Reardon, Barrett, Berdegué & Swinnen (2009) distinguish two stages in the transformation of food supply chains in low-income countries. The first "pre-liberalization/pre-globalization"-stage[3] took place before the 1990's and mainly consisted of government investments in the supply chains of important export crops (under the form of for example price regulations, marketing boards and state-owned companies). These programs aimed to trigger a shift from traditional small-scale informal agri-food supply chains, to more formal larger-scale supply chains. However,

[3] In line with the first wave of macro-scale market-based rural development programs discussed before.

these interventions mainly led to dysfunctional supply chains in SSA[4], characterised by the exclusion of smallholder farmers, late supply of inputs and payments, large margins and losses, low productivity, amongst other deficiencies. The second "liberalization/globalization"-stage is still ongoing, and is mainly driven by trade liberalisation and logistical improvements attracting significant amounts of Foreign Direct Investments (FDI). Nowadays, we can distinguish between traditional, transitional and modern food supply chains (Reardon et al., 2019). These systems' size of production and distribution units, the capital-intensity of operations, the level of vertical coordination, the length of the chains and its level of integration in international markets increase from traditional over transitional to modern supply chains.

Food supply chains are an important component of rural households' livelihood in SSA, as they are often producers, informal supply chain middlemen and consumers at the same time. Supply chain transformations can therefore bring about both risks and opportunities for rural farm households. Risks, as high quality standards, exposure to international trade fluctuations, increased consolidation, and dominance and land grabbing of large multinational companies can outcompete small-scale farmers and informal middlemen, and make them more vulnerable to income and consumption shocks (De Schutter, 2011; Dolan & Humphrey, 2000; Nolte & Ostermeier, 2017). Opportunities, as contract farming schemes and increased availability of wage employment provides a way to integrate rural households in modern high value food supply chains, possibly leading to positive multiplier and spillover effects (Barrett et al., 2012; Bellemare, 2012; Deininger & Xia, 2016; Maertens, 2009; Maertens, Minten, & Swinnen, 2012; Minten, Randrianarison, & Swinnen, 2009).

[4] In some Asian countries, these governmental interventions were highly successful, and led to a dramatic and widespread process of agricultural growth and poverty reduction (Dorward et al., 2005).

1.2. Rural labour markets

As labour can be considered to be the most important asset of the poor, increasing the returns to labour can be a major driver of poverty reduction and rural development (Fields, 2019; Ivanic & Martin, 2018; Lanjouw & Murgai, 2009; Loayza & Raddatz, 2010; Mccullough, 2017; Narayan, Pritchett, & Kapoor, 2009). Many rural development strategies focus on increasing rural incomes through self-employment, for example through credit programmes, input subsidies, or extension and training programs, as a large proportion of rural households in low-income countries are small-scale entrepreneurs in agriculture, non-agriculture or both (Christiaensen, 2017; B. Davis et al., 2017; Nagler & Naudé, 2017; P. Winters, Essam, Zezza, Davis, & Carletto, 2010). Some scholars and policy makers, however, stress the importance of wage employment and job creation in rural development and poverty reduction (Fields, 2019; Inchauste, 2012; Reardon, Berdegue, & Escobar, 2001; World Bank, 2012).

There exists a strong correlation between labour market development and the share of wage employment in total employment on the one hand, and income levels and economic growth on the other hand, as illustrated in figure 2. In North America and the European Union respectively 92% and 82% of men, and 94% and 89% of women were wage employed in 2019. This stands in striking contrast to the wage employment numbers in SSA. Only 30% of men and 19% of women were wage employed in 2019, and no remarkable increasing trend can be found. In Asia, on the other hand, wage employment levels have risen tremendously in the last decades (World Bank, 2021b).

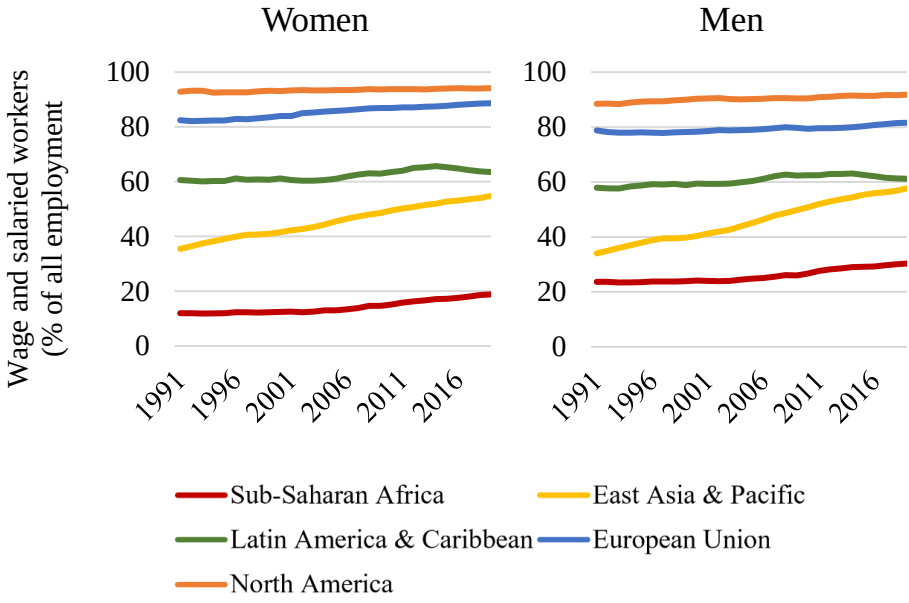

Figure 2: Contribution of wage and salaried employment in total employment, subdivided for men and women, in Sub-Saharan Africa, East Asia and the Pacific, Latin America and the Caribbean, the European Union, and North America. (Source: World Bank).

Empirical studies that specifically analyse the welfare effects of participation in wage employment mainly point to positive effects. Reardon and co-authors (2001) summarize findings from 11 studies across Latin-America and conclude that off-farm wage income contributes substantially to rural incomes. Other authors provide evidence for poverty reducing or household expenditure growth effects of participation in the rural nonfarm sector, but do not distinguish between wage employment and self-employment (Bezu, Barrett, & Holden, 2012; Imai, Gaiha, & Thapa, 2015). For SSA, there is evidence for welfare improving effects of wage employment in emerging agro-industries (Getahun & Villanger, 2018; Herrmann, 2017; Herrmann & Grote, 2015; Van den Broeck, Swinnen, & Maertens, 2017; Van den Broeck, Van Hoyweghen, & Maertens, 2018). Holden, Shiferaw & Pender (2004) conclude that both wage- and self-

employment contribute to household wellbeing, while Scharf & Rahut (2014) find that only high-return activities improve household wellbeing. Adjognon and co-authors (2017) find that nonfarm wage- and self-employment increases rural households' welfare and reduces poverty, and that the nonpoor benefit more from participation than the poor, while Van den Broeck et al. (2017) show that wage employment in the agricultural sector contributes most to the incomes of the poorest.

In addition to a direct income effect, participation in wage employment may also contribute to rural development through the creation of indirect effects on self-employment income. These indirect effects can be positive, through investment, technology or managerial spillover effects, but can also be negative, due to a negative investment effect or competition for labour. A limited number of empirical studies analyse specifically how households' farm production is affected by off-farm wage employment. These studies indicate that wage employment relaxes farmers' liquidity constraints, induces investment on the household farm and results in higher farm productivity (Adjognon, Liverpool-Tasie, de la Fuente, et al., 2017; Maertens, 2009). Other studies analyse the effect of nonfarm employment in general, without distinguishing between wage and self-employment, and mostly point to positive spillover effects on farm production and income (Anríquez & Daidone, 2010; Ayenew et al., 2017; Oseni & Winters, 2009; Ruben & van den Berg, 2001; Stampini & Davis, 2009; Takahashi & Otsuka, 2009). Other studies find that off-farm employment competes for labour and capital, which results in negative effects on household farm production (Holden et al., 2004; Kilic, Carletto, Miluka, & Savastano, 2009; Mathenge, Smale, & Tschirley, 2015; Smale, Kusunose, Mathenge, & Alia, 2016).

1.3. Fertility, child-raising and intra-household decision-making

Fertility rates in SSA are the highest in the world (figure 3). While in Asia and Latin America the demographic transition[5] started in the 1950s, with a drop in total fertility rates from 6 to 2 births per woman between 1950 and 2019 (World Bank, 2021a), SSA's

[5] The demographic transition is the process in which countries evolve from high mortality and fertility rates to low mortality and fertility rates.

demographic transition started significantly later and progresses considerably slower. This leads to a total fertility rate still as high as 4.6 births per woman in 2019 (World Bank, 2021a). SSA's population numbers are projected to continue to grow for the next several decades and predictions are worrying. If SSA continues on this path, its population is projected to double between 2010 and 2050, in some countries possibly even tripling, which could ultimately lead to a more than quadrupling of its population over the short period of one century (Ezeh, Bongaarts, & Mberu, 2012; United Nations, 2019).

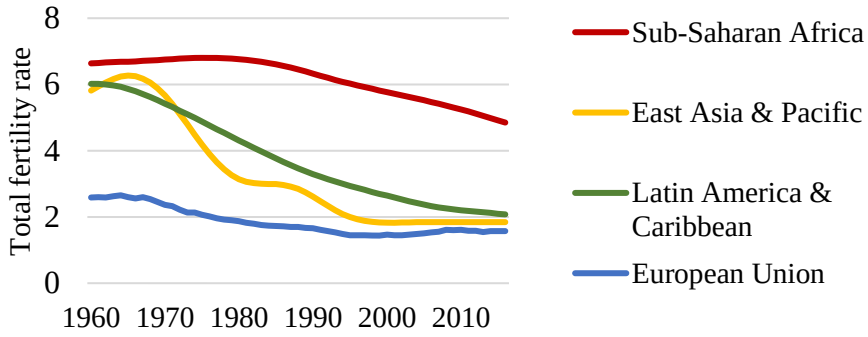

Figure 3: Total fertility rate dynamics in Sub-Saharan Africa, East Asia and the Pacific, Latin America and the Caribbean, and the European Union. Total fertility rate is defined as the number of childbirths a woman would have if she were to live to the end of her reproductive life and bear children in accordance with age-specific fertility rates of the specified year (Source: World Bank).

This constant trend of high fertility rates is disturbing, as the adverse effects of high population growth are numerous and unsustainable in the economic, social and environmental spectrum. Research shows that pressure on land and natural resources, accelerating climate change, persistent food insecurity, insufficient availability and quality of public infrastructure, and increased infant and maternal mortality are amongst the major sustainable development challenges aggravated by large population numbers and high fertility rates (Alexandratos, 2005; Drechsel, Gyiele, Kunze, &

Cofie, 2001; Ezeh et al., 2012; Graves, Rosa, Nouhou, Maina, & Adoum, 2019; Headey & Jayne, 2014; O'Sullivan, 2020; Shi, 2003; Wendt, Gibbs, Peters, & Hogue, 2012; World Bank, 2005).

Many studies describe fertility outcomes and their socioeconomic drivers, theoretically as well as empirically. The literature points to fertility reducing effects of parents' education (F. R. M. Ali & Gurmu, 2018; Masuda & Yamauchi, 2020; Osili & Long, 2008; Snopkowski, Towner, Shenk, & Colleran, 2016; Wang & Sun, 2016), household economic welfare (Amin, Ahmed, Chowdhury, & Ahmed, 1994; Beegle & Christiaensen, 2019; Garenne, 2015; Handa, 2000), or mothers' employment (Jensen, 2012; Tiruneh, Chuang, Ntenda, & Chuang, 2016; Van den Broeck & Maertens, 2015) and autonomy (Abadian, 1996). The few studies that analyse fertility preferences show that desired family size is lower on average for women (Bankole & Singh, 1998; Matovu, Makumbi, Wanyenze, & Serwadda, 2017; Westoff, 2010), for better educated individuals (Bongaarts, 2011; Muhoza, 2019; Westoff, 2010), for households with higher economic welfare (Muhoza, 2019), and in a context of lower population density and lower child mortality (Headey & Jayne, 2014; Muhoza, 2019). The literature remains inconclusive about which spouse's fertility preference is decisive for fertility outcomes (Bankole, 1995; Gipson & Hindin, 2009; Rasul, 2008).

2. Specific contributions to the literature and research questions

In the first part of this dissertation (chapters 2 and 3), I will study the Senegalese fresh fruit and vegetable supply chain to address two specific research gaps in the literature. First, while resilience of high value food systems can be considered a prerequisite for sustainable global food provisioning, increasing the quality of diets worldwide and reducing food insecurity, research on food supply shocks has primarily focused on the production phase of mainly staple crops such as maize, rice and wheat (K. F. Davis, Downs, & Gephart, 2021). Some papers conceptually discuss supply chain resilience, either in a more general context (Stone & Rahimifard, 2018; Vroegindewey & Hodbod, 2018) or with respect to climate change shocks (Kangogo, Dentoni, & Bijman, 2020;

Lim-Camacho et al., 2017; Reardon & Zilberman, 2018). Other studies assess the impact of shocks on the dairy and meat value chains of Poland (Falkowski, 2015), Scotland (Leat & Revoredo-Giha, 2013), France (Gohin & Rault, 2013), Spain (Perez-Mendez, Roibas, & Wall, 2019), the US (Countryman, Paarlberg, & Lee, 2016) or Zimbabwe (Chari & Ngcamu, 2017). Studies on the resilience of horticultural value chains are largely lacking. To my knowledge, only the papers of Jacobi et al. (2018) and Smith, Lawrence, MacMahon, Muller, & Brady (2016) use case-study evidence to study and compare the resilience of different supply chains (agro-industrial, local, and agroecological value chains in the first case, and "long" and "short" value chains in the latter). In the second chapter of my dissertation, I will compare the resilience of the Senegalese traditional and modern FFV supply chains to the Covid-19 pandemic, and identify which characteristics of the supply chains contribute to this resilience. The specific case of FFV supply chains in Senegal is relevant because a more traditional domestic supply chain and an export-oriented modern supply chain coexist, and because the country is both an exporter and importer of fresh produce (Van den Broeck et al., 2017, 2018). As FFV such as onion and tomato are important in the Senegalese diet, crisis-induced impacts on FFV chains matter for food and nutrition security in the country.

Second, while the literature mainly points towards positive welfare implications of rural SSA farm household inclusion in modernised high value food supply chains through labour markets, especially for the poor (Getahun & Villanger, 2018; Herrmann, 2017; Herrmann & Grote, 2015; Van den Broeck et al., 2017, 2018)[6], little is known about how this wage employment compares to self-employment, or wage employment in other sectors with respect to returns to labour. However, understanding which types of employment contribute most to household income and welfare is indispensable if rural development strategies are to increase welfare and reduce poverty in the most efficient

[6] Beghin, Maertens & Swinnen (2015) provide an overview of empirical studies that show that smallholder farmer's welfare improves after inclusion in high value food supply chains through product markets. They conclude that technology spillover effects and access to more and better inputs through vertical coordination in supply chains, are important channels of the effects of and reasons for the increases in smallholder farmers' welfare.

way (Fields, 2019; Ivanic & Martin, 2018; Lanjouw & Murgai, 2009; Loayza & Raddatz, 2010; Mccullough, 2017; Narayan et al., 2009). In the third chapter of my dissertation, I discuss conceptually how wage employment affects household welfare, and empirically estimate welfare effects using household survey data from a balanced household sample collected in rural Senegal. I distinguish between agricultural and non-agricultural wage employment, and between casual and contractual wage employment. In addition, I separate effects of entry into and continued wage employment, the intensity of wage employment, and estimate direct and indirect effects. This approach, including different types and sectors of employment, dynamic effects, employment linkages and different welfare measures, results in more nuanced and comprehensive insights on how wage employment contributes to rural development through rural income growth and poverty reduction.

Understanding fertility and child-raising preferences of households in SSA is important from both a theoretical perspective, to understand the factors influencing the demographic transition, and from a policy perspective to develop more effective family-planning programs and policies. In the second part of this dissertation (chapters 4 and 5), I will use choice experimental data from rural Senegal and Uganda to analyse the preferences of spouses with respect to fertility and child-raising, and the drivers behind these preferences. I will address multiple gaps in the literature. In the fourth chapter of my dissertation, I will focus on intra-household decision-making and its link with fertility and child-raising preferences. The literature that describes this link is scarce and remains inconclusive. The specific structure of the discrete choice experiment (DCE) allows to distinguish between individual and household choices, as the experiment was first implemented with both spouses separately, and repeated with the spouses jointly as couple. I am therefore able to distinguish between couples with a dominant spouse and couples where household choices are made using a more collective, balanced decision-making approach. I will add to the methodological literature that contributes to a better understanding of the differences and interactions between individual and household choices. Previous experiments using a similar approach revealed the divergence between individual and joint preferences with respect to a varying range of topics (Bateman & Munro, 2009; Beck & Rose, 2019; Beharry-

Borg, Hensher, & Scarpa, 2009; Dosman & Adamowicz, 2006; Marcucci, Stathopoulos, Rotaris, & Danielis, 2011; Mariel, Scarpa, & Vega-Bayo, 2018), however, to my knowledge, no experiment exists that considers fertility and child-raising. Only five other studies[7] calculate a measure that considers intra-household decision-making, only one of them (Wiig, Bråten, & Orge Fuentes, 2012) in a rural middle-income setting (Peru).

In the fifth chapter of my dissertation, I will focus on three other socio-economic drivers of fertility and child-raising preferences, namely the education level, poverty status and polygamy status of the respondent. While these drivers have been proven to reduce actual fertility, and lead to better child-raising outcomes in terms of child education and health, little is known about the correlation with fertility and child-raising preferences. In addition, I am the first to empirically investigate quantity-quality (Q-Q) trade-offs in fertility decisions from a preferences perspective and to apply a DCE method within the framework of the Q-Q trade-off theory. The Q-Q trade-off theory assumes that a lower total fertility rate (TFR) will improve the quality of child-raising (e.g. in terms of education, nutrition and health care). However, empirical evidence does not always support this, as it is difficult to disentangle the factors that jointly determine the quantity and quality aspects of child-raising.

3. Research areas

3.1. Senegal

The main research area of this dissertation is the Senegal River Delta (SRD) region (community of Saint-Louis) in the Northern Sahel part of Senegal. This is an ideal case-study region for the research questions in chapters 2 and 3, as the region experiences increasingly diverse wage employment opportunities, both in the agricultural and the non-agricultural sector, and because two horticultural supply chains coexist: a modern supply chain, producing for both the export and the domestic market, and a traditional

[7] More specifically the studies of Abdellaoui et al. (2013), Beharry-Borg et al. (2009), Carlsson et al. (2012), Dosman & Adamowicz (2006) and Wiig et al. (2012).

supply chain. This region is characterised by its diversity in farm-based livelihoods, including agricultural communities focussing on small-scale commercial horticulture and rice production (traditionally households belonging to the Wolof ethnicity) and livestock communities relying on rather extensive and semi-nomadic grazing systems (traditionally households belonging to the Peulh ethnicity). Since 2003, mainly foreign (multinational) companies invest in the region to produce cherry tomatoes, green beans, sweet potatoes and mangoes. In 2016, five companies were active in the region, all vertically integrated, having their own production, processing and packaging units. At that time, these companies employed around 4,500 casual and low-skilled employees on daily or seasonal basis to work on the fields or in the processing and packaging stations, and another 800 employees with a fixed-term or permanent contract for white- and blue-collar jobs requiring some education. Next to agricultural wage employment in the export companies, the region's non-agricultural wage employment sector is also expanding, with common jobs being taxi driver, functionary, mason, merchant or housemaid. These non-agricultural jobs can be low- or high-skilled, on a casual or contractual basis.

The rural society in the SRD region is organised in a traditional and patrilineal manner. Households in the SRD region live together with their extended multi-generational families in compounds. Marriages are often polygamous and fertility rates are high. These high fertility rates and resulting high population growth rate (3.4%), and the patrilineal structure of the society and the household – meaning that often women and (female) children are treated as secondary – validates the choice for this case-study region to study the research questions of chapters 4 and 5.

A second FFV production zone, studied in the second chapter of this dissertation alongside the SRD region, is the Niayes region, a long and narrow coastal area stretching between Dakar and Saint-Louis. In both the SRD and the Niayes region, the main FFV export season runs from December to the end of April, when there is a large demand for off-season vegetables in the EU. From June to August there is a second, but smaller peak of mango exports. Domestic production of vegetables (mainly onions and tomatoes) is seasonal as well but differs by crop and by region. Since 2003 the

Senegalese government implements seasonal import bans and other trade restrictions for onion, potato and carrot to boost domestic production and protect it from relatively cheap, but high-quality imports from Europe (David-Benz & Seck, 2018). The timing of these seasonal import bans largely coincides with the main domestic harvest season, from end of January, until end of August or beginning of September.

3.2. Uganda

In the second part of the dissertation (chapters 4 and 5), I use data from a second research area: the Mount Elgon region in Eastern Uganda. The Mount Elgon region is located in the humid tropics and characterised by its densely populated mountainous area, dominated by smallholder subsistence farmers who grow coffee in a shade-garden system, usually intercropped with bananas and other food crops (Akoyi & Maertens, 2018). Farmers' parcels are small and slopes steeper than 80% are cultivated, leading to high landslide risk in the area (Knapen et al., 2006; Vlaeminck et al., 2016). This study-region perfectly complements the SRD region to study the research questions of chapters 4 and 5, as population pressure is extremely high in the region (with a population density of 838/km^2 and population growth of 3.9%), which leads to high pressure on land and land degradation problems. Households live together in a singular parents-children structure. Polygamous marriages are common, but wives do not necessarily live under the same roof. While the Mount Elgon region also knows a patrilineal tradition, women experience a higher status compared to women from the SRD region.

4. Data collection

The research in this dissertation relies on 6 data collection campaigns, using three different data collection methods: household surveys, choice experiments and a remote data collection using telephone interviews and online self-administered questionnaires. The data collection campaigns are linked to the dissertation chapters in figure 4. In the following subsection, I will discuss each data collection method, and review the data collection campaigns in chronological order.

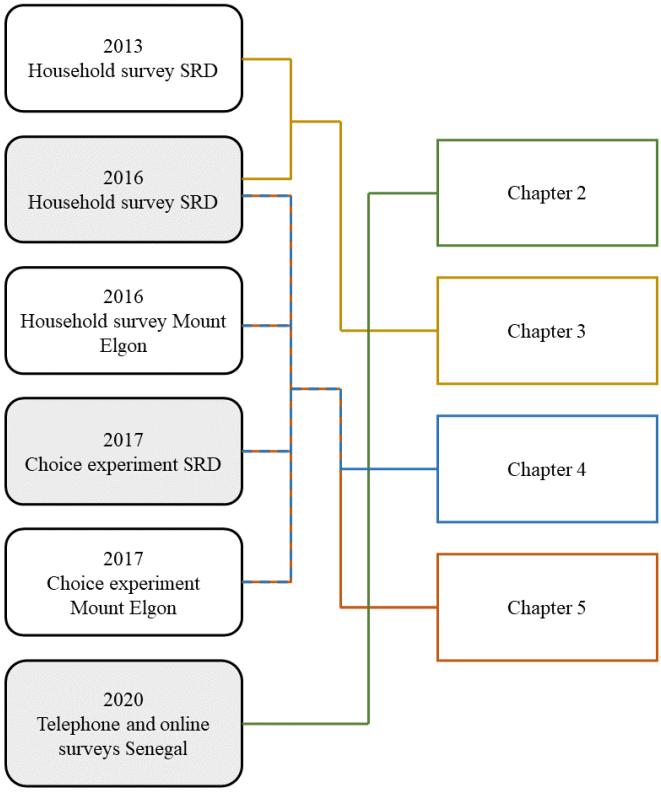

Figure 4: visualisation of data collection campaigns and their contribution to the dissertation chapters. I was involved in the 2016, 2017 and 2020 data collection campaigns in Senegal (grey boxes), and the main supervisor of the 2016 SRD household survey.

4.1. Household survey data collections

In 2013, quantitative household data was collected[8] in the SRD region in Senegal, covering three rural communities (Gandon, Diama and Fass) (figure 5). The sample was created based on a 2006 survey round (2006 data not used in this dissertation) covering 284 households in 17 villages across two rural communities (Gandon and Diama). In 2006, a two-stage stratified sampling design was used. In the first stage, villages were stratified according to their distance to the road and randomly selected within the strata with an oversampling of villages closer to the road. In the second stage, households in the sampled villages were stratified according to whether or not members of the household are employed in the horticultural export industry and randomly selected within the strata with an oversampling of households with employment. The aim of the 2013 survey round was to create panel data (using the 2006 survey round), and to extent this panel data set with extra households from an area where a horticultural export business was planning to invest in new production and processing units. In 2013, 17 new villages were added to the sample according to their distance to the new investment site, with an oversampling of villages closer to the site. Households within these villages were sampled randomly from a village census. The final 2013 sample consisted of 500 households spread over 34 villages.

[8] By Goedele Van den Broeck in the framework of her PhD dissertation.



Figure 5: Visualisation of the Senegal River Delta research area. The research area is marked by the red square, the 34 sampled villages are marked with blue dots, the fields of horticultural export companies are marked with green polygons (source: Google maps).

In 2016, a follow-up survey of the 2013 household survey was conducted, supervised by myself and assisted by Goedele Van den Broeck. The 2016 sample includes 464 of the original 500 households, an attrition rate of 7.2%. As I find that attrition is non-random with households with older heads and more literate members less likely to drop out of the sample, I use inverse probability weights in the data analysis (Baulch & Quisumbing, 2011). To complement the household survey data, and to extend my understanding of the research area and its dynamics, I carried out multiple stakeholder semi-structured interviews during a preparatory mission. I interviewed CEOs and delegates of the horticultural export companies (STS, Soldive, SOCAS, GDS, SCL and

West Africa Farms) and representatives of research institutes (ISRA, ANSD and SAED), a local governmental development program (PDIDAS) and four rural villages.

Both in 2013 and 2016, a structured quantitative questionnaire was used to collect household-level data on farm production, land and non-land assets, and living conditions, and individual-level data on demographic characteristics, and agricultural and non-agricultural wage- and self-employment. To be able to compare income, poverty, food security and employment dynamics over time, the two questionnaires were designed in the same way. In 2016, a module on risk and vulnerability, and a module specifically targeting female decision-making and empowerment were added to the survey. The two survey rounds were implemented with a team of trained enumerators. In 2013, paper questionnaires were used, while in 2016 tablets and computer-assisted personal interviewing software were used. In addition, I used a structured quantitative questionnaire for the collection of quantitative village-level data on geographical and institutional characteristics of the sampled villages.

Also in 2016, quantitative household data was collected[9] in the Mount Elgon region in Uganda. The sample includes 700 households from 7 districts in the Mount Elgon region (Bududa, Manafwa, Sironko, Bulambuli, Kapchorwa, Kween and Bukwo). Households were selected using a three-stage stratified sampling design. First, the more urbanized district of Mbale was dropped from the sample. In the second stage, villages in the seven districts were stratified into three classes according to altitude, and 20 villages were selected in each strata. In the third stage, ten households in each village were randomly selected. A quantitative questionnaire was used, structured in different topical modules. The data provides information on household demographics, land ownership and management, agricultural production and marketing, forest interaction, non-land asset holdings, off-farm wage employment, self-employment and non-labour income. In addition, a quantitative village-level survey provides information on institutions, infrastructure, accessibility and agro-ecology.

[9] By Moses Kakungulu in the framework of his PhD dissertation.

4.2. Choice experiment data collections

In 2017, the same choice experiment was implemented in the SRD region in Senegal and in the Mount Elgon region in Uganda[10]. In each region, 250 households were randomly selected from the respective household survey sample (2016 SRD household survey sample and 2016 Mount Elgon region household survey sample). Within a household, both husband and wife completed the choice experiment separately, after which they completed the experiment together as a couple. This results in a total sample of 750 individual responses in the SRD region and 750 individual responses in the Mount Elgon region.

A discrete choice experiment (DCE) originates from random utility theory and is often used to elicit and understand consumers' or farmers' preferences. It is a method consistent with Lancaster's consumer theory of value (K. J. Lancaster, 1966), which posits that (consumer) preferences are shaped by the individual characteristics a good or service possesses and not by the good as a whole. Respondents will therefore derive utility from a specific combination of individual characteristics. During a DCE, respondents face a number of hypothetical scenarios from which the most preferred scenario (the scenario that provides the highest utility) is chosen. Each scenario is a combination of different characteristics (attributes) which will vary according to a predefined range of attribute levels.

During the choice experiment implemented in the SRD region and Mount Elgon region, the hypothetical scenarios describe different situations of fertility and child-raising. As the validity of a DCE largely depends on the choice of the attributes (Mangham, Hanson, & McPake, 2009), a detailed literature review, and multiple key informant interviews and focus group discussions in the SRD and Mount Elgon region were implemented prior to the design of the experiment to identify and select attributes that best characterize pressing issues and trade-offs households make with respect to child-raising. In total we specify four attributes, with the first referring to the fertility aspect,

[10] The choice experiment in the SRD was supervised by Janne Bemelmans and assisted by myself. The choice experiment in the Mount Elgon region was supervised by Hendrik Feyaerts and assisted by Goedele Van den Broeck.

and the next three to the child-raising aspect, covering education, nutrition and health care (table 1).

Table 1: Attributes and attribute levels

Attribute	Description	Attribute levels
Children	Number of children	1, 2, 4, 6, 9, 12
Education	Share of children from the household that can obtain a secondary school degree	None (base level), Half, All
Nutrition	Number of days a week a household can eat a complete meal	Zero (base level), Four, Seven
Health care	Quality of the health care institute the household can go for help when a child has a severe fever	Low (base level), Medium, High

We use choice sets with three alternatives and visual illustrations to assist illiterate people when making their choice. An example of the choice cards used is presented in figure 6. During the DCE the same 12 choice cards were presented to each respondent and the order was randomized to avoid learning bias. As the DCE was first executed with the husband and wife separately and repeated with the husband and wife together, the DCE yields information on 54,000 observations.

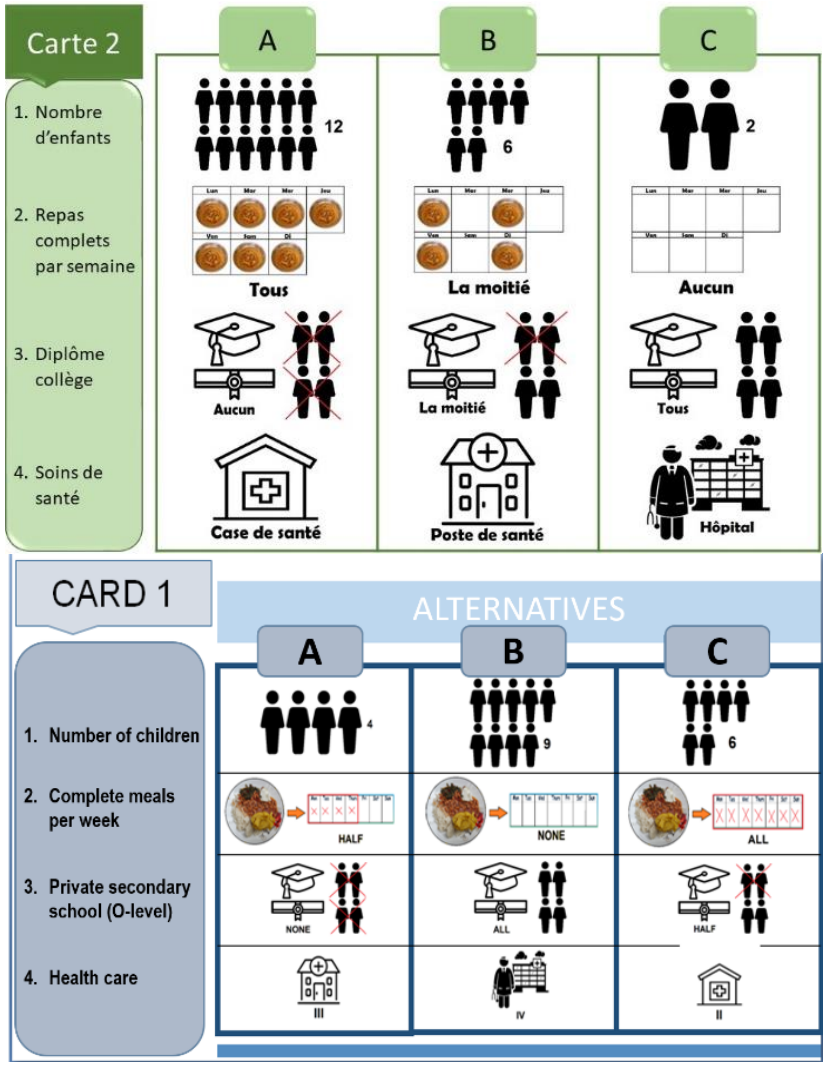

Figure 6: Examples of choice cards from the Senegalese (upper) and Ugandan (lower) experiment

4.3. Remote data collection

In 2020, a few months after the onset of the global Covid-19 epidemic, I was involved in a remote primary survey data collection, targeting all relevant actors in the fresh fruits and vegetables (FFV) supply chain active in the two main FFV exporting regions (the SRD region and the Niayes region) of Senegal[11]. Data was collected with farm and horticultural export company workers, smallholder farmers, traders (bana-banas, and small and larger wholesalers), medium and large-scale agro-industrial companies, importers and consumers (table 2). Data was collected from mid-April to mid-June 2020, using both phone interviews and self-administered online questionnaires. Two trained local enumerators administered phone interviews with workers, smallholder farmers, traders and importers. Horticultural export companies and importers were directly contacted to fill in an online survey. Consumer interviews were conducted online as well, on a voluntary basis by the respondents themselves. The consumer survey was promoted both on social media (through various Facebook groups) and by email within the social and professional networks of local partners. For most actor groups contact details were sourced from previous data collections in the SRD and Niayes region, and sometimes complemented with additional contacts obtained through snowball sampling or various online sources.

[11] This data collection was team work with Anna Fabry, Hendrik Feyaerts, Idrissa Wade and Miet Maertens.

Table 2: Overview of sampling strategy per supply chain actor

Supply chain actor	Sample size	Method	Source of contact details
Consumers	172	Online survey	Social media
Smallholder farmers	102	Phone survey	Previous data collection and database of local farmer organization[1]
Workers	50	Phone survey	Previous data collection
Traders	80	Phone survey	Previous data collection, online sources and snowball sampling
Agro-industrial companies	10	Online survey	Previous data collection
Importers	20	Phone survey	Previous data collection, ITC company data

Note: [1]APPASEN (Association Pour la Promotion des Produits Agricoles du Sénégal). Source: authors' construction.

All surveys started with a common demographics section, followed by multiple actor-specific sections. Data was collected on food consumption (consumers) and food insecurity[12] (consumers and workers); labour (workers, smallholder farmers and horticultural export companies); agricultural inputs (smallholders farmers and horticultural export companies); and prices and transactions (smallholder farmers, horticultural export companies and traders), amongst other issues. Questions were built around the declaration of the state of emergency (*l'état d'urgence*) on March 23rd, allowing a comparison of the situation before and after the start of the Covid-19 crisis.

While the sample of workers is somewhat biased towards horticultural export company workers (hired workers on smallholder farms are underrepresented (5 out of the 51 interviewed workers)), the sample of smallholder producers, traders, horticultural export companies and importers is representative for the FFV export and import chains in Senegal, as well as for the domestic FFV chain that originates from the two main horticultural regions in the country. The data therefore allows to reveal how farms have been affected through Covid-19 induced changes in labour availability but do not allow

[12] Food insecurity was measured with the Household Food Insecurity Access Scale (HFIAS) developed by the Food and Nutrition Technical Assistance (FANTA) program of USAID (Coates et al., 2007).

to draw conclusions on the implications for hired workers. There is a more problematic bias in the consumer sample, as it includes mostly highly educated urban consumers. Hence, caution is advised when drawing conclusions on changes at the consumption side of the FFV supply chains in Senegal or on the food and nutrition security implications of changes in the FFV supply chain.

5. Outline of the dissertation

This dissertation is structured as follows. In the second chapter I descriptively investigate the Covid-19 pandemic's early impact on the fresh fruit and vegetable supply chain in Senegal, using trade statistics and survey data collected through online questionnaires and telephone interviews with all relevant FFV supply chain actors. In the third chapter I assess conceptually and empirically the direct and indirect welfare effects of entry and continuation in different types of wage employment in the Senegal River Delta region in rural Senegal. I use panel data, fixed effects and first-difference estimation, and show substantial positive welfare and linkage effects. In the fourth chapter I use choice experimental data to value preferences with respect to fertility (the household's number of children) and child-raising (the education, nutrition and health care provisioning of the children), using a sample of married couples living in the SRD region in Senegal and the Mount Elgon region in Uganda. As I first implement the experiment with both spouses separately, and repeat the experiment with the spouses jointly as couple, I can distinguish between individual and household choices, analyse spouses' preferences on fertility and child-raising, and calculate a decision-making coefficient based on the method proposed by Beharry-Borg et al. (2009). In the fifth chapter I use the same choice experimental data to add on the knowledge on rural fertility preferences and its drivers, and the existence of a quantity-quality trade-off between the number of children and child-raising quality. In the sixth chapter I will reiterate the main findings of this dissertation, their limitations, and implications for rural development, policy and future research.

Chapter 2

Resilience of global and local supply chains to the Covid-19 pandemic: Survey evidence from vegetable supply chains in Senegal[1]

1. Introduction

The 2020 worldwide Covid-19 pandemic is expected to have severe economic consequences, with a projected contraction of the global economy of three percent (IMF, 2020). Countries in Sub-Saharan Africa (SSA) are expected to be most severely affected, with a simulated drop in Gross Domestic Product of almost nine percent (Laborde, Martin, & Vos, 2021). The expected global recession is anticipated to result in increased global poverty: the number of additional people in extreme poverty is estimated to be nearly 150 million, of which 80 million in SSA (Laborde et al., 2021). Food prices are expected to rise or become more volatile than usual (Z. Ali et al., 2020; Laborde, Martin, Swinnen, & Vos, 2020; Reardon, Bellemare, & Zilberman, 2020; RPCA, 2020) and food insecurity expected to worsen substantially as a result of Covid-19 (Z. Ali et al., 2020; Laborde et al., 2021).

This paper provides an early and descriptive assessment of the consequences of the Covid-19 pandemic on the fresh fruits and vegetables (FFV) supply chain in Senegal. The recent literature puts forward that the Covid-19 shock and subsequent imposed measures may affect production, supply and availability of food through disruptions in international trade, through reduced on-farm labour supply, and through related productivity and output decreases (Laborde et al., 2021; Vos, Martin, & Laborde, 2020). We elaborate on these channels of effects and conceptually discuss how effects

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may differ across food supply chains with diverse characteristics. We rely on survey data collected through online questionnaires and telephone interviews with different types of stakeholders in FFV supply chains, and on available trade statistics, to empirically describe how FFV supply chains in Senegal have been affected by the pandemic. Our study adds micro-economic empirical evidence to the rapidly emerging literature on the impact of Covid-19 on food systems in developing countries. The specific case of FFV supply chains in Senegal is relevant because an export-oriented modern supply chain and a more traditional domestic supply chain coexist, and because the country is both an exporter and importer of fresh produce (Van den Broeck et al., 2017, 2018). Because of the importance of FFV such as onion and tomato in the local diet in Senegal, effects on FFV chains matter for food and nutrition security in the country. Moreover, our study brings some insights in the broader but scarce literature on the resilience of food supply chains to adverse shocks (Falkowski, 2015; Jacobi et al., 2018; Kangogo et al., 2020; Leat & Revoredo-Giha, 2013; Reardon & Zilberman, 2018; Vroegindewey & Hodbod, 2018).

The remainder of the paper is structured as follows. In the next section we provide a conceptual discussion on the resilience of diverse food supply chains to the Covid-19 shock, and its implications for the Senegalese FFV supply chains. In section three we first provide background information on the Covid-19 situation and related measures in Senegal, and on the different FFV production and marketing seasons in the research area. Next, we describe our data collection methods, data analysis and limitations of our study. We present our descriptive results in section four and discuss these in section five.

2. Conceptual discussion

2.1. Supply chain resilience to Covid-19 pandemic

Based on recent literature (Vos et al., 2020), we can identify three channels of effects through which the Covid-19 pandemic affects food supply chains. A first effect is through disruptions in international trade, stemming from an increase in trade costs due to restrictions in international mobility and quarantine measures, or stemming from trade policy measures, such as export taxes and bans, in response to the crisis. A second effect is through a decline in on-farm labour, stemming from workers being unwilling or unable to work due to contamination risk and various containment measures, leading to reductions in land productivity and declining agricultural output. A third effect is through a decline in productivity and farm output, caused by disruptions in distribution channels and in the provision of capital inputs and services. Effects likely differ with the type of product, and the structure and organization of supply chains.

Reardon, Bellemare, et al. (2020) draw a distinction between traditional, transitional and modern food supply chains: the size of production and distribution units, the capital-intensity of operations, the level of vertical coordination, the length of the chains, and its level of integration in international markets increase from traditional over transitional to modern supply chains. The resilience[2] to the Covid-19 pandemic might differ substantially between these supply chains (Reardon, Bellemare, et al., 2020; Reardon & Swinnen, 2020). As traditional and transitional supply chains are less integrated in international markets on the output side and oriented more towards production for domestic markets, they might be less affected by international trade disruptions. Traditional and transitional food supply chains typically include a mix of small-scale family farms and medium-sized production units, and small to medium-sized traders. While small farms and trading enterprises use more labour-intensive production and distribution methods, they often rely mainly on family labour. This

[2] Ponomarov & Holcomb (2009) define supply chain resilience as "The adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function.".

might make them less vulnerable to Covid-19 induced reductions in labour availability. Yet, even family labour might become unavailable, e.g., due to illness of family members or inability of family members to return from places of temporary migration to the family farm. Medium-sized enterprises might be hit harder by reduced labour availability as they rely more intensively on hired labour, whose availability is more severely affected by containment measures and mobility restrictions. Disruptions in the provision of capital inputs and in distribution channels might more severely affect transitional supply chains and medium-sized production units because of more capital-intensive production methods, a more pronounced commercial orientation and more distant market outlets in these chains. Small farms in traditional supply chains might be less affected through this channel if they sell produce in local village markets. Yet, traditional supply chains include poor farmers, who might revert to food-first strategies when the risk related to commercial production increases due to disruptions in distribution channels. Moreover, poor farmers may not be able to overcome short term losses or reduced farm incomes, and, hence, may be forced to sell land or non-land assets, jeopardizing future production.

Modern supply chains, being more complex and highly integrated in international markets, are likely to be impacted by international trade disruptions or a possible global recession. The consequences of the Covid-19 pandemic could be massive for export and import enterprises when borders close, trade costs soar, or demand for export goods decreases. Vos et al. (2020) and Laborde et al. (2020) predict effects through this channel to be most severe for developing countries with a strong dependence on international trade, such as most African countries. Arouna et al. (2020) specifically point to a large impact in the West-African rice supply chain, that heavily depends on imports. Modern supply chains include large-scale and agro-industrial companies that rely on more capital-intensive production methods, which makes them more vulnerable to supply chain disruptions. High-value supply chains of fresh produce and produce of animal origin are particularly vulnerable to disruption in distribution channels because of the high perishability of these products. Yet, a higher level of vertical coordination and a better organization of exchange in these supply chains might reduce this vulnerability. Mobility restrictions and containment measures might be biased towards

less formal ways of transport and more personal ways of exchange, and thereby affect spot market transactions of small traded volumes (in traditional supply chains) more than agreed transactions of larger volumes (in modern supply chains). Further, large-scale agro-industrial companies rely on hired labour, unskilled as well as skilled labour. A Covid-19 induced reduction in the availability of labour might be specifically harmful for these companies, especially for labour-intensive production as is the case in vegetable supply chains (Hobbs, 2020; Minten, Mohammed, & Tamru, 2020), and especially in case agro-industrial companies heavily depend on migrant labour. While modern supply chains might be more severely affected by Covid-19 triggered disruptions, the more capitalized companies in these chains might be better able to overcome short term losses, and might be better able to respond to shocks and mitigate the impact through innovations (Reardon & Swinnen, 2020).

2.2. Fruit and vegetable supply chains in Senegal

Two FFV supply chains coexist in Senegal: 1/ a modern, vertically coordinated, high capital- and labour-intensive supply chain, producing for both the export and the domestic market, and 2/ a traditional, high labour-/low capital-intensive, domestic supply chain. The structure of the FFV supply chain in Senegal, drawing a distinction between the export and the domestic market, and the traditional and the modern supply chain, is depicted in figure 1. At the upstream end, the traditional supply chain is dominated by smallholder farmers. The most common way produce reaches the domestic market is through a web of small to medium-scale itinerant traders or 'bana-banas' and small wholesalers who buy produce at the farmgate or at rural assembly markets and transport it to larger urban wet markets (in Dakar, Touba, Saint-Louis) or to more remote regions in the South of the country. Within urban areas, smaller (street) retailers, grocery shops and the food services industry source produce from these wet markets. Also for consumers, at the downstream end of the supply chain, wet markets are the main FFV outlet. While the domestic FFV supply largely remains traditional, some modernization is ongoing. At the upstream end of the domestic supply chain a few medium- and large-scale agro-industrial companies entered the market in the last decade. They mainly supply the domestic market through medium-scale, well-

organized traders and wholesalers. In addition, since a few years modern supermarket chains – such as Auchan and Casino – are spreading in Senegal's cities, especially in Dakar. They offer a wide range of fresh products at competitive prices, and attract customers of various social backgrounds, not exclusively the more affluent. Nevertheless, the market share of these supermarkets is still much smaller than the traditional wet markets. FFV imports are controlled by a small number of importing companies, almost all located in Dakar. Imported produce (mostly onions, potatoes, carrots and garlic) reach wet markets and consumers throughout the country by means of the 'bana-bana' traders. The modern export supply chain is organized around a few large capital-intensive agro-industrial companies who produce, process and export produce. Contract farming with smallholder farmers exists for mangoes (and a little bit for green beans) but the overall trend of the past 15 to 20 years in the export supply chain is towards greater consolidation, industrialization and complete vertical integration of production and export. Export companies mainly sell directly to overseas importers, but in recent years, when prices in the domestic market are favourable due to seasonal import bans, they also sell to domestic traders and local supermarkets.

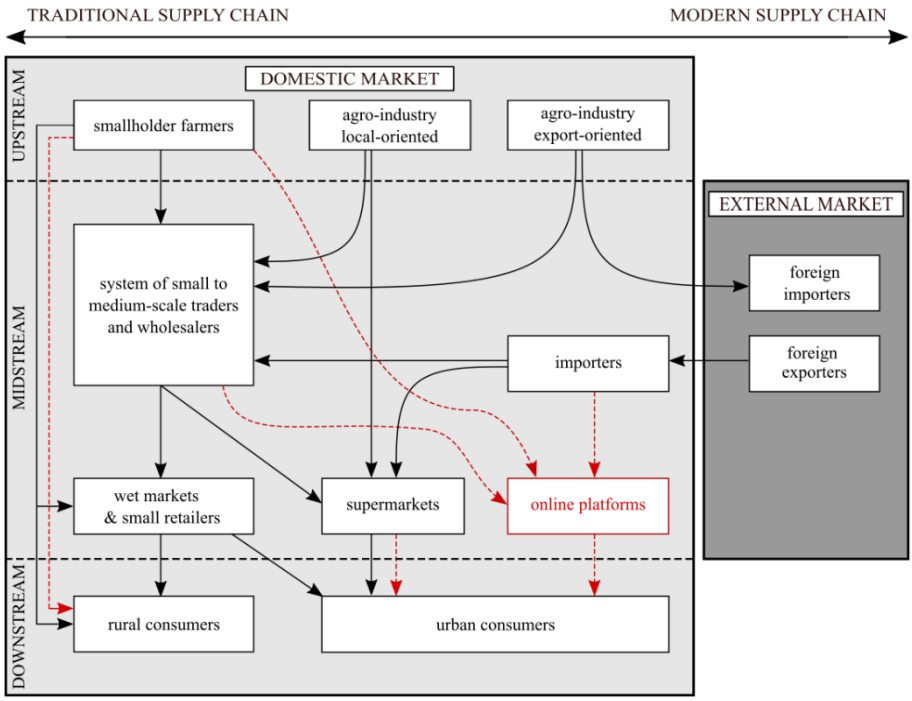

Figure 1: Schematic representation of the fruit and vegetable supply chains in Senegal. (Source: authors' construction).

In line with the general conceptual discussion above, we hypothesize that traditional supply chain actors – such as smallholder farmers, small informal traders and wet market vendors – might be more affected when labour and product markets are disrupted. Especially mobility restrictions might hinder traditional supply chain continuity, because of its inherent poor organization and dependence on public transport. Modern supply chain actors – such as large-scale export companies and traders – might be more affected through international market disturbances, as many of them work on an international scale, either within Africa or across continents. As the modern FFV supply chain highly depends on wage employees, Covid-19 related labour market disturbances might be important as well.

3. Methods

To describe the implications of the Covid-19 pandemic on the FFV supply chain in Senegal, we rely on a before-after comparison informed by the course of events in terms of Covid-19 measures in Senegal. This is not perfect and limited by the seasonality in FFV production. We first give some background information on these issues, and then describe the methods and associated limitations.

3.1. Background

Until October 30th, 2020, Senegal has reported 15,605 positive Covid-19 cases and 323 deaths. The first confirmed Covid-19 case reported on March 2nd 2020 triggered a range of policy measures to prevent the spread of the virus. On March 23rd 2020 the state of emergency (*l'état d'urgence*) was declared, followed by a range of other measures (table 1). Transport was significantly restricted, both between and within regions and cities, wet markets were regularly closed for not complying with the rules or for complete sanitation, and shops were required to limit opening hours. The government started to relax some measures to reopen the economy as of May 12th 2020, even though the total number of cases continued to rise. Since the beginning of September 2020, less than 50 new cases are reported each day and the total number of infected people is decreasing fast. Except from face masks and distancing measures which remain mandatory in shops, public places and transport, all other restrictions have been removed. Since the beginning of the Covid-19 crisis in Senegal, both the government and international institutions promised financial and food aid. In March 2020, the Senegalese government created a *Response and Solidarity Fund* "Force Covid-19" to deal with the impact of Covid-19. The fund is planned to be endowed with 1,000 billion FCFA (approximately 1.5 billion euros) through state and donor funding. A food aid distribution operation was launched to help 1 million vulnerable households and the state declared to pay the energy bills (electricity and water) of almost 1 million households.

Table 1: Covid-19 measures in Senegal

Date	Measure
Introduction of measures	
14/03/2020	Closure of schools and universities Public events are forbidden
16/03/2020	Suspension all in & outbound flights from Europe
20/03/2020	Closure of airspace
23/03/2020	**Declaration of state of emergency** Establishment of curfew Regional transport restrictions Creation of solidarity fund
24/03/2020	Interurban transport restrictions
17/04/2020	Face masks mandatory in public administration services, private sector services, commercial places and on all types of transportation
Relaxation of measures	
12/05/2020	Relaxation of curfew Markets and shops can open for 6 days a week Reopening of weekly markets Religious and educational events allowed
04/06/2020	Suspension of interregional travel restrictions
07/06/2020	Suspension of interurban transport restrictions
15/06/2020	Resume domestic air travel
30/06/2020	Suspension of curfew and state of emergency
15/07/2020	Resume international air travel
23/09/2020	Suspension public transport passenger limitation

Source: Senegalese government website (https://www.sec.gouv.sn/).

The main FFV production zones in Senegal are: 1/ the *Niayes region*, a long and narrow coastal area stretching between Dakar and Saint-Louis, and 2/ the *Senegal River Delta region* in the North of the country. These two zones produce FFV for the domestic market, mostly tomatoes and onions, and for the export market, mostly (cherry) tomatoes, green beans and mangoes. For the most important horticultural crops, an overview of different export, import and domestic harvest and marketing seasons are presented in figure 2. The main FFV export season runs from December to the end of April, when there is a large demand for off-season vegetables in the EU. From June to August there is a second, but smaller peak of mango exports. Domestic production of vegetables is seasonal as well but differs by crop and by region. The main harvesting

season takes place from February to May, when the bulk of onion, potato, carrot and tomato production reaches the domestic market, and prices often drop. Later in the year, during the *hivernage* or rainy season, mangoes and watermelons are widely available, in addition to onions and other vegetables from a smaller second harvest season. Imports of FFV are concentrated in the period August to January, when domestic production is low. Since 2003 the Senegalese government implements seasonal import bans and other trade restrictions for onion, potato and carrot to boost domestic production and protect it from relatively cheap, but high-quality imports from Europe (David-Benz & Seck, 2018). The timing of these seasonal import bans largely coincides with the main domestic harvest season, from end of January, until end of August or beginning of September.

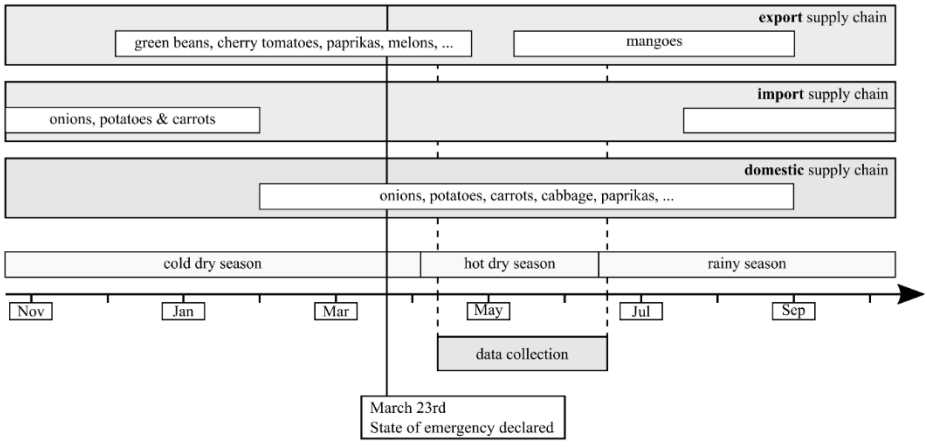

Figure 2: Timeline of horticultural production seasons and period of data collection. (Source: authors' construction).

3.2. Data collection and analysis

We use primary survey data complemented with secondary data on international FFV trade flows to and from Senegal. Monthly trade statistics, available until June 2020, are sourced from the International Trade Center's TradeMap (ITC Trade Map, 2020). We

collected primary survey data from all relevant actors in the FFV supply chain in Senegal, including farm and agro-industry workers, smallholder farmers, traders (banabanas, and small and larger wholesalers), medium and large-scale agro-industrial companies, importers and consumers (table 2). Data were collected from mid-April to mid-June 2020, using both phone interviews and self-administered online questionnaires. Two trained local enumerators implemented phone interviews with workers, smallholder farmers, traders and importers. In addition, agro-industrial companies and importers were directly contacted to fill in an online survey. Consumer interviews were conducted online as well, on a voluntary basis by the respondents themselves using Qualtrics software. The consumer survey was promoted both on social media (through various Facebook groups) and by email within the social and professional networks of local partners. For most actor groups contact details were sourced from the authors' previous data collections in the two main FFV producing areas in Senegal, the *Niayes region* and the *Senegal River Delta region*, and sometimes complemented with additional contacts obtained through snowball sampling or various online sources.

Table 2: Overview of sampling strategy per supply chain actor

Supply chain actor	Sample size	Method	Source of contact details
Consumers	172	Online survey	Social media
Smallholder farmers	102	Phone survey	Previous data collection and database of local farmer organization[1]
Workers	50	Phone survey	Previous data collection
Traders	80	Phone survey	Previous data collection, online sources and snowball sampling
Agro-industrial companies	10	Online survey	Previous data collection
Importers	20	Phone survey	Previous data collection, ITC company data

Note: [1]APPASEN (Association Pour la Promotion des Produits Agricoles du Sénégal). Source: authors' construction.

All surveys started with a common demographics section, followed by multiple actor-specific sections. We enquired about food consumption (consumers) and food

insecurity[3] (consumers and workers); labour (workers, smallholder farmers and agro-industrial companies); agricultural inputs (smallholders farmers and agro-industrial companies); and prices and transactions (smallholder farmers, agro-industrial companies and traders), amongst other issues. Questions were built around the declaration of the state of emergency (*l'état d'urgence*) on March 23rd, allowing us to compare the situation before and after the start of the Covid-19 crisis.

We use descriptive statistics to highlight the early consequences of Covid-19 on the Senegalese FFV supply chain by focusing consecutively on effects at the level of international trade, production, consumption and domestic trade. We believe that our sample of smallholder producers, traders, agro-industrial companies and importers is representative to capture the situation of the FFV export and import chains in Senegal as well as the domestic FFV chain that originates from the two main horticultural regions in the country. Our sample of workers is somewhat biased towards agro-industry workers while hired workers on smallholder farms are underrepresented (5 out of the 51 interviewed workers). Our data allow to reveal how farms have been affected through Covid-19 induced changes in labour availability but do not allow to draw conclusions on the implications for hired workers. We have a more problematic bias in the consumer sample, including mostly highly educated urban consumers. Hence, we cannot draw conclusions on changes at the consumption side of the FFV supply chains in Senegal or on the food and nutrition security implications of changes in the FFV supply chain.

3.3. Limitations

Agriculture is inherently seasonal. As we do not have access to time-series agronomic and socio-economic data to correct for seasonal variation, we must interpret the results with some caution. We are not able to completely disentangle Covid-19 related impacts from seasonal variation. The first months of the Covid-19 crisis ran parallel to the end of the export season (except for mango) and the harvesting season of vegetables for the

[3] We measure food insecurity with the Household Food Insecurity Access Scale (HFIAS) developed by the Food and Nutrition Technical Assistance (FANTA) program of USAID (Coates et al., 2007)

domestic market. During this harvesting season, domestic supply of onion, potato and other vegetables increases and prices often decrease. In the interpretation of our results, we need to take into account that quantities are likely to increase and prices likely to decrease in the period after the declaration of the state of emergency because of seasonal variation, and thus that observed changes cannot always be attributed to Covid-19 impacts.

To compare the situation before and after the declaration of the state of emergency, we use recall questions. While recall questions are commonly used in surveys[4], they are prone to bias as the accuracy of respondents' memories cannot be controlled for. One the one hand, our data might suffer from recall bias as we ask for very specific transactions that date back to up to four months before the survey. Such details might be hard for respondents to remember accurately. On the other hand, bias might still be limited. Several scholars indicate that there is little proof of recall bias for cash crops that are harvested over short periods of time at specific moments of the year (Beegle, Carletto, & Himelein, 2012; Carletto, Jolliffe, & Banerjee, 2013). In our case, events are recalled that happened a maximum of four months before the survey, the recall period is linked to a very specific and important event that everybody is aware of (the establishment of the state of emergency), and the survey asks for quantitative information about the production and marketing of high value cash crops and other important aspects of respondents' daily life – which may refresh respondents' memory. In addition, our analysis relies on a comparison of events right before and right after the state of emergency. If recall bias in the data runs in the same direction for the two sets of events, the comparative analysis may partially reduce bias in the data.

While online surveys and phone interviews allowed us to rapidly collect relevant data from a large variety of actors in the supply chain (during lockdown or otherwise), both the quantity and quality of such data are limited, as these methods are prone to some weaknesses (Alvi, Gupta, Meinzen-Dick, & Ringler, 2020; Himelein, Eckman, Lau, & McKenzie, 2020). In order to not fatigue and 'loose' respondents, we kept the online

[4] See for example recent studies by Bernard, De Janvry, Mbaye, & Sadoulet (2017) or Hirvonen et al. (2021).

surveys and telephone interviews short (i.e., 10 to 15 minutes). The resulting survey data as well as the analysis are hence not very detailed. This remote data collection was only possible owing to an extensive research experience in the FFV sector in Senegal.[5] This is important as not knowing the research area or not being able to experience the local situation first-hand, could lead to difficulties in collecting data and in bias in interpreting data and statistical results. Knowing the FFV sector in Senegal very well, we are confident about the robustness of the data collection, analysis and interpretation. In addition, the secondary trade statistics we use are limited as well, as they do not yet cover a large enough period of time after the start of the pandemic to be able to observe changes in trends in the medium to long run.

4. Results

4.1. International trade

The start of the Covid-19 crisis coincides with the end of the main FFV export season in Senegal and with the low-season for FFV imports (figure 3). FFV export volumes during the first half of 2020 are very similar to preceding years. While exports in April 2020 are 11% lower than in April 2019, they are still higher than exports in April 2016 and 2017. FFV import volumes of March and April 2020 are less than half compared to those in March and April 2019, but already in February 2020, before Senegal was hit by the Covid-19 crisis, imports were substantially below those of the preceding year. Moreover, FFV imports in this period are influenced by irregular import bans in Senegal. The trade data show no clear indication of major implications for FFV trade volumes in the first months of the crisis. Also available trade statistics for agricultural inputs do not show major changes in imported agricultural inputs in this period (ITC Trade Map, 2020).

[5] See for example the papers of Colen, Maertens & Swinnen (2012); Fabry, Van den Broeck & Maertens (2020); Feyaerts, Van den Broeck & Maertens (2020); Maertens, Colen & Swinnen (2011); Maertens, Minten & Swinnen (2012); Maertens & Swinnen (2009); Van den Broeck & Maertens (2017); Van den Broeck, Van Hoyweghen & Maertens (2016) and (2018) and Van Hoyweghen, Van den Broeck & Maertens (2020).

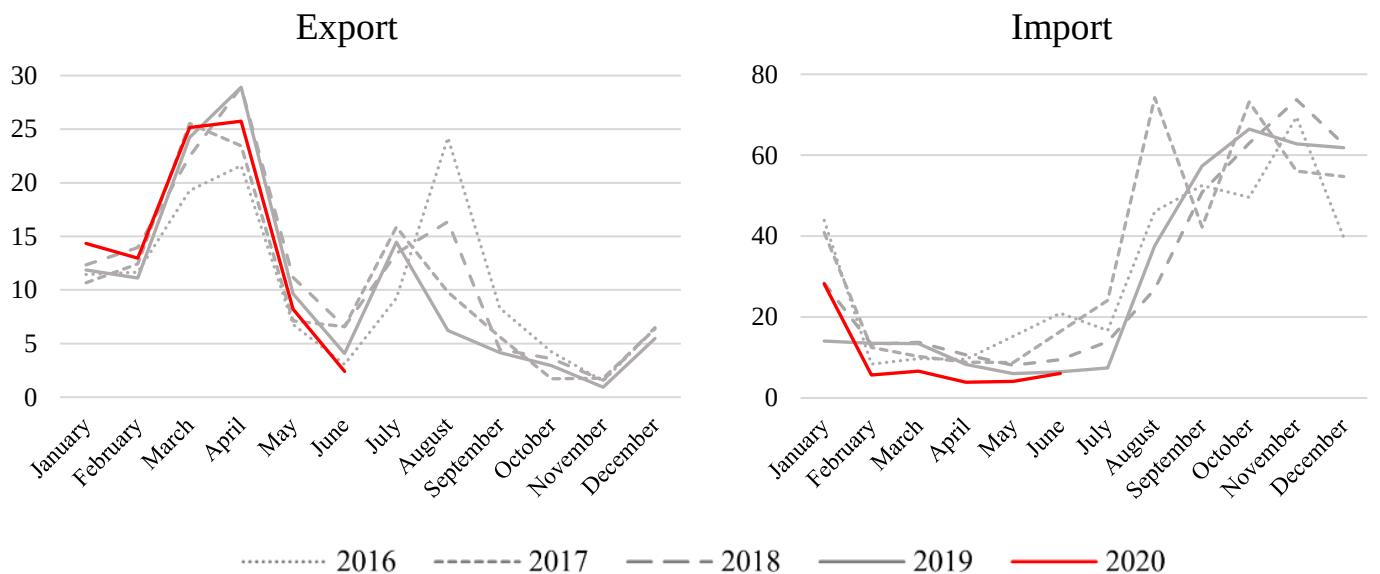

Figure 3: Evolution of fruit and vegetable exports and imports, in million kg, in Senegal, 2016-2020. Fruits and vegetables include the following product categories: 07 (edible vegetables and certain roots and tubers) and 08 (Edible fruits and nuts) (Source: ITC Trade Map, accessed October 2020).

The majority of surveyed export-oriented agro-industrial companies continued their export activities but do indicate to export smaller volumes since the Covid-19 crisis because of a declining demand from their overseas clients. Only a few smaller companies temporarily suspended all export activities. Three fourths of the interviewed importers did not import FFV since mid-March 2020, which more likely relates to the end of their import season, and possible import bans, than to the Covid-19 crisis. Import and export companies that continued international trade activities, indicate to experience delays in transactions and in transport by air cargo, as well as by boat or truck. Smaller companies point to more severe customs procedures and commercial restrictions in the EU, hindering their export activities.

4.2. Production

At the supply side of the FFV chains, the Covid-19 pandemic and containment measures in Senegal may affect production activities through changes in the allocation and productivity of land, labour and capital inputs. We consecutively discuss these effects.

Large export-oriented companies indicate to not have changed their production area, nor their crop mix of fruits and vegetables targeted to the international market. Yet, the majority of smaller companies indicate to have reduced the size of their FFV production area, by 50 to 75%, because of the crisis. Also smallholder FFV farmers producing for the domestic market, drastically decreased their FFV production area. The summary statistics in table 3 indicate that 25% of the interviewed farmers left land completely fallow during the hot dry season, for which preparation more or less coincides with the start of the Covid-19 crisis. Only 15% of the farmers in our sample actually started new horticultural production in the months after the declaration of the state of emergency (while during the cold dry season, 83% of the sampled farmers grew FFV and allocated on average 1.65 ha to this). These farmers use on average 0.59 ha for FFV production while they indicate they would have allocated on average 1.1 ha under normal circumstances. Also for the rainy season, farmers seem reluctant to cultivate horticultural crops. Only 40% of the farmers intend to allocate land to horticultural crops during the rainy season, with an average planned acreage of only 0.65 ha. Almost

one fifth of the farmers who will not grow horticultural crops, are planning to grow groundnuts or staple crops such as millet. This is in line with evidence on shock-driven shifts away from perishable cash crops to less perishable and staple crops in SSA (Salazar-Espinoza, Jones, & Tarp, 2015). The observed land allocation changes could have important repercussions on the availability of fresh produce in domestic markets and for own consumption by rural households, which may result in food and nutrition security impacts in the medium run.

Table 3: Land allocated to horticultural production for three growing seasons

	Mean	**Mean hypothetical scenario without Covid-19** [a]	**Number of farmers**
Total land (ha)	4.44		102
Left land fallow (1/0)	0.25		102
Land under production (conditional on producing in particular season)			
Cold dry season (ha)	1.65		85
Hot dry season (ha)	0.59	1.10	15
Rainy season (ha)	0.65	0.91	41

Notes: [a] Respondents were asked about the size of the land they would have allocated to horticultural crops, if the Covid-19 pandemic would not have taken place. Source: authors' derivation from smallholder farmer survey data.

Smaller agro-industrial companies and the majority of smallholder farmers (80.4%) indicate to face important restrictions to hire workers. Mobility restrictions make it difficult for agricultural workers to commute. Moreover, workers are scared, either to be caught and fined for breaking mobility regulations or to become infected at the workplace or during commuting. Larger agro-industrial companies report no problems with the supply of labour. These companies overcome worker constraints by investing in protective masks and gloves, in training on sanitary measures, in creating conditions for social distancing between workers in the field and in processing units, and in a larger or more frequent commuter bus service capacity for their workers – a service that many large companies offer to attract workers. Nevertheless, in all agro-industrial companies

the demand for labour reduced because activities reduced, particularly in conditioning stations. This reduction ranges from 20 to 90% of the normal workforce across the companies. Extra social protection laws put in place by the government, prohibit employers to layoff or dismiss workers during the period of Covid-19 containment (except in case of gross negligence). Yet, many agro-industry employees are casual day-to-day labourers (Maertens, 2009; Van den Broeck et al., 2017) for whom such protection laws might be less effective. Our data show that 66% of the sampled agro-industry workers were employed both before and after the declaration of the state of emergency, that 45% of them work less frequently than before the declaration, and that only 29% of those workers who stopped working since the declaration indicate the crisis to be the main cause. Moreover, we find no changes in wages and contracts of workers since the start of the crisis.

Access to agricultural inputs such as seeds and agro-chemicals is a major constraint for smallholder farmers. In general, 82% of the sampled smallholders indicate that since the declaration of the state of emergency they encounter problems to buy inputs, mainly because of mobility restrictions (90.5%), closed shops (45.2%) and lower availability of vendors (15.5%), or increased input prices (10.7%). Also cash constraints play a role for smallholder farmers. The large majority (75.9%) of farmers who did not start a new growing season in the months after the declaration and more than half of the farmers (57.4%) who are not planning to produce FFV in the main rainy season, indicate to lack cash to buy the necessary inputs (seeds, fertilizer, etc.). Also smaller agro-industrial companies face problems accessing inputs. They indicate that both national and international suppliers of inputs reduced or stopped their activities, and that mobility restrictions inhibit an adequate input supply. Two companies specify a price increase of agricultural inputs, while another company reports the use of an expensive emergency air freight shipment of inputs that were depleted in the local market. The largest agro-industrial companies however, do not experience input related problems because they have enough input stocks, because they have direct buying relations with international input dealers, or because they are able to switch between input suppliers in case of delivery problems. In general, agro-industrial companies report to have input

stocks to work at full capacity for 3 up to 16 weeks, with larger stocks in larger companies.

4.3. Consumption

Our data, despite not being representative for the downstream segment of the supply chain, do suggest that the demand for FFV reduced since the start of the Covid-19 crisis in Senegal. Figure 4 shows that 14% of sampled consumers consume less meals per day since the crisis. Figure 5 shows that diets changed: 29% of consumers indicate to have reduced the amount of rice consumed, 41% reduced vegetable consumption and 47% reduced fruit consumption – 15% reduced fruit consumption to a large extent. These figures point to important Covid-19 induced changes in consumption but likely severely underestimate these changes. Our sample is biased towards urban and highly educated respondents, who are more likely to have a lower income elasticity and a lower price elasticity of food consumption, especially for more expensive food categories such as fruits and vegetables. Changes towards less FFV in diets might be much more pronounced among less affluent consumers. A reduction in local demand for FFV is confirmed by data from supply side actors, including smallholder farmers, traders and agro-industrial companies.

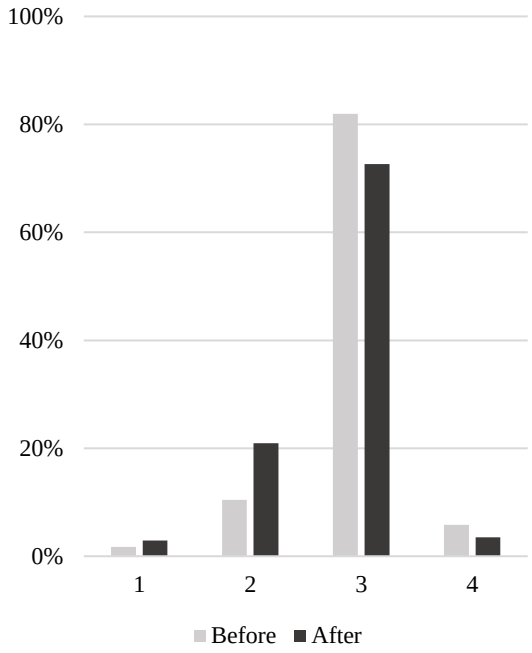

Figure 4: Consumers' number of meals per day before and after the declaration of the state of emergency. (Source: authors' derivation from consumer survey data).

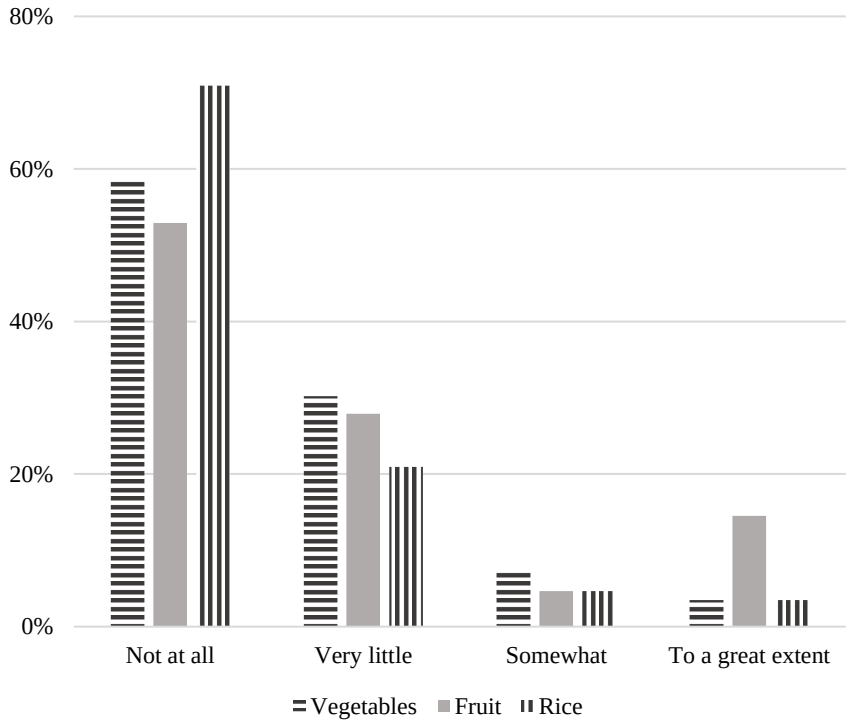

Figure 5: Change in consumption of rice, vegetables and fruits after the declaration of the state of emergency. (Source: authors' derivation from consumer survey data).

4.4. Domestic trade

With the declaration of the state of emergency, the Senegalese government restrained the activity of (and sometimes even closed) local wet markets to contain the spread of the virus. Moreover, they imposed transportation restrictions within and between regions, cities and urban-rural axes. In doing so, they cut off consumers, producers and traders from their usual FFV sales outlets. The results show that the likelihood of consumers to buy fruits and vegetables in local wet markets reduced by 8 percentage points since the declaration of the state of emergency (figure 6) and the likelihood of smallholder farmers to sell produce in village and town markets reduced by 58 and 30 percentage points respectively (figure 7). We find that in rural markets, FFV trade is more likely to happen at the farm gate, while urban consumers increase shopping online.

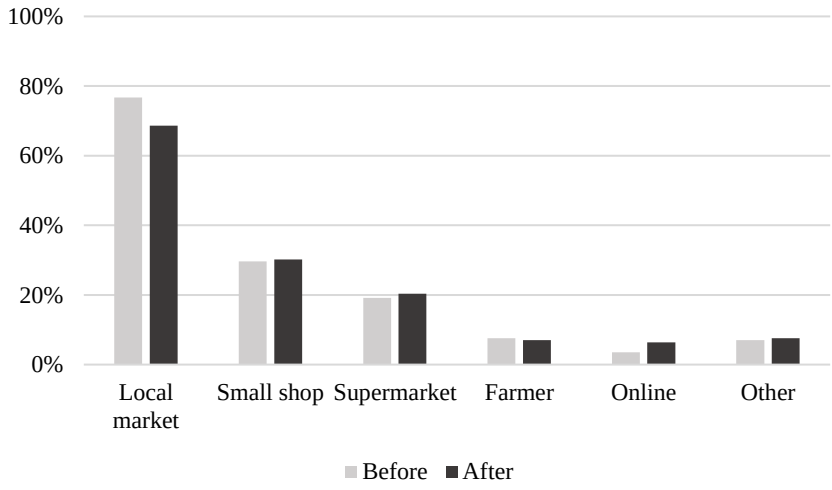

Figure 6: Consumers' purchase location of fruits and vegetables, before and after the declaration of the state of emergency. (Source: authors' derivation from consumer survey data).

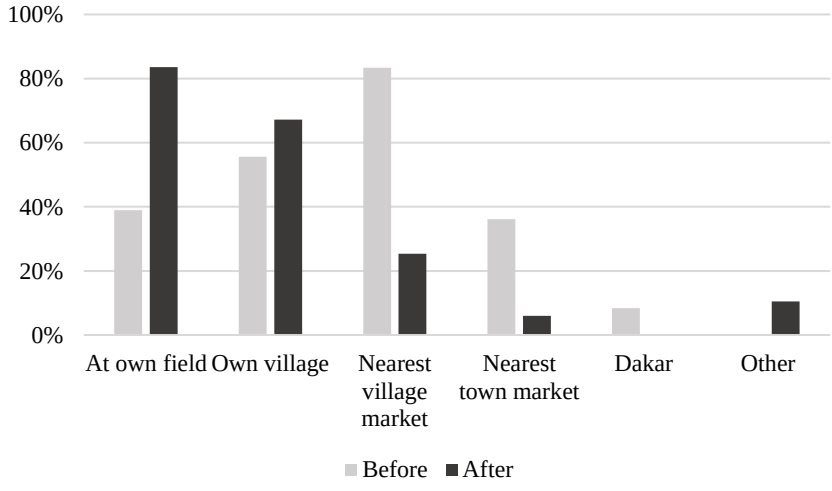

Figure 7: Smallholder farmers' fruit and vegetable sales outlets, before and after the declaration of the state of emergency. (Source: authors' derivation from farmer survey data).

The large majority of traders indicate that the emergency measures make it very difficult (if not impossible) to transport produce between and within regions, while this is the main way of living for traders. This is confirmed by smallholder farmers, who reduce FFV sales to traders and other intermediaries (figure 8). Figure 9 documents how the volumes that traders commercialize decreased in the two weeks after the declaration of the state of emergency (compared to the two weeks before): purchase volumes dropped from 7.3 to 4.9 tons, and sales volumes from 6.7 to 4.4 tons on average[6]. As we expect traded volumes at the start of the harvest season to increase, these differences are likely underreporting Covid-19 related trade reductions.

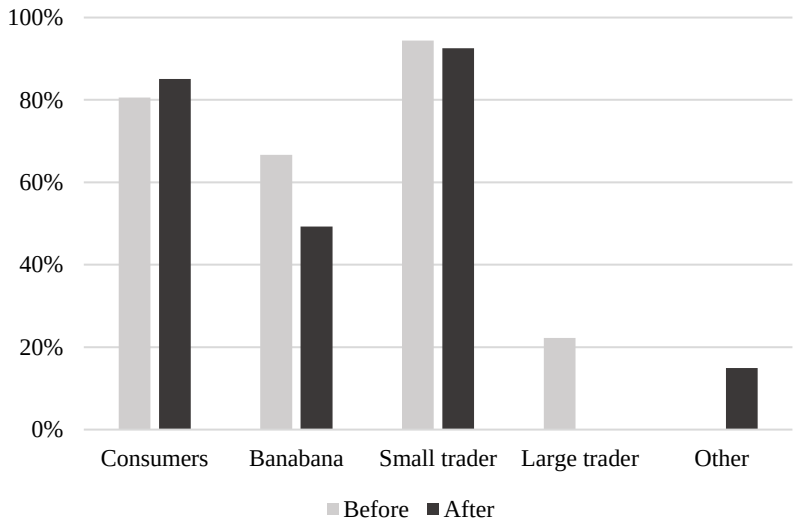

Figure 8: Smallholder farmers' customers before and after the declaration of the state of emergency. (Source: authors' derivation from farmer survey data).

[6] Differences significant at the 1% significance level.

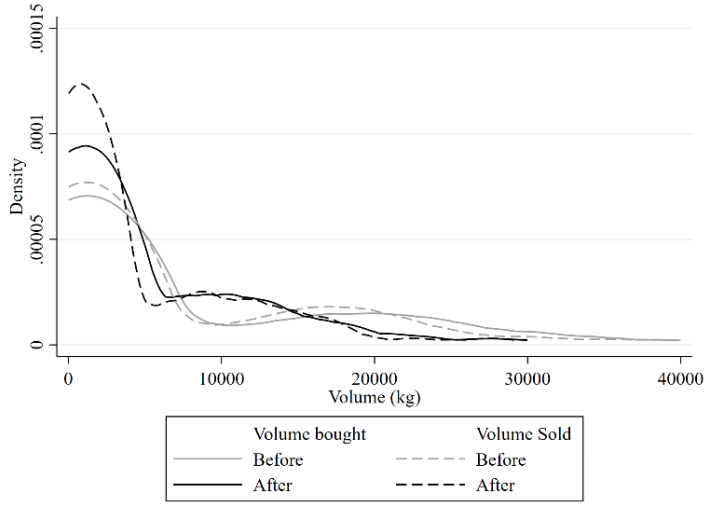

Figure 9: Purchase and sales volumes (kg) of traders during the two weeks before and two weeks after the declaration of the state of emergency. (Source: authors' derivation from trader survey data).

Figures 10 and 11 depict producer sales prices, and trader sales and purchase prices, before and after the start of the Covid-19 crisis[7]. There is a significant decrease in producer and trade prices after the declaration of the state of emergency[8]. As we expect prices to decrease when produce arrives in bulk on the market at the start of the harvest season, it is difficult to attribute the observed price reductions completely to the impact of Covid-19. However, the markup of traders does not change. The reduced income reported by traders is mainly driven by the lower volumes and increased cost of transportation, caused by closed markets and mobility restrictions. Smallholder farmers indicate that the lack of decent storage for their perishable products forces them to sell at an inferior price. Traders have a much better access to storage facility, which likely contributes to the stable markup of traders.

[7] We enquired about sales and purchase prices of the crop that contributes most to their revenue. These are onions and peppers for smallholders, and onions, peppers and potatoes for traders.
[8] We use two-sided t-tests. Significant at the 10% significance level for producer sales prices, and at the 1% significance level for trader purchase and sales prices.

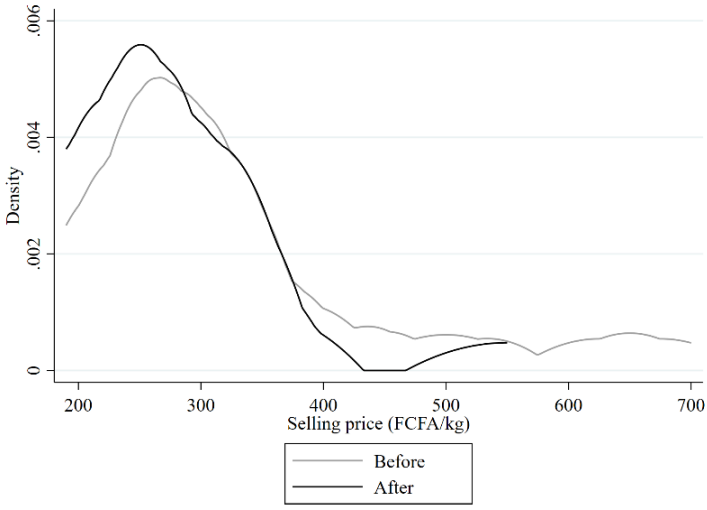

Figure 10: Smallholder farmers' sales prices (FCFA/kg) for the last transaction before and the first transaction after the declaration of the state of emergency. (Source: authors' derivation from farmer survey data).

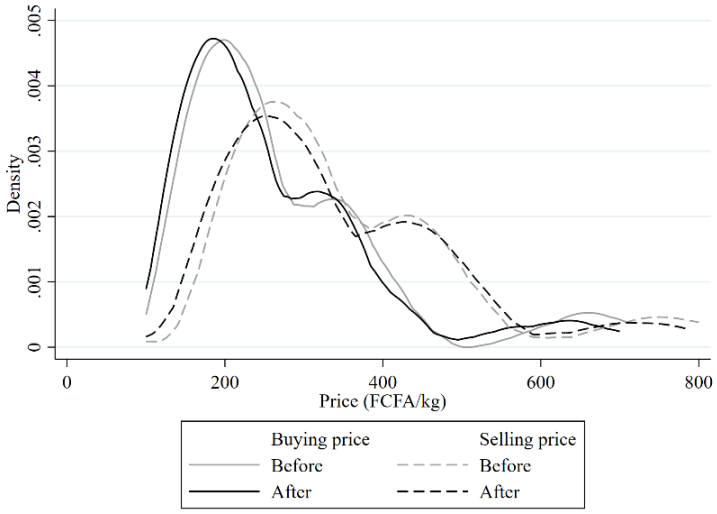

Figure 11: Average trader purchase and sales prices (FCFA/kg) during the two weeks before and two weeks after the declaration of the state of emergency. (Source: authors' derivation from trader survey data).

The large majority of smallholder farmers (80%) indicate that they have experienced increased postharvest losses since the declaration of the state of emergency. Due to a lack of storage capacity and the perishability of produce, disruptions and delays in transactions stemming from containment measures, result in losses at the farm gate. Only 10% of sampled traders report an increase in losses, which likely relates to their access to storage (78.5% of traders have access). The same holds for the importers and agro-industrial companies who do not report increased losses. Still, almost all importers indicate to have sold large shares of their produce at inferior prices, half of the export companies report longer storage periods than usual and some companies sold export quality produce on the domestic market or donated produce to food aid programs in order not to waste it.

The results show that the crisis has stimulated innovations in the supply chain, as depicted by the red arrows on figure 2. To adapt to the new reality, traders, and to a limited extend also smallholder farmers, increasingly use online platforms for the marketing of their products (figure 12), and urban consumers increasingly rely on online shopping. These platforms reduce the need of traders to travel the country, and the number of face-to-face encounters, as they are able to link up with potential suppliers and buyers, and agree on quantities and prices, online. The move towards online buying and selling of FFV presents itself in many different forms and is part of a larger trend of increasing e-commerce (although the market is still assumed small), from informal advertising by small-scale traders and smallholders via different social media channels (Facebook and Whatsapp groups) and specific trading fora[9], to well-built webshops by local small- and medium-sized enterprises (e.g., Niokobok, Yonutol or Soreetul), and more established international e-commerce platforms (e.g., Jumia or Auchan's webshop). One online food company experienced a doubling of demand for fruits and vegetables in April 2020 and had to hire 25 people extra to keep up with demand (Reuters, 2020).

[9] For example: http://shop.mlouma.com/ or www.espaceagro.com

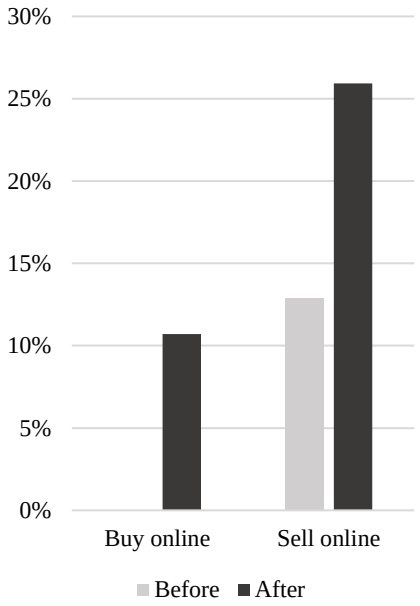

Figure 12: Traders' use of online platforms for buying and selling fruits and vegetables, before and after the declaration of the state of emergency. (Source: authors' derivation from trader survey data).

5. Discussion and conclusion

We find major differences in how Covid-19 and containment measures disrupt supply chains between the modern export-oriented FFV supply chain that is centred around a few large vertically integrated agro-industrial companies, and the more traditional domestic-oriented FFV supply chain with a large number of small producers and traders. In line with the hypotheses of Reardon & Swinnen (2020), the results show that the former is more resilient than the latter. As put forward in the conceptual discussion, this relates to the supply chains' export- versus domestic-orientation, size of operation, level of vertical coordination and ability to innovate.

First, our data reveal that during the first months of the crisis, the export-oriented supply chain is less severely affected, while the domestic-oriented supply chain is more severely disrupted by the Covid-19 crisis. While we find some anecdotal evidence of reduced overseas demand, and increased transport delays, customs procedures and commercial restrictions, the majority of the export-oriented companies continued their export activities. Yet, the domestic FFV supply chain has been affected more severely by the containment measures, especially by mobility restrictions and closure of wet markets. Others also document severe supply chain disruptions. Hirvonen, Minten, Mohammed & Tamru (2021) show that vegetable supply chains in Ethiopia were affected by international as well as interregional trade disruptions, resulting in higher prices for farmers usually competing with international and regional imports, and lower prices for farmers usually supplying other regions – and thereby creating winners and losers among domestic farmers. Yet, if global supply chains are more resilient to the Covid-19 shock than domestic supply chains, international trade could contribute to mitigating the short-term global food security impacts of the Covid-19 pandemic (Glauber, Laborde, Martin, & Vos, 2020; Torero, 2020a), in the same way as international trade has been documented to be crucial in limiting the long-term global hunger consequences of climate change (Janssens et al., 2020).

Second, the results show that small-scale enterprises are more severely affected than large-scale enterprises. While both large- and small-scale FFV production is labour-intensive, we find that smallholder farmers are most affected by decreasing availability

of on-farm labour. Agro-industrial companies overcome labour availability disruptions by providing protective gear, doubling the number of shifts (halving the number of labourers per shift) and increasing the number of shuttle buses. These findings can be put in perspective to the findings of Minten et al. (2020), who show that smaller vegetable farms in Ethiopia are less affected by the Covid-19 situation than medium-sized farms because they rely less on hired labour. Covid-19 disruptions in the availability of farm labour may increase with farm size due to increased use of hired labour (as hypothesized by Reardon, Bellemare, et al. (2020)) but decrease again if economies of scale are reached in re-organizing labour to adapt to containment measures. In addition, our findings nuance the hypothesis of a possible inflow of (family) labour due to urban-rural migration (Reardon, Mishra, Nuthalapati, Bellemare, & Zilberman, 2020). Horticultural regions in Senegal (and other countries) receive migrants from other rural regions with a lower labour productivity (Fabry, Van den Broeck, & Maertens, 2020; Van Hoyweghen, Van den Broeck, & Maertens, 2020). A Covid-19 triggered rural-rural migration in the opposite direction is observed, reducing agricultural labour productivity overall. In addition, labour productivity decreases when access to capital inputs (seeds, agro-chemicals) is disrupted, which is more pronounced on small-scale farms. Qualitative data from local farmer organizations point to similar findings of smallholder farms facing more difficulties in marketing output, hiring labour and accessing inputs during the state of emergency (IPAR, 2020).

Third, a higher level of vertical coordination plays a role in explaining the resilience of the FFV chains to the Covid-19 pandemic. The low level of organization and the more informal transactions, lead to a larger impact of mobility restrictions in the traditional FFV supply chain. The closure of shops and wet markets impedes smallholders' access to capital inputs and marketing outlets. As small-scale enterprises do not have the means to invest in stocks of capital inputs or adequate storage facilities, containment measures lead to reduced productivity and increased crop losses. In the modern FFV supply chain, agro-industrial companies and large traders have formal agreements and private transport possibilities, facilitating continued marketing even in a constrained environment. Moreover, large-scale companies have the financial power to invest in stocks of capital inputs and cold storage rooms – a proofed supply chain risk mitigating

strategy (Sheffi & Rice Jr., 2005) – making them less vulnerable to disruptions in distribution and marketing channels.

Fourth, we find that the export-oriented FFV supply chain in Senegal is more resilient to the Covid-19 shock because of the capacity of large vertically integrated agro-industrial companies to invest and innovate in order to adapt to the measures and continue operations. This is in line with the literature on supply chain innovations emerging from capital-intensive large-scale companies (Jacobi et al., 2018; Reardon et al., 2019; Swinnen, 2007; Swinnen & Maertens, 2007) and on Covid-19 triggered supply chain innovations (Hawkes, 2020; Hobbs, 2020; Pu & Zhong, 2020; Reardon & Swinnen, 2020). We find that agro-industrial companies reorganize labour to overcome mobility restrictions, and adapt to social distancing and sanitation obligations. Yet, also the traditional domestic FFV supply chain innovates with increased online marketing. While the seeds were sown for e-commerce before the crisis – through an active promotion by the government and introduction of a legal framework (UNCTAD, 2020) – the Covid-19 crisis accelerated its use, owing to the country's telecom infrastructure and relatively high phone, internet and smartphone penetration[10]. Similar findings on a Covid-19 induced spread of e-commerce are reported by others (Dou et al., 2020; Hobbs, 2020; Kazeem, 2020; Lal, 2020; Leesa-Nguansuk, 2020; Narayanan, 2020; Tandon, 2020). However, these online platforms might not have supported smallholder farmers much to cope with the Covid-19 shock, and might not persistently spread when restrictions ease. The perishability of FFV and the lack of quality standards in Senegal increases consumers' need to assess product quality first-hand.

Our findings and resultant nuances in the debate – while case-specific for the Senegalese FFV supply chain – have some important policy and research implications. The stronger disruptive impact and the lower resilience found in more traditional food supply chains imply that developing countries will be affected more severely by the Covid-19 crisis. Traditional and transitional food supply chains are most prevalent in the poorest countries, and most important in their domestic food sectors (Feyaerts et

[10] Already in 2017, 10% of the population used the internet to pay bills or shop online (World Bank, 2020a).

al., 2020; Reardon et al., 2019). Especially the disruption of domestic food production and supply, rather than international trade effects, might reduce food availability in poor countries and cause additional food insecurity and hunger in the aftermath of the Covid-19 pandemic. Mitigating this food security impact requires support to domestic food production – e.g., through the introduction of green passage lanes for food products during mobility restrictions – and attention to smallholder farmers in Covid-19 related financial aid programs in developing countries (Laborde et al., 2021; United Nations, 2020). In addition, our observation of a Covid-19 induced shift from high-value FFV production to lower value staple and cash crops among smallholders might imply a reduced availability of more nutritious food, such as fruits and vegetables – as evidenced for Ethiopian consumers by Hirvonen, De Brauw and Abate (2020). Consequently, not only the accessibility of FFV is a concern (Harris, 2020), but also its availability may become a concern in the short to medium run (Torero, 2020b) – and likewise, not only food security but also nutrition security may become a concern (Jayawardena & Misra, 2020).

Our study on the early consequences of the Covid-19 pandemic on food supply chains in developing countries is constrained by the limited quantity and quality of data from phone and online surveys. Our study entails further limitations with respect to the difficulty in disentangling inherent seasonal variation and Covid-19 implications, and potential recall bias in the data. Nevertheless, this study brings some important nuances in the debate on the resilience of the food system to the pandemic. Further research remains necessary to reveal longer term implications after Covid-19 triggered restrictions ease, as Dai et al. (2020) did for the case of China.

Chapter 3

Employment dynamics and linkages in the rural economy: Insights from Senegal[1]

1. Introduction

Labour is considered to be the most important asset of the poor. Increased returns to labour are a prerequisite to poverty reduction (Fields, 2019; Ivanic & Martin, 2018; Lanjouw & Murgai, 2009; Loayza & Raddatz, 2010; Mccullough, 2017; Narayan et al., 2009). Various studies focus on labour productivity in self-employment, as a large proportion of rural households in low-income countries are small-scale entrepreneurs in agriculture, non-agriculture or both (Christiaensen, 2017; B. Davis et al., 2017; Nagler & Naudé, 2017; P. Winters et al., 2010). Many poverty reduction strategies focus on increasing rural incomes through self-employment, for example through credit programmes, input subsidies, extension and training programs. Some scholars and policy makers, however, stress the importance of wage employment and job creation in rural development and poverty reduction (Fields, 2019; Inchauste, 2012; Reardon et al., 2001; World Bank, 2012).

A stylized fact in labour economics is the strong correlation between labour market development and the share of wage employment in total employment on the one hand, and income levels and economic growth on the other hand. This trend is illustrated by the fact that 87% of the employed population in high-income countries is wage employed while this is only 19% in low-income countries (ILOSTAT, 2019). Some empirical studies show that wage employment substantially improves income and welfare levels of rural households (Holden et al., 2004; Maertens & Swinnen, 2009; Reardon et al., 2001). This literature however is thin and lacks nuance on different

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employment sources, insights on dynamic effects, and an understanding of the channels of effects. In this article we assess, conceptually as well as empirically with data from Senegal, how entry and continuation in different types of wage employment affect household welfare through direct and indirect effects.

First, the literature on the rural nonfarm economy often does not distinguish between self-employment and wage employment, or between different types of wage employment. In addition, casual and agricultural wage employment are often disregarded. This might reflect data limitations – casual and agricultural wage employment is often semi- or informal and therefore underreported in statistics and survey data (Oya, 2013; Rizzo, Kilama, & Wuyts, 2015) – but is also rooted in an intrinsic idea that such wage employment is a low-remunerative, marginal and insecure source of income that cannot significantly contribute to household welfare and rural development (Deaton & Dreze, 2002; Matsumoto, Kijima, & Yamano, 2006; Oya, 2013). Yet, agricultural wage employment is the most important off-farm employment sector for the rural poor because of lower capital and skills requirements for entry and lower reservation wages of poor households (Adjognon, Liverpool-Tasie, de la Fuente, et al., 2017; Ayenew et al., 2017; B. Davis et al., 2010; Lanjouw & Murgai, 2009). Neglecting this sector, and by extension the large diversity in rural activities, may result in erroneous conclusions about the welfare effect of wage employment and failure to identify whether stimulating small-scale entrepreneurship or supporting job creation are effective poverty reduction strategies.

Second, the scarce literature on rural wage employment largely neglects dynamics over time. Households' participation in wage employment is characterised by high entry and exit rates, and could be part of an income diversification strategy as well as a strategy to move out of agriculture. This results in possible asymmetric welfare effects of new employment entry and continued employment (Van den Broeck & Kilic, 2019; Van den Broeck & Maertens, 2017). The need for panel data largely explains why dynamic aspects are understudied, as many studies on rural wage employment use cross-sectional data. Moreover, studies that do use longitudinal data typically only estimate

effects of entry into nonfarm employment (Adjognon, Liverpool-Tasie, de la Fuente, et al., 2017; Bezu et al., 2012).

Third, the literature on linkages in the rural economy is confined to farm-nonfarm linkages. An older literature points to economy-wide linkages from the farm to the nonfarm sector, emerging from production and consumption linkages and resulting in growth multiplier effects (Delgado, Hopkins, & Kelly, 1998; Haggblade, Hazell, & Brown, 1989). More recent studies investigate investment and knowledge spillover effects from the rural nonfarm economy on agricultural production at the household level (Adjognon, Liverpool-Tasie, de la Fuente, et al., 2017; Amare & Shiferaw, 2017; Anríquez & Daidone, 2010; Kilic et al., 2009; Mathenge et al., 2015; Oseni & Winters, 2009; Ruben & van den Berg, 2001; Smale et al., 2016; Stampini & Davis, 2009). In the latter strand of literature as well – with the exception of the Mathenge, Smale and Tschirley (2015) and Smale *et al.* (2016) studies – different types of wage and self-employment are pooled, making it impossible to detect linkages between agricultural and non-agricultural wage employment on the one hand and self-employment on the other, and disentangle different channels of effects.

In this article, we assess conceptually how wage employment affects household welfare and empirically estimate effects using household survey data from a balanced sample of 461 households in rural Senegal, surveyed in 2013 and 2016. We distinguish between agricultural and non-agricultural wage employment, and between casual and contractual wage employment. We separate effects of entry into and continued wage employment, the intensity of wage employment, and estimate direct and indirect effects. We use different welfare indicators: household income (specified in absolute and proportional terms), poverty, poverty gap and poverty severity, and food security. Our approach, including different employment sources, dynamic effects, employment linkages and different welfare measures, results in more nuanced and comprehensive insights on how wage employment contributes to rural income growth and poverty reduction.

2. Concepts and literature

Conceptually, participation in wage employment can have both direct and indirect effects on the household income of a household initially engaged in only small-scale self-employed activities. The direct effects are obviously to increase household income, depending on the persistence and remuneration of the wage employment. The indirect effects might be either positive, for example through increased investment possibilities, or negative, for example through reducing labour to self-employed activity. In addition, the pursuit of wage income might involve an initial shock to income from self-employment, as households adjust to the wage earning activities.

2.1. Direct income effects

Entry into wage employment creates an instant positive income shock. The size of the shock depends on how much household labour is relocated to wage employment and on market wage levels. The effect of continued wage employment depends on whether wage income increases over time or not. If not, the household will be on a higher income level but not on a faster income-growth path. Wage income can increase over time if wage employment intensifies over time (i.e., more household members enter wage employment or they work longer hours or longer periods over the year), if they move to better paid jobs or if real wages increase. In this case, the household will be at a higher income level and a faster income growth path. The latter is more likely for high-skilled employment with promotion and transfer possibilities.

Empirical studies that specifically analyse the income and welfare effects of participation in wage employment mainly point to positive effects. Reardon and co-authors (2001) summarize findings from 11 studies across Latin-America and conclude that off-farm wage income contributes substantially to rural incomes. Imai and co-authors (2015) provide evidence for poverty reducing effects of participation in the rural nonfarm sector in Asian countries, but do not distinguish between wage employment and self-employment. For Sub-Saharan Africa, there is evidence for welfare improving effects of wage employment in emerging agro-industries (Getahun & Villanger, 2018; Herrmann, 2017; Herrmann & Grote, 2015; Van den Broeck et al.,

2017, 2018). Two studies specifically distinguish high- from low-earning off-farm activities (without distinguising between wage- and self-employment), with one study concluding that both types of employment contribute to household wellbeing (Holden et al., 2004) and the other concluding that only high-return activities improve household wellbeing (Scharf & Rahut, 2014). Two other studies use panel data to study the effects of household participation in rural nonfarm employment, ommiting the effect of agricultural wage employment. Bezu and co-authors (2012) reveal a positive relation between nonfarm employment participation and household expenditure growth, however they do not disentangle wage and self-employment. Adjognon and co-authors (2017) find that nonfarm employment increases rural households' welfare and reduces poverty, and that the nonpoor benefit more from participation than the poor. These articles, with the exception of the studies by Holden and co-authors (2004) and Adjognon and co-authors (2017), do not investigate indirect effects.

2.2. Indirect income effects

In addition to a direct income effect, participation in wage employment may create positive indirect effects on income from self-employment. These indirect effects may stem from investment spillover effects when wages earned in the wage sector are (partially) invested in the household farm or nonfarm business. Positive indirect effects may also emerge from technology, managerial and knowledge spillovers, which are more likely in the case of wage employment in the agricultural sector because of proximity in activities between the agricultural employer and the employee farm-household. Positive indirect effects bring the household onto a faster income-growth path.

The indirect effect of participation in wage employment on income from self-employment may be negative due to a negative investment effect or due to competition for labour. If the return to labour is higher in wage employment than in self-employment, households may specialize in wage employment and disinvest in their own productive farm (and nonfarm) activities, resulting in a decrease in income from self-employment. This situation is more likely if households enter high-earning, high-skilled or permanent wage employment. In addition, relocating labour from self-

employment to wage employment may reduce productivity and income from self-employment, which likely creates a more instant negative shock in income from self-employment when household members relocate labour to the wage sector. This is likely in regions where labour is scarce or in the case of contractual employment in the wage sector. Yet, when there is no competition for labour between wage and self-employment – which is to some extent the case in Sub-Saharan Africa where there is substantial hidden unemployment among farm-households (Mccullough, 2017) – or perhaps in the case of casual wage employment during particular seasons of the year, entry into wage employment may not reduce income from self-employment. Moreover, entry into wage employment may result in positive investment spillovers as wages can be important in lifting capital constraints.

There are a few empirical studies that analyse specifically how households' farm production is affected by off-farm wage employment. These studies indicate that wage employment relaxes farmers' liquidity constraints, inducing investment on the household farm and resulting in higher farm productivity (Adjognon, Liverpool-Tasie, de la Fuente, et al., 2017; Maertens, 2009). Other studies analyse the effect of nonfarm employment in general, without distinguishing between wage and self-employment, and mostly point to positive spillover effects on farm production and income (Anríquez & Daidone, 2010; Ayenew et al., 2017; Oseni & Winters, 2009; Ruben & van den Berg, 2001; Stampini & Davis, 2009; Takahashi & Otsuka, 2009). Some studies find that off-farm employment competes for labour and capital, which results in negative effects on household farm production (Holden et al., 2004; Kilic et al., 2009; Mathenge et al., 2015; Smale et al., 2016). Only the studies by Mathenge, Smale and Tschirley (2015) and Smale and co-authors (2016) consider different types of wage employment; and none consider dynamic effects. There is a specific discussion in the literature on informal agricultural wage employment in Malawi (i.e., ganyu labour). Some argue that this low-risk, low-return employment pushes poor households into a spiral of destitution because of negative effects on households' own farm production (Bryceson, 2002; Kerr, 2005; Whiteside, 2000). Others contest this view and argue that ganyu labour represents an important source of additional income that can be used for

investments on the farm (Fink, Jack, & Masiye, 2014; Orr, Mwale, & Saiti-Chitsonga, 2009).

The conceptual discussion implies that different types and intensities of wage employment may have diverging direct and indirect income effects, and that welfare effects may differ for entry in and continued wage employment. We analyse these effects using survey data from Senegal.

3. Background and data

Our research is conducted in the Saint-Louis region, located in the Northern Sahel part of Senegal. This region experiences increasingly diverse wage employment opportunities, both in the agricultural and the non-agricultural sector. Saint-Louis is one of the main horticultural export regions in Senegal, and agribusiness companies are important employers in the area. In 2016, around 4,500 casual and low-skilled workers were employed on daily or seasonal basis to work on the fields or in the conditioning stations, and another 800 workers with a fixed-term or permanent contract for white- and blue-collar jobs requiring some education[2]. In addition, there is a variety of employment opportunities outside agriculture, with most common jobs being taxi driver, functionary, mason, merchant and housemaid. These non-agricultural jobs can be low- or high-skilled, on a casual or contractual basis.

We hypothesize that the impact of wage employment on household welfare depends on the type and characteristics of the wage employment the household is involved in. Agricultural wage employment in the region is mainly situated in the agribusiness companies. We therefore would expect the positive spillovers from this employment to the own household farm to be high, as employees might pick-up some good agricultural and managerial practices, or wages might be reinvested in the own farm business. Moreover, these agribusinesses produce for the export market, meaning that their peak production season does not (completely) coincide with the production season of the

[2] Company-level data collected by the authors in 2016.

smallholder household farms[3]. We therefore expect the competition for labour between the agricultural wage employment and the self-employment on the household farm to be low. In addition, as agribusinesses often work with daily contracts (and to a lesser extent with seasonal contract), employees are able to choose whether or not to work, in function of the work on the own household farm. On the other hand, the casualness of such employment might limit the impact on household welfare. As wage employment in the non-agricultural sector is often less casual, there might be a higher competition for labour with the own farm business. Still, if the return to labour is higher in this non-agricultural wage employment than in self-employment, households may specialize in wage employment and disinvest in their own productive farm (and nonfarm) activities.

We collected two rounds of quantitative household survey data, in 2013 and 2016. The 2013 sample includes 500 households in 34 villages (three rural communities; Diama, Gandon and Fass), selected through a two-stage stratified random sampling procedure. In the first stage, we stratified villages according to their distance to the road, and randomly selected within the strata with an oversampling of villages closer to the road. In the second stage, we stratified households (in the sampled villages) according to whether or not household members are employed in the agribusiness sector. We randomly selected within the strata, and to have enough observations of households taking up wage employment, we oversampled households with agricultural wage employment. The 2016 sample includes 464 of the original 500 households, an attrition rate of 7.2%. We find that attrition is non-random with households with older heads and more literate members less likely to drop out of the sample. Therefore, we use inverse probability weights in our data analysis. This method gives more weight to households who have similar initial characteristics to households that subsequently drop out than to households with characteristics that make them more likely to remain in the panel (Baulch & Quisumbing, 2011). Inverse probability weights do not cause biased or inconsistent estimates, but can reduce the efficiency of the estimates

[3] See section 3.1 of chapter 2 for a detailed explanation of the horticultural production seasons in the region.

(Anríquez & Daidone, 2010). After dropping three households because of outlying data, the final sample consists of a balanced panel data set of 461 households.

A structured quantitative questionnaire was used to collect household-level data on farm production, land and non-land assets, and living conditions, and individual-level data on demographic characteristics and employment. To be able to compare income, poverty and food security over time, the two questionnaires were designed in the same way. The surveys were implemented with a team of trained enumerators, tablets and computer-assisted personal interviewing software. We use the statistical software Stata version 16 to analyse the data.

4. Econometric analysis

4.1. Welfare effects of wage employment

To analyse the impact of entry into and intensity of wage employment on household welfare, we estimate fixed effects regressions of the following type:

$$Y_{ijt} = \alpha_1 EMPL_{ijt} + \alpha_2 X_{ijt} + V_{jt} + \theta_t + \mu_i + \varepsilon_{ijt} \quad (1)$$

In this model, Y_{ijt} is a welfare indicator for household *i* in village *j* at time *t*, $EMPL_{ijt}$ the main independent variable of interest, X_{ijt} a set of time-variant observable household characteristics, V_{jt} a set of village-year dummies, θ_t a year fixed effect capturing aggregate time trends and shocks, μ_i household fixed effects capturing time-constant unobservable household characteristics, and ε_{ijt} the error term capturing remaining time-variant unobservable effects.

We use three different structural specifications for $EMPL_{ijt}$, each time for three different wage employment specifications, resulting in a total of nine models. The first three models consider entry into wage employment using dummy specifications. First, we specify it as one dummy variable defining wage employment in general. We consider a household to be wage employed when at least one member is wage employed during the 12 months prior to the survey. Second, we use two dummies to distinguish

between agricultural and non-agricultural wage employment. The first indicates whether at least one member is agricultural wage employed during the 12 months prior to the survey, with agricultural wage employment defined as any job in the agricultural or agribusiness sector – consistent with the terminology of Barrett, Reardon and Webb (2001). The second indicates whether at least one member is non-agricultural wage employed during the 12 months prior to the survey, with non-agricultural wage employment defined as any job in any sector that is not agriculture or agribusiness. Third, in the same way we construct two dummies for casual and contractual wage employment. The first indicates whether at least one member has been employed on a daily or seasonal basis, while the second indicates whether at least one member has been employed under a fixed-term or permanent contract. Contracted wage employees as a rule have a firm commitment in advance from an employer about how long they will be employed for, or the days (and hours) they will work. In addition, they can be entitled to benefits such as a health insurance, pension scheme, maternity leave, paid holidays or sick leave[4]. Casual wage employees often do not have guaranteed days or hours of work, nor do they have access to social security benefits. Casual and contractual wage employment are defined irrespective of the sector of employment.

Next, we consider the number of wage employees in the household using discrete variables (model 4 to 6) and the number of person-days employed using continuous variables (model 7 to 9). We use the same trilateral breakdown of wage employment. First, we consider all wage employed household members and all person-days performed in wage employment in general. Second, we distinguish between the number of household members and between the number of person-days the household performed in agricultural and non-agricultural wage employment. Third, we distinguish between the number of household members and between the number of person-days the household performed in casual and contractual wage employment.

[4] However, this is not mandatory by law and thus at the discretion of the employer.

We use six different indicators to measure household welfare Y_{ijt}. First, we use an absolute income measure: per adult equivalent[5] total household income, specified in real terms[6]. This comprises income from crop production, livestock rearing, agricultural wage employment, non-agricultural wage employment, non-agricultural self-employment, and non-labour sources of income such as remittances or government transfers. Second, we use a proportional income measure: the log transformed per adult equivalent total household income. Third, we define monetary poverty as per adult equivalent total household income falling below the national rural poverty line of Senegal[7]. Fourth, we define the poverty gap as the extent to which households fall below the national rural poverty line, expressed as a ratio of the poverty line. Fifth, we define poverty severity as the squared poverty gap, giving a higher weight to households in severe poverty. With the latter two continuous measures (censored at zero), we are able to study the impact on households that fall far below the poverty line. Sixth, we include food security as a non-monetary welfare measure. We derive this measure from the Household Food Insecurity Access Scale (HFIAS) developed by the Food and Nutrition Technical Assistance (FANTA) program of USAID (Coates, Swindale, & Bilinsky, 2007). Households are considered food insecure when they experienced moderate to severe food insecurity problems with regards to access to food in the four weeks prior to the survey. In order to compare the effects for the different dependent variables, all models are linearly estimated.

The vector X_{ijt} includes the age, gender, marital status and level of education of the household head, the number of dependents and non-dependents (age 18 to 65), and the share of literate workers in the household to control for human capital, total landholdings and its square, the number of tropical livestock units and its square, and a dummy for ownership of a motorized vehicle to control for productive capital, and a

[5] The modified OECD adult equivalence scale, assigning a value of 1 to the household head, 0.5 to additional adult members and 0.3 to children, is used. This is commonly used for rural areas in developing countries.
[6] IMF data on consumer price indices are used to convert all nominal income measures to real income measures.
[7] 221,208 FCFA per capita per year in 2011 (Gouvernement Sénégalais, 2014), inflated to 2016 prices.

dummy considering membership of an organisation to control for social capital. In all models, standard errors are clustered at the village level to control for the two-stage sampling strategy and attrition weights are applied to control for attrition bias.

The main strength of fixed effects regression is that time-constant unobserved heterogeneity is cancelled out. However, households might self-select into wage employment on the basis of time-variant unobservable characteristics. We address this endogeneity problem by including village-year dummies V_{jt} that control for unobserved time-variant village characteristics that may be correlated with household welfare and participation in wage employment, such as expansion of companies, construction of roads, or the onset of governmental or civil society projects. We cannot control for unobserved time-variant heterogeneity at household level, but we argue that household characteristics that are correlated with self-selection into employment are likely time-constant, as the survey covers a three-year interval and intrinsic motivations probably do not change during such a short period.

4.2. Employment dynamics and linkages

A drawback of fixed effects regression is that only the effects of entry into (and exit from) wage employment are estimated. The welfare effects of continued wage employment cannot be derived from these models, as households who are employed in the two survey rounds cannot be distinguished from control households who are not employed in any of the two rounds. We hypothesize that welfare effects of entry in and continued wage employment may be different and estimate a second model in which we use a differencing technique:

$$\left(Y_{ij,2016} - Y_{ij,2013}\right) = \beta_1 EMPL_{ij} + \beta_2\left(X_{ij,2016} - X_{ij,2013}\right) + \beta_3(V_{j,2016} - V_{j,2013}) + \upsilon_{ij} \quad (2)$$

The main variable of interest, $EMPL_{ij}$, is now defined as a categorical variable that represents the change of household participation in wage employment. We use three different specifications. First, we analyse the impact of wage employment dynamics in general. We classify households into four different categories: 1/ never wage employed

households, 2/ households who enter wage employment, 3/ households who are wage employed during both survey rounds (continued wage employment)[8], and 4/ households who exit wage employment. Second, we analyse the impact of agricultural and non-agricultural wage employment dynamics. Third, we analyse the impact of casual and contractual wage employment dynamics. For the latter two specifications, we classify households each time into nine categories (in detail described in table A1 in appendix). We need the nine categories to be mutually exclusive, such that the effect of entering the different types of wage employment is not confounded with the effect of households shifting between the different employment types. Therefore, we consider a household to be agricultural/casual wage employed when all wage employed members are agricultural/casual wage employed, while we consider a household to be non-agricultural/contractual wage employed when at least one household member is non-agricultural/contractual wage employed. In the analysis we focus on four categories: 1/ entry into agricultural/casual wage employment, 2/ continued agricultural/casual wage employment, 3/ entry into non-agricultural/contractual wage employment, and 4/ continued non-agricultural/contractual wage employment. In all three specifications, the base category is households who are never wage employed.

We use the intertemporal change in household welfare $\left(Y_{ij,2016} - Y_{ij,2013}\right)$ as dependent variable and use six different specifications of Y_{ijt}, capturing the absolute and proportional change in 1/ total household income, 2/ income from wage employment, and 3/ income from self-employment[9]. By analysing the different sources of income, we disentangle potential linkages between rural wage employment and self-employment, and how this may differ for wage employment entry and continued wage employment.

[8] Households' employment status in between survey years is unknown and they could have moved in and out of wage employment. It is thus a limitation of our study that we can only make claims based on the employment status in 2013 and 2016.

[9] In addition, we broke self-employment income down into agricultural self-employment income and non-agricultural self-employment income. However, as the categories are small, standard errors are large and no robust conclusions can be derived. Therefore, we directed this part of the analysis to the appendix (table A14).

In all models we control for intertemporal changes in household $(X_{ij,2016} - X_{ij,2013})$ and village characteristics $(V_{j,2016} - V_{j,2013})$. X_{ijt} contains the same variables as defined in the fixed effects regressions (excluding the squared terms for landholdings and livestock). V_{jt} includes the distance to a concrete road and a dummy for proximity to an agribusiness company (i.e., closer than 3km, which is a feasible walking distance). Standard errors are clustered at village level and attrition weights are used to control for attrition bias.

5. Results

5.1. Employment dynamics and characteristics

We observe substantial employment dynamics over the rather short panel period of three years: 26% of sampled households enter wage employment between 2013 and 2016, 39% are wage employed in 2013 and continue that wage employment in 2016, 28% never enter wage employment and 7% exit from wage employment (table 1). In addition, there is substantial movement between employment sectors and employment status. Of the 182 households who continue wage employment, 20% moves from agricultural to non-agricultural wage employment while 15% moves from non-agricultural to agricultural wage employment. Likewise, 23% moves from casual to contractual wage employment while 21% moves from contractual to casual wage employment.

Table 1: Matrix of Wage Employment Dynamics between 2013 and 2016

2013 \ 2016		Without wage employment	With wage employment	Total
Without wage employment	N	127	122	249
	Cell %	28%	26%	54%
	Row %	51%	49%	100%
With wage employment	N	30	182	212
	Cell %	7%	39%	46%
	Row %	14%	86%	100%
Total	N	157	304	461
	Row %	34%	66%	100%

We summarize the characteristics of employment at the individual worker level in table 2. The majority of workers in the agricultural sector (72 %) are employed on a casual basis. Compared to contracted workers in the agricultural sector, these casual workers are employed significantly fewer days per year – on average 150 days, which corresponds to about 7.5 months or 65% of a fulltime contractual employment – and receive a significantly lower wage – on average 2,392 FCFA or €3.8 per day of eight working hours. About one third of the workers in the non-agricultural sector are employed on a casual basis but they are employed on average the same number of days per year as contracted workers in the sector. Yet, the wages they receive are significantly lower than the wages of contracted workers. Wages in the non-agricultural sector are significantly and substantially higher than in the agricultural sector. The wage inequality between contracted and casual workers is, in absolute terms, larger in the non-agricultural sector than in the agricultural sector. Large standard deviations point to substantial wage variation in the sample, especially among non-agricultural workers. Table 2 reports data from the pooled sample because we find no significant differences in real wages and employment duration over time[10].

[10] Daily wages are 2,265 FCFA and 2,472 FCFA for casual agricultural workers in 2013 and 2016 respectively, 3,497 FCFA and 3,647 FCFA for contracted agricultural workers, 3,475 FCFA and 3,348 FCFA for casual non-agricultural workers, and 6,024 FCFA and 5,443 FCFA for contracted non-agricultural workers. Working days per year are 148.52 and 151.53 for casual agricultural workers in 2013 and 2016 respectively, 240.89 and 231.92 for contracted agricultural workers, 245.46 and 239.59 for casual non-agricultural workers, and 236.72 and 250.26 for contracted non-agricultural workers.

Table 2: Employment Characteristics of Individual Workers, Pooled Data

	Agricultural sector		Non-agricultural sector					
	Casual workers	Contracted workers	Casual workers	Contracted workers	Comparison of means			
	(1)	(2)	(3)	(4)	(1) – (2)	(3) – (4)	(1) – (3)	(2) – (4)
Number of workers	582	229	107	223				
Working days per year	150.36 (70.98)	235.92 (73.95)	241.73 (93.43)	245.04 (83.42)	-85.55*** [<0.01]	-3.31 [0.75]	-91.37*** [<0.01]	-9.12 [0.22]
Daily wage (FCFA)	2,392 (1,630)	3,580 (2,277)	3,394 (3,656)	5,667 (6,443)	-1,189*** [<0.01]	-2,273*** [<0.01]	-1,002*** [<0.01]	-2,086*** [<0.01]

Notes: We used two-sided t-tests. Significant differences are indicated with * p < 0.1, ** p < 0.05 or *** p < 0.01. Standard deviations are reported between parentheses. P-values are reported between square brackets. The wage employment categories are mutually exclusive.

5.2. Household characteristics and welfare indicators

We compare characteristics of households with and without wage employment, including a comparison between different types of wage employment (agricultural vs non-agricultural, and casual vs contractual) in table 3. We find that households with (any type of) wage employment have an older and better educated household head; are larger with more dependents and non-dependents, and a higher share of literate non-dependents; live closer to roads and agribusiness companies; have less livestock and land assets; and are more likely to be member of an organisation (except for non-agricultural wage employed households who have as much landholdings as households without wage employment and are not more likely to be member of an organisation). This implies that households with wage employment are better endowed with human and social capital, are more strategically located, but have less productive assets. Compared to agricultural wage employed households, non-agricultural wage employed households are composed of more working-age household members. They have more land and live closer to a concrete road, however further away from an agribusiness company. When we compare casual wage employed households with contractual wage employed households, we find that the latter are larger and better educated, and that they are more likely to own a motorised vehicle. Contractual wage employed households live closer to a concrete road, but further away from an agribusiness company.

Table 3: Mean Comparison of Household Characteristics between Households With and Without Wage Employment, Pooled Data

	Without employment	Agricultural employment	Non-agricultural employment	Casual employment	Contractual employment	Comparison of means					
	(1)	(2)	(3)	(4)	(5)	(1) - (2)	(1) - (3)	(2) - (3)	(1) - (4)	(1) - (5)	(4) - (5)
Age household head (years)	55.36	59.40	58.59	58.73	59.56	-4.04***	-3.22***	0.05	-3.36***	-4.20***	-2.22*
	(13.60)	(13.67)	(14.53)	(13.77)	(14.60)	[<0.01]	[0.01]	[0.97]	[<0.01]	[<0.01]	[0.08]
Female household head (1/0)	0.15	0.12	0.13	0.13	0.12	0.03	0.02	-0.01	0.03	0.03	0.00
	(0.36)	(0.33)	(0.34)	(0.33)	(0.33)	[0.19]	[0.42]	[0.65]	[0.28]	[0.24]	[0.97]
Married household head (1/0)	0.90	0.91	0.90	0.91	0.92	-0.01	0.00	0.03	0.00	-0.01	-0.01
	(0.30)	(0.29)	(0.30)	(0.29)	(0.27)	[0.74]	[0.90]	[0.31]	[0.95]	[0.49]	[0.69]
Elementary education household head (1/0)	0.14	0.20	0.24	0.20	0.21	-0.06**	-0.10***	-0.05	-0.06**	-0.07**	-0.01
	(0.35)	(0.40)	(0.43)	(0.40)	(0.41)	[0.02]	[<0.01]	[0.16]	[0.03]	[0.01]	[0.82]
Secondary education household head (1/0)	0.04	0.13	0.16	0.12	0.19	-0.09***	-0.12***	-0.02	-0.08***	-0.15***	-0.10***
	(0.19)	(0.34)	(0.36)	(0.33)	(0.39)	[<0.01]	[<0.01]	[0.42]	[<0.01]	[<0.01]	[<0.01]
Number of working age members	4.09	5.96	6.25	5.99	6.27	-1.87***	-2.15***	-0.68**	-1.90***	-2.18***	-0.93***
	(2.37)	(3.29)	(3.40)	(3.31)	(3.36)	[<0.01]	[<0.01]	[0.02]	[<0.01]	[<0.01]	[<0.01]
Number of dependent members	4.94	5.80	6.10	5.84	6.14	-0.86***	-1.16***	-0.48	-0.90***	-1.19***	-0.70**
	(2.57)	(3.68)	(4.11)	(3.78)	(3.95)	[<0.01]	[<0.01]	[0.15]	[<0.01]	[<0.01]	[0.04]
Share literate working age members	0.28	0.47	0.48	0.44	0.51	-0.18***	-0.19***	-0.02	-0.16***	-0.22***	-0.09***
	(0.31)	(0.34)	(0.34)	(0.34)	(0.33)	[<0.01]	[<0.01]	[0.59]	[<0.01]	[<0.01]	[<0.01]
Total landholdings (ha)	2.85	1.70	2.52	1.93	1.93	1.15***	0.34	-1.05***	0.93**	0.93**	0.03
	(7.26)	(2.96)	(4.97)	(3.28)	(3.98)	[<0.01]	[0.53]	[<0.01]	[0.03]	[0.05]	[0.93]
Tropical livestock units	8.28	3.88	2.99	4.19	3.29	4.40**	5.29**	1.37	4.09**	4.99**	1.07
	(35.95)	(10.54)	(7.28)	(10.61)	(10.43)	[0.02]	[0.03]	[0.12]	[0.04]	[0.02]	[0.22]
Motorised vehicle (1/0)	0.10	0.09	0.09	0.08	0.10	0.01	0.01	0.00	0.02	-0.01	-0.05*
	(0.30)	(0.28)	(0.28)	(0.27)	(0.31)	[0.57]	[0.61]	[0.95]	[0.39]	[0.79]	[0.07]
Membership organisation (1/0)	0.79	0.84	0.84	0.85	0.86	-0.05*	-0.05	0.00	-0.06**	-0.07**	-0.04
	(0.41)	(0.36)	(0.36)	(0.36)	(0.34)	[0.07]	[0.11]	[0.91]	[0.04]	[0.01]	[0.19]

Distance to concrete road (km)	2.55 (3.05)	1.87 (2.79)	1.40 (2.10)	1.88 (2.80)	1.39 (2.18)	0.67*** [<0.01]	1.15*** [<0.01]	0.64*** [0.01]	0.66*** [<0.01]	1.15*** [<0.01]	0.84*** [<0.01]
Agribusiness company in proximity (1/0)	0.27 (0.44)	0.77 (0.42)	0.36 (0.48)	0.72 (0.45)	0.54[i] (0.50)	-0.51*** [<0.01]	-0.16*** [<0.01]	0.37*** [<0.01]	-0.47*** [<0.01]	-0.32*** [<0.01]	0.10** [0.02]
Number of observations	406	381	232	359	296						

Notes: We use two-sided t-tests and indicate significant differences with * p < 0.1. ** p < 0.05 or *** p < 0.01. Standard errors are reported between parentheses. P-values are reported between square brackets. The wage employment categories are not mutually exclusive, based on the fixed-effects regressions definitions.

Table 4: Mean Comparison of Income, Poverty and Food Security between Households With and Without Wage Employment, Pooled Data

	Without employment	Agricultural employment	Non-agricultural employment	Casual employment	Contractual employment	Comparison of means					
	(1)	(2)	(3)	(4)	(5)	(1) - (2)	(1) - (3)	(2) - (3)	(1) - (4)	(1) - (5)	(4) - (5)
Total income [+]	408.11	520.66	627.86	509.24	603.48	-112.55***	-219.75***	-165.24***	-101.14***	-195.37***	-156.12***
	(507.06)	(451.69)	(529.29)	(472.94)	(412.72)	[<0.01]	[<0.01]	[<0.01]	[<0.01]	[<0.01]	[<0.01]
Poverty (1/0)	0.48	0.27	0.17	0.30	0.15	0.19***	0.29***	0.14***	0.17***	0.31***	0.23***
	(0.50)	(0.44)	(0.38)	(0.46)	(0.36)	[<0.01]	[<0.01]	[<0.01]	[<0.01]	[<0.01]	[<0.01]
Poverty gap	0.26	0.12	0.06	0.13	0.04	0.15***	0.20***	0.08***	0.14***	0.22***	0.15***
	(0.37)	(0.35)	(0.20)	(0.36)	(0.16)	[<0.01]	[<0.01]	[<0.01]	[<0.01]	[<0.01]	[<0.01]
Poverty severity	0.21	0.13	0.04	0.15	0.03	0.07	0.17***	0.13	0.06	0.18***	0.21**
	(0.40)	(1.28)	(0.20)	(1.32)	(0.13)	[0.26]	[<0.01]	[0.19]	[0.37]	[<0.01]	[0.04]
Food insecurity (1/0)	0.54	0.47	0.43	0.50	0.41	0.06*	0.11**	0.07	0.04	0.12***	0.14***
	(0.50)	(0.50)	(0.50)	(0.50)	(0.49)	[0.07]	[0.01]	[0.10]	[0.29]	[<0.01]	[<0.01]
Income from wage employment [+]	0.00	252.39	368.00	252.99	346.43	-252.38***	-368.00***	-172.95***	-252.99***	-346.43***	-172.68***
	(0.00)	(253.48)	(334.83)	(282.50)	(263.75)	[<0.01]	[<0.01]	[<0.01]	[<0.01]	[<0.01]	[<0.01]
Income from self-employment [+]	337.56	229.25	213.25	223.80	205.08	108.31***	124.31***	14.1	113.76***	132.48***	37.38
	(492.61)	(361.23)	(360.74)	(359.70)	(300.45)	[<0.01]	[<0.01]	[0.65]	[<0.01]	[<0.01]	[0.23]
Number of observations	406	381	232	359	296						

Notes: We use two-sided t-tests and indicate significant differences with * p < 0.1. ** p < 0.05 or *** p < 0.01. Standard errors are reported between parentheses. [+] per adult equivalent (1,000 FCFA). The wage employment categories are not mutually exclusive, based on the fixed-effects regressions definitions..

Regarding household welfare (table 4), we find that households without wage employment have a lower per adult equivalent household income, are more likely to be poor and food insecure, and experience a larger poverty gap than households with wage employment (except for casual wage employed households who are as likely to be food insecure as households without wage employment). In addition, households with non-agricultural or contractual wage employment are less likely to experience severe poverty compared to households without wage employment. Households with wage employment derive significantly less income from self-employment activities. Households with agricultural or casual wage employment have a lower (wage) income, and are more likely to be poor and experience a larger poverty gap than households with non-agricultural or contractual wage employment. Poverty severity is higher for casual wage employed households than for contractual wage employed households.

5.3. Welfare effects of wage employment

We report a summary of the estimated effects of wage employment in general, of agricultural and non-agricultural wage employment, and of casual and contractual wage employment, for three structural specifications (dummy variables, number of workers and person-days employed) in table 5. The full results of these regressions are reported in tables A2 to A10 in appendix. Given the large share of households entering wage employment and the small share exiting wage employment over the panel period (see table 1), the estimated effects of the first three fixed effects regressions can be interpreted as welfare-enhancing effects of entry into wage employment. We find that entry into wage employment increases household income both in absolute and proportional terms, and reduces the likelihood to be poor, the poverty gap and food insecurity. Estimates indicate strong effects[11]: wage employment increases per adult equivalent income with 165 thousand FCFA (about €250) or 143%, and reduces the likelihood to be poor by 20 percentage points (pp), the poverty gap by 16 pp (i.e., the poor are moving closer to the poverty line), and food insecurity by 24 pp. With an

[11] However, magnitudes of effects reduce when inverse probability weights are omitted. Without weights, entry into wage employment increases income by 66%, and reduces poverty and food insecurity by 20 and 16 pp.

average poverty, poverty gap and food insecurity rate in the sample of 32%, 18% and 50%, the latter effects correspond to a poverty reduction of 63%, a poverty gap reduction of 89% and a food insecurity reduction of 48%.

Table 5: Effects of Wage Employment on Income, Poverty and Vulnerability, Estimated from Fixed Effects Regressions

	Income	Log(Income)	Poverty	Poverty gap	Poverty severity	Food insecurity
Dummy Employment						
Model 1						
Wage employment	164.69**	1.43**	-0.20**	-0.16***	-0.07	-0.24***
	(63.45)	(0.65)	(0.07)	(0.05)	(0.09)	(0.09)
Model 2						
Agricultural wage employment	130.92	1.55*	-0.17**	-0.11*	-0.02	-0.13
	(86.41)	(0.80)	(0.08)	(0.05)	(0.12)	(0.08)
Non-agricultural wage employment	148.43**	0.26	-0.18**	-0.11***	-0.07**	-0.24**
	(65.37)	(0.23)	(0.07)	(0.03)	(0.03)	(0.09)
Model 3						
Casual wage employment	111.95	1.30**	-0.18*	-0.15**	-0.08	-0.24**
	(89.34)	(0.61)	(0.09)	(0.05)	(0.08)	(0.10)
Contractual wage employment	197.56***	0.53***	-0.18***	-0.11***	-0.08**	-0.13
	(59.04)	(0.18)	(0.06)	(0.04)	(0.03)	(0.11)
Number of Employees						
Model 4						
Wage employees	86.66***	0.34***	-0.09***	-0.05***	-0.03**	-0.07*
	(23.20)	(0.12)	(0.03)	(0.02)	(0.01)	(0.03)
Model 5						
Agricultural wage employees	61.31***	0.39**	-0.08**	-0.06**	-0.03*	-0.06
	(20.97)	(0.16)	(0.03)	(0.02)	(0.02)	(0.04)
Non-agricultural wage employees	137.97***	0.23*	-0.10**	-0.05**	-0.03*	-0.08
	(42.16)	(0.13)	(0.04)	(0.03)	(0.02)	(0.07)

Model 6						
Casual wage employees	79.57***	0.39**	-0.10***	-0.06**	-0.04**	-0.08***
	(24.48)	(0.15)	(0.03)	(0.02)	(0.02)	(0.03)
Contracted wage employees	104.08***	0.19*	-0.07**	-0.04**	-0.03**	-0.04
	(31.16)	(0.11)	(0.03)	(0.02)	(0.01)	(0.07)
Person-days Employed						
Model 7						
Wage employed	0.46427***	0.00128***	-0.00045***	-0.00024***	-0.00015***	-0.00025*
	(0.10717)	(0.00035)	(0.00012)	(0.00006)	(0.00005)	(0.00015)
Model 8						
Agricultural wage employed	0.41217***	0.00162***	-0.00049***	-0.00028***	-0.00019***	-0.00023
	(0.11544)	(0.00041)	(0.00016)	(0.00008)	(0.00006)	(0.00017)
Non-agricultural wage	0.51412***	0.00096**	-0.00042***	-0.00019**	-0.00012*	-0.00028
employed	(0.14853)	(0.00040)	(0.00015)	(0.00007)	(0.00006)	(0.00025)
Model 9						
Casual wage employed	0.43754***	0.00165***	-0.00052***	-0.00028***	-0.00020**	-0.00046***
	(0.13044)	(0.00049)	(0.00015)	(0.00010)	(0.00007)	(0.00010)
Contracted wage employed	0.49232***	0.00089**	-0.00039***	-0.00019***	-0.00011**	-0.00004
	(0.13914)	(0.00038)	(0.00013)	(0.00005)	(0.00004)	(0.00026)

Notes: Significant coefficients are indicated with * $p < 0.1$, ** $p < 0.05$ or *** $p < 0.01$. Full regression results are reported in tables A2 to A10 in appendix. Standard errors are clustered at the village level and are reported between parentheses. Income is specified in 1,000 FCFA and refers to income per adult equivalent. N = 922 for all specifications

Entry into agricultural and non-agricultural wage employment increases income, and reduces poverty and the poverty gap. The effects remain large with a poverty reduction of 17 to 18 pp and a poverty gap reduction of 11 pp for both employment sectors. Agricultural wage employment does not add significantly to household income in absolute terms but does significantly increase income in proportional terms, with an increase of 155%. The reverse holds for non-agricultural wage employment, adding significantly to household income in absolute terms, with an estimated effect of 148 thousand FCFA, but not in proportional terms. We find similar effects for entry into casual and contractual wage employment. They both increase household income significantly – casual wage employment only in percentage terms, with an estimated effect of 130%, contractual wage employment increases income both in absolute and proportional terms, with estimated effects of 198 thousand FCFA and 53% – and both decrease the likelihood to be poor by 18 pp and the poverty gap by 11 to 15 pp. Only non-agricultural and contractual wage employment reduce poverty severity significantly by 7 to 8 pp respectively. In addition, only non-agricultural and casual wage employment reduce food insecurity by 24 pp.

We find that an increase in the intensity of wage employment – either by an increase of the number of household members employed, or by an increase in the number of person-days employed – has a large positive impact on household welfare. For all specifications we show that household income increases both in absolute (between 61 and 138 thousand FCFA per additional member) and proportional (between 19 and 39 pp per additional member) terms, and that the likelihood to be poor, the poverty gap and poverty severity decreases. Food insecurity on the other hand only decreases when the intensity of casual wage employment (and wage employment in general) increases.

5.4. Employment dynamics and linkages

We report a summary of the estimated effects of entry into wage employment and continued wage employment, in general and for different employment sectors (agricultural and non-agricultural wage employment), and different employment status (casual and contractual wage employment) in table 6. The full results of these regressions are reported in tables A11 to A13 in appendix. We find that both entry in

and continued wage employment result in an absolute and proportional increase in total household income. The estimated absolute increase is slightly higher for entry (235 thousand FCFA) than for continued wage employment (272 thousand FCFA), while the estimated proportional increase is much higher for entry in wage employment (226%) than for continued wage employment (104%). The income increase from wage employment entry is driven by a sharp increase in wage income of 266 thousand FCFA, while self-employment income does not increase. The income increase from continued wage employment is driven by an increase in self-employment income of 144 thousand FCFA or 151% and not by an increase in wage income. A further breakdown of self-employment income into agricultural and non-agricultural self-employment income (table A14 in appendix) shows that this increase in self-employment income is driven by an increase in income from non-agricultural self-employment.

Table 6: Effects of Wage Employment Entry and Continued Wage Employment on Income from Different Sources , First-Difference Estimations

	Income	Log (Income)	Wage income	Log (Wage income)	Self-employment income	Log (Self-employment income)
Model 10						
Wage employment entry	272.04***	2.26**	266.14***	11.92***	-45.22	-0.22
	(68.83)	(1.02)	(56.59)	(0.16)	(74.42)	(1.43)
Continued wage employment	235.13***	1.04**	16.18	0.12	144.01*	1.51*
	(72.45)	(0.39)	(29.99)	(0.10)	(73.23)	(0.84)
Model 11						
Agricultural wage employment entry	260.22***	3.40*	155.04***	11.33***	96.01	1.88
	(87.77)	(1.72)	(49.42)	(0.27)	(88.09)	(2.25)
Continued agricultural wage employment	195.75***	1.00**	1.90	-0.01	141.70**	2.36*
	(58.01)	(0.46)	(44.23)	(0.19)	(69.07)	(1.20)
Non-agricultural wage employment entry	286.82***	1.44***	361.15***	12.40***	-151.50*	-1.85
	(93.83)	(0.50)	(80.41)	(0.16)	(82.06)	(1.15)
Continued non-agricultural wage employment	398.92***	1.35**	86.53**	0.25	199.44	0.66
	(126.64)	(0.49)	(39.82)	(0.17)	(123.83)	(0.80)

Model 12						
Casual wage employment entry	175.82*	2.99*	136.86***	11.23***	31.62	2.43
	(86.69)	(1.68)	(44.78)	(0.19)	(94.35)	(1.77)
Continued casual wage employment	216.08	1.43**	-40.52	0.20	220.74	3.43***
	(130.18)	(0.56)	(80.58)	(0.25)	(150.63)	(1.24)
Contractual wage employment entry	346.92***	1.58***	372.90***	12.51***	-118.83	-2.34**
	(106.09)	(0.47)	(82.95)	(0.16)	(80.35)	(0.99)
Continued contractual wage employment	271.47***	1.14**	49.02	0.17	154.25*	0.19
	(90.14)	(0.42)	(45.81)	(0.10)	(79.31)	(1.07)

Notes: Coefficients significantly different from zero are indicated with * $p < 0.1$. ** $p < 0.05$ or *** $p < 0.01$. Full regression results are reported in tables A11, A12 and A13 in appendix. Standard errors are clustered at the village level and reported between parentheses. All income measures are specified in 1,000 FCFA and refer to income per adult equivalent. N = 461 for all specifications.

While in general, we observe the same trends for agricultural and non-agricultural wage employment, and for casual and contractual wage employment as for wage employment in general, there are some important nuances. The proportional income increase from entry in wage employment is always stronger than the proportional income increase from continued wage employment. The same goes for the absolute income increase, except for non-agricultural wage employment, where continued non-agricultural wage employment yields a larger absolute income increase than entry into non-agricultural wage employment. The results show that the proportional income increase from entry in wage employment is stronger for agricultural and casual wage employment, than for non-agricultural and contractual wage employment, while the opposite is true for the absolute income increase. When we decompose income into income from wage employment and income from self-employment, we find that entry into all types of wage employment increases income from wage employment, while only continued non-agricultural wage employment has a wage income increasing effect. Entry to agricultural or casual wage employment has no effect on income from self-employment, while entry to non-agricultural or contractual wage employment reduces income from self-employment, either in absolute (non-agricultural) or in proportional (contractual) terms. Continued agricultural and casual wage employment has a strong effect on income from self-employment, either in both absolute and proportional terms (agricultural) or only proportional terms (casual). Continued contractual wage employment has a self-employment income increasing effect. Whether these increases in self-employment income are triggered by an increase of agricultural or non-agricultural self-employment income, depends on the type of wage employment. However, because of the small groups and subsequent large standard errors, we cannot draw strong conclusions on this.

6. Discussion

We find substantial positive welfare effects of participation in wage employment in general. Estimates indicate strong effects: per capita income increases by 143%, and poverty, poverty gap and food insecurity decrease by respectively 63%, 89% and 48%. Our results are in line with other studies that point to the importance of rural wage employment in boosting income, and reducing poverty and food insecurity, both in the short run and in the long run (Fields, 2019; Reardon et al., 2001; Van den Broeck et al., 2018; World Bank, 2012). When the intensity of wage employment increases – either by increasing the number of wage employees in the household or by increasing the number of person-days employed – the positive welfare effects are robust. Moreover, we find that intensification of wage employment reduces poverty severity, indicating that even the poorest households benefit from wage employment.

The size of the welfare effect depends on the type of wage employment. On the one hand, we find that agricultural and casual wage employment more than double per capita income and reduce poverty and the poverty gap, even though employment conditions are inferior compared to non-agricultural and contractual wage employment. This contrasts with previous studies indicating that such employment does not add to household income and may trap people into poverty (Kerr, 2005; Scharf & Rahut, 2014). The positive results for agricultural wage employment corroborate other studies that find welfare-enhancing effects of wage employment on large-scale farms (Getahun & Villanger, 2018; Herrmann, 2017; Herrmann & Grote, 2015; Van den Broeck et al., 2017) and refute the idea that agricultural wage employment is an inferior activity that traps people in poverty (Matsumoto, Kijima, and Yamano 2006; Oya 2013; Deaton and Dreze 2002). We find that the likelihood of being food insecure reduces when households enter casual wage employment, and even more profoundly when the intensity of casual wage employment increases. As agricultural production in the study region is faced with a dry season, casual wage employment may bridge the period when smallholder self-employment activity is low and food insecurity is high, as demonstrated by Van den Broeck, Van Hoyweghen and Maertens (2018). On the other hand, non-agricultural and especially contractual wage employment involve higher

quality jobs, resulting in larger absolute income increases and reductions in poverty severity. Yet, agricultural, non-agricultural, casual and contractual wage employment reduce poverty and the poverty gap to the same extent. As the (casual) agricultural sector is the most important employer in our study region, this implies that (casual) agricultural wage employment matters more for poverty reduction than (contractual) non-agricultural wage employment. This is in line with a broader view on structural transformation that growth in agriculture is on average more rural welfare increasing than an equivalent amount of growth outside agriculture (Christiaensen & Martin, 2018).

The overall positive welfare effect of wage employment is a combination of a direct effect through wage income and an indirect effect through self-employment income. Our findings point to important linkages between wage employment and self-employment, which differ across employment sectors and employment status, and vary with employment dynamics.

Entry in agricultural and casual wage employment causes a sharp jump in wage income, while self-employment income does not decrease. As households with agricultural or casual wage employment are less endowed with productive assets (land and livestock) and have more members of working age, there is likely considerable unemployment and labour surplus within our sampled households before entering these types of wage employment, suggesting that competition for labour between wage and self-employment might be limited. When households continue agricultural or casual wage employment, they do not experience a further increase in wage income. This might be explained by stagnant wages and the casual nature of these jobs. However, their income from self-employment increases over time, which points to possible positive spillover effects between agricultural and casual wage employment on the one hand and self-employment on the other hand. Transmission mechanisms could be reduced liquidity constraints – increasing households' ability to make productive investments in agricultural or non-agricultural businesses – as well as knowledge spillover effects. Although such spillovers from wage employment to agricultural production have been documented before (Maertens, 2009; Oseni & Winters, 2009; Ruben & van den Berg,

2001), this evidence is relatively scant compared to the broad literature on farm-nonfarm linkages (e.g., Stampini and Davis, 2009; Takahashi and Otsuka, 2009; Anríquez and Daidone, 2010; Adjognon *et al.*, 2017; Amare and Shiferaw, 2017; Ayenew *et al.*, 2017). Our results demonstrate the importance of thinking beyond standard farm-nonfarm linkages and considering linkages between wage employment and self-employment as well, and call for further study of this issue.

Similar to agricultural wage employment, entry in non-agricultural wage employment is associated with a large jump in wage income. The positive shock is even larger, which relates to higher wages in the non-agricultural sector. Continued non-agricultural wage employment, in contrast to continued agricultural or casual wage employment, increases wage income further. This might be due to better employment conditions and/or households' intensification or specialization in wage employment. Households face a decrease in income from self-employment when entering non-agricultural wage employment. In addition, when households continue to be non-agricultural wage employed, income from self-employment does not recover from the downward shock. As these households are better educated compared to households who participate in agricultural wage employment, this suggests that households reallocate labour (or other productive capital) from farm or nonfarm enterprises to nonfarm wage employment and confirms that growth multiplier effects are stronger from the agricultural than from the non-agricultural sector (Christiaensen & Martin, 2018).

When entering contractual wage employment, after a large upward shock in wage income and a downward shock in self-employment income, there is no further increase in wage income for these households. There is however, an increase in self-employment income. This could mean that households reinvest wages in their own farm or nonfarm enterprises. However, more in-depth analysis on investments would be necessary before strong conclusions can be made.

7. Conclusion

In this article we unravel the role of wage employment in rural development. Based on a conceptual framework and using household survey data from Senegal and fixed effects and first-difference estimations, we reveal direct and indirect welfare effects of entry and continuation in different types of wage employment. The results point to substantial positive welfare and linkage effects: we find that participation in wage employment increases per capita income by 143%, and reduces poverty, poverty gap and food insecurity by respectively 63%, 89% and 48%. Non-agricultural and contractual wage employment lead to larger absolute increases in income, but also agricultural and casual wage employment, with lower wages and inferior employment conditions, more than double per capita income and reduce poverty more than half. While the direct effect on income is larger for non-agricultural and contractual wage employment, the indirect income effects through self-employment are more pronounced for agricultural and casual wage employment. In addition, continued agricultural wage employment leads to the largest absolute positive spillover effects on income from self-employment. The results suggest that entry in non-agricultural and contractual wage employment competes for labour with self-employment activities, while this is not the case for entry in agricultural and casual wage employment.

Care is needed in generalizing results as they cover a relatively short period (three years) and are derived from a particular research area with a booming high-value horticultural export sector. In comparison to other African countries, a large share of household income in the research area is derived from agricultural wage employment (B. Davis, Di Giuseppe, & Zezza, 2014) and casual employment is rather stable with average employment periods of seven months per year. The welfare implications of rural wage employment may differ for a longer time horizon and for regions where competition for labour is higher or employment conditions worse.

Nevertheless, our results imply that job creation contributes importantly to upward income mobility, and poverty and food security reduction in rural areas. The development of a rural labour market does not only result in direct income gains from wages but can also increase labour productivity in smallholder farm (and nonfarm)

enterprises. We show that the agricultural sector, with mainly casual jobs in large-scale agro-industries, is particularly important as a source of job creation, in reducing rural poverty and food insecurity, and creating positive investment spillover effects on the smallholder sector. This is in line with the view on structural transformation that stresses the importance of agriculture in creating growth multiplier effects (Christiaensen & Martin, 2018). Our findings support the notion that substantial synergies exist between small-scale and large-scale farms (Deininger & Xia, 2016; Van den Broeck et al., 2017), which calls for moving beyond the either-or rhetoric in the debate on the future of small-scale farming and for more attention to agricultural wage employment in data collection, research and policy. Our findings suggest that wages reduce liquidity constraints and could enable rural households to invest in small-scale farm (and nonfarm) businesses. This suggests that (casual) jobs can be a substitute for micro-credit – which is sometimes inaccessible and even harmful for the poorest (Adjognon, Liverpool-Tasie, & Reardon, 2017; Ellis, 2000; Hossain, Malek, Hossain, Reza, & Ahmed, 2019; Van Rooyen, Stewart, & De Wet, 2012) – and opens further research and policy questions on the allocation of agricultural credit to the agribusiness versus the smallholder sector.

8. Appendix

Table A1: Summary of Employment Classification for Agricultural / Non-agricultural and Casual / Contractual Wage Employment in Differencing Technique

	Classification	Dummy equals one when:
Dynamics in agricultural / non-agricultural wage employment		
0/	Never wage employed (base category)	No member is wage employed in 2013 and 2016
1/	Agricultural wage employment entry	No member is wage employed in 2013, all wage employed members have agricultural wage employment in 2016
2/	Continued agricultural wage employment	All wage employed members have agricultural wage employment, both in 2013 and 2016
3/	Non-agricultural wage employment entry	No member is wage employed in 2013, at least one wage employed member has non-agricultural wage employment in 2016
4/	Continued non-agricultural wage employment	At least one wage employed member has non-agricultural wage employment, both in 2013 and 2016
5/	Agricultural to non-agricultural wage employment transition	All wage employed members have agricultural wage employment in 2013, at least one wage employed member has non-agricultural wage employment in 2016
6/	Non-agricultural to agricultural wage employment transition	At least one wage employed member has non-agricultural wage employment in 2013, all wage employed members have agricultural wage employment in 2016
7/	Agricultural wage employment exit	All wage employed members have agricultural wage employment in 2013, no member is wage employed in 2016
8/	Non-agricultural wage employment exit	At least one wage employed member has non-agricultural wage employment in 2013, no member is wage employed in 2016
Dynamics in casual / contractual wage employment		
0/	Never wage employed (base category)	No member is wage employed in 2013 and 2016
1/	Casual wage employment entry	No member is wage employed in 2013, all wage employed members have casual wage employment in 2016
2/	Continued casual wage employment	All wage employed members have casual wage employment, both in 2013 and 2016

3/	Contractual wage employment entry	No member is wage employed in 2013, at least one wage employed member has contractual wage employment in 2016
4/	Continued contractual wage employment	At least one wage employed member has contractual wage employment, both in 2013 and 2016
5/	Casual to contractual wage employment transition	All wage employed members have casual wage employment in 2013, at least one wage employed member has contractual wage employment in 2016
6/	Contractual to casual wage employment transition	At least one wage employed member has contractual wage employment in 2013, all wage employed members have casual wage employment in 2016
7/	Casual wage employment exit	All wage employed members have casual wage employment in 2013, no member is wage employed in 2016
8/	Contractual wage employment exit	At least one wage employed member has contractual wage employment in 2013, no member is wage employed in 2016

Table A2: Results of Fixed Effects Regressions Estimating the Impact of Entry Into Wage Employment on Income, Poverty (Headcount, Gap and Severity) and Food Insecurity

	Income	Log(Income)	Poverty headcount	Poverty gap	Poverty severity	Food insecurity
Wage employment	164.69**	1.43**	-0.20**	-0.16***	-0.07	-0.24***
	(63.45)	(0.65)	(0.07)	(0.05)	(0.09)	(0.09)
Age household head	2.59	0.05	-0.00	-0.00	-0.00	-0.00
	(3.61)	(0.03)	(0.01)	(0.00)	(0.00)	(0.00)
Female household head	308.45**	0.76	-0.24	0.01	0.06	-0.47
	(125.17)	(0.61)	(0.17)	(0.08)	(0.07)	(0.29)
Household head married	2.73	-0.29	0.17	0.12	0.10	-0.11
	(170.87)	(0.76)	(0.19)	(0.11)	(0.11)	(0.22)
Household head finished primary education	-9.73	-0.16	0.05	0.01	0.02	0.01
	(96.97)	(0.41)	(0.09)	(0.05)	(0.05)	(0.09)
Household head finished secondary education	161.13	-0.01	-0.05	-0.01	0.02	-0.06
	(153.96)	(0.47)	(0.18)	(0.12)	(0.09)	(0.17)
Number of working age members	4.16	-0.05	-0.01	0.00	0.00	0.02
	(19.61)	(0.07)	(0.02)	(0.01)	(0.01)	(0.02)
Number of dependent members	-10.64	0.06	-0.00	-0.01	-0.01	-0.01
	(14.18)	(0.09)	(0.02)	(0.01)	(0.01)	(0.03)
Share literate working age members	4.02	-1.17	-0.02	0.03	0.05	-0.12
	(123.64)	(1.03)	(0.09)	(0.07)	(0.09)	(0.15)
Total landholdings	8.25	0.01	-0.02	-0.01	-0.00	0.00
	(9.49)	(0.04)	(0.02)	(0.01)	(0.01)	(0.01)

(Total landholdings)^2	-0.14	-0.00	0.00	0.00	0.00	0.00
	(0.14)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Tropical livestock units	3.71	0.04*	-0.01**	-0.00	0.00	-0.01
	(4.04)	(0.03)	(0.00)	(0.00)	(0.01)	(0.00)
(Tropical livestock units)^2	-0.01	-0.00*	0.00**	0.00	-0.00	0.00
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Motorised vehicle	-50.33	0.41	-0.05	-0.06	-0.06	0.14
	(42.02)	(0.35)	(0.14)	(0.06)	(0.05)	(0.10)
Membership organisation	84.82	0.20	-0.10	-0.05	-0.01	0.00
	(89.65)	(0.37)	(0.14)	(0.06)	(0.04)	(0.08)
2016	-100.90**	-0.37	0.07	0.01	0.04	0.05
	(43.64)	(0.29)	(0.05)	(0.03)	(0.03)	(0.05)
Village-year fixed effects	Included	Included	Included	Included	Included	Included
Constant	203.88	8.98***	0.82*	0.46*	0.27	0.83**
	(308.08)	(2.45)	(0.45)	(0.25)	(0.24)	(0.35)
R^2 within	0.17	0.19	0.21	0.20	0.09	0.26
R^2 between	0.04	0.04	0.04	0.06	0.07	0.00
N	922	922	922	922	922	922

Notes: Significant coefficients are indicated with * $p < 0.1$. ** $p < 0.05$ or *** $p < 0.01$. Standard errors are clustered at the village level and reported between parentheses. Income is specified in 1,000 FCFA and refers to income per adult equivalent.

Table A3: Results of Fixed Effects Regressions Estimating the Impact of Entry Into Agricultural and Non-agricultural Wage Employment on Income, Poverty (Headcount, Gap and Severity) and Food Insecurity

	Income	Log(Income)	Poverty headcount	Poverty gap	Poverty severity	Food insecurity
Agricultural wage employment	130.92	1.55*	-0.17**	-0.11*	-0.02	-0.13
	(86.41)	(0.80)	(0.08)	(0.05)	(0.12)	(0.08)
Non-agricultural wage employment	148.43**	0.26	-0.18**	-0.11***	-0.07**	-0.24**
	(65.37)	(0.23)	(0.07)	(0.03)	(0.03)	(0.09)
Age household head	2.23	0.04	-0.00	-0.00	-0.00	-0.00
	(3.58)	(0.03)	(0.01)	(0.00)	(0.00)	(0.00)
Female household head	251.82*	0.53	-0.17	0.06	0.09	-0.39
	(138.02)	(0.63)	(0.18)	(0.08)	(0.07)	(0.23)
Household head married	-0.56	-0.19	0.18	0.12	0.10	-0.10
	(171.63)	(0.82)	(0.20)	(0.11)	(0.11)	(0.20)
Household head finished primary education	-18.51	-0.19	0.06	0.02	0.03	0.03
	(100.97)	(0.42)	(0.09)	(0.05)	(0.05)	(0.09)
Household head finished secondary education	158.77	0.10	-0.05	-0.00	0.03	-0.04
	(156.14)	(0.42)	(0.17)	(0.11)	(0.09)	(0.18)
Number of working age members	-0.15	-0.04	-0.01	0.01	0.01	0.03
	(19.56)	(0.07)	(0.02)	(0.01)	(0.01)	(0.02)
Number of dependent members	-9.50	0.07	-0.01	-0.01	-0.01	-0.01
	(13.94)	(0.09)	(0.02)	(0.01)	(0.01)	(0.03)
Share literate working age members	17.58	-1.10	-0.04	0.01	0.04	-0.14
	(119.26)	(1.01)	(0.09)	(0.07)	(0.09)	(0.14)

Total landholdings	7.03	0.01	-0.02	-0.01	-0.00	0.00
	(9.56)	(0.04)	(0.02)	(0.01)	(0.01)	(0.01)
(Total landholdings)^2	-0.12	0.00	0.00	0.00	0.00	0.00
	(0.14)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Tropical livestock units	3.34	0.05*	-0.01*	-0.00	0.00	-0.00
	(4.17)	(0.03)	(0.00)	(0.00)	(0.01)	(0.00)
(Tropical livestock units)^2	-0.01	-0.00**	0.00**	0.00	-0.00	0.00
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Motorised vehicle	-39.69	0.37	-0.07	-0.07	-0.07	0.12
	(43.75)	(0.35)	(0.15)	(0.07)	(0.05)	(0.10)
Membership organisation	88.75	0.10	-0.10	-0.05	-0.02	-0.00
	(92.84)	(0.36)	(0.14)	(0.06)	(0.04)	(0.07)
2016	-57.52	-0.41*	0.02	-0.02	0.02	-0.03
	(48.95)	(0.22)	(0.06)	(0.03)	(0.03)	(0.06)
Village-year fixed effects	Included	Included	Included	Included	Included	Included
Constant	245.73	9.09***	0.78*	0.41	0.23	0.74**
	(305.48)	(2.43)	(0.44)	(0.24)	(0.24)	(0.30)
R^2 within	0.18	0.19	0.22	0.20	0.09	0.27
R^2 between	0.06	0.03	0.04	0.05	0.06	0.00
N	922	922	922	922	922	922

Notes: Significant coefficients are indicated with * p < 0.1. ** p < 0.05 or *** p < 0.01. Standard errors are clustered at the village level and reported between parentheses. Income is specified in 1,000 FCFA and refers to income per adult equivalent.

Table A4: Results of Fixed Effects Regressions Estimating the Impact of Entry Into Casual and Contractual Wage Employment on Income, Poverty (Headcount, Gap and Severity) and Food Insecurity

	Income	Log(Income)	Poverty headcount	Poverty gap	Poverty severity	Food insecurity
Casual wage employment	111.95	1.30**	-0.18*	-0.15**	-0.08	-0.24**
	(89.34)	(0.61)	(0.09)	(0.05)	(0.08)	(0.10)
Contractual wage employment	197.56***	0.53***	-0.18***	-0.11***	-0.08**	-0.13
	(59.04)	(0.18)	(0.06)	(0.04)	(0.03)	(0.11)
Age household head	2.43	0.05	-0.01	-0.00	-0.00	-0.01
	(3.58)	(0.03)	(0.01)	(0.00)	(0.00)	(0.00)
Female household head	262.03*	0.65	-0.20	0.04	0.07	-0.45*
	(135.09)	(0.61)	(0.18)	(0.09)	(0.08)	(0.26)
Household head married	-36.09	-0.19	0.20	0.13	0.11	-0.11
	(166.83)	(0.83)	(0.20)	(0.12)	(0.11)	(0.21)
Household head finished primary education	-12.84	-0.15	0.04	0.00	0.02	0.00
	(101.64)	(0.40)	(0.09)	(0.05)	(0.05)	(0.09)
Household head finished secondary education	160.15	0.02	-0.05	-0.01	0.02	-0.07
	(155.16)	(0.42)	(0.18)	(0.12)	(0.09)	(0.17)
Number of working age members	-1.09	-0.05	-0.01	0.01	0.01	0.03
	(20.29)	(0.07)	(0.02)	(0.01)	(0.01)	(0.02)
Number of dependent members	-10.38	0.08	-0.01	-0.01	-0.01	-0.01
	(13.26)	(0.10)	(0.02)	(0.01)	(0.01)	(0.03)
Share literate working age members	38.88	-1.19	-0.05	0.02	0.04	-0.12
	(116.87)	(1.12)	(0.09)	(0.07)	(0.10)	(0.16)

Total landholdings	8.69	-0.01	-0.02	-0.01	-0.00	0.00
	(9.74)	(0.05)	(0.02)	(0.01)	(0.01)	(0.01)
(Total landholdings)^2	-0.14	0.00	0.00	0.00	0.00	0.00
	(0.15)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Tropical livestock units	3.33	0.04*	-0.01*	-0.00	0.00	-0.01
	(3.95)	(0.02)	(0.00)	(0.00)	(0.01)	(0.00)
(Tropical livestock units)^2	-0.01	-0.00*	0.00**	0.00	-0.00	0.00
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Motorised vehicle	-47.12	0.34	-0.05	-0.05	-0.06	0.15
	(41.06)	(0.32)	(0.14)	(0.06)	(0.05)	(0.10)
Membership organisation	86.78	0.09	-0.09	-0.04	-0.01	0.02
	(93.49)	(0.36)	(0.14)	(0.07)	(0.04)	(0.08)
2016	-99.44**	-0.28	0.06	0.00	0.03	0.03
	(43.33)	(0.34)	(0.05)	(0.03)	(0.03)	(0.05)
Village-year fixed effects	Included	Included	Included	Included	Included	Included
Constant	244.11	9.17***	0.80*	0.44*	0.27	0.82**
	(305.45)	(2.37)	(0.44)	(0.25)	(0.23)	(0.33)
R^2 within	0.19	0.19	0.22	0.21	0.09	0.26
R^2 between	0.06	0.03	0.05	0.06	0.07	0.00
N	922	922	922	922	922	922

Notes: Significant coefficients are indicated with * p < 0.1. ** p < 0.05 or *** p < 0.01. Standard errors are clustered at the village level and reported between parentheses. Income is specified in 1,000 FCFA and refers to income per adult equivalent.

Table A5: Results of Fixed Effects Regressions Estimating the Impact of the Number of Wage Employees on Income, Poverty (Headcount, Gap and Severity) and Food Insecurity

	Income	Log(Income)	Poverty headcount	Poverty gap	Poverty severity	Food insecurity
Wage employees	86.66***	0.34***	-0.09***	-0.05***	-0.03**	-0.07*
	(23.20)	(0.12)	(0.03)	(0.02)	(0.01)	(0.03)
Age household head	3.01	0.04	-0.01	-0.00	-0.00	-0.00
	(3.22)	(0.03)	(0.00)	(0.00)	(0.00)	(0.00)
Female household head	301.82**	0.63	-0.23	0.03	0.06	-0.46
	(124.31)	(0.58)	(0.17)	(0.08)	(0.07)	(0.30)
Household head married	33.12	-0.02	0.14	0.09	0.09	-0.15
	(159.81)	(0.82)	(0.19)	(0.11)	(0.11)	(0.24)
Household head finished primary education	10.13	-0.19	0.03	0.00	0.01	0.01
	(101.20)	(0.48)	(0.10)	(0.06)	(0.05)	(0.10)
Household head finished secondary education	179.05	-0.04	-0.06	-0.01	0.02	-0.06
	(150.55)	(0.49)	(0.17)	(0.12)	(0.09)	(0.19)
Number of working age members	-19.87	-0.11	0.01	0.02*	0.01*	0.04*
	(15.73)	(0.08)	(0.02)	(0.01)	(0.01)	(0.02)
Number of dependent members	-9.13	0.07	-0.01	-0.01	-0.01	-0.01
	(14.16)	(0.09)	(0.02)	(0.01)	(0.01)	(0.02)
Share literate working age members	-5.79	-1.18	-0.02	0.03	0.05	-0.11
	(118.70)	(1.07)	(0.09)	(0.07)	(0.09)	(0.15)
Total landholdings	7.04	-0.00	-0.02	-0.01	-0.00	0.00
	(10.66)	(0.05)	(0.02)	(0.01)	(0.01)	(0.01)

(Total landholdings)^2	-0.13	0.00	0.00	0.00	0.00	0.00
	(0.16)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Tropical livestock units	3.74	0.04	-0.01*	-0.00	0.00	-0.01
	(3.91)	(0.03)	(0.00)	(0.00)	(0.01)	(0.00)
(Tropical livestock units)^2	-0.01	-0.00*	0.00**	0.00	-0.00	0.00
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Motorised vehicle	-35.07	0.47	-0.07	-0.07	-0.07	0.13
	(46.58)	(0.36)	(0.15)	(0.07)	(0.05)	(0.10)
Membership organisation	103.13	0.18	-0.11	-0.05	-0.02	0.00
	(87.06)	(0.34)	(0.14)	(0.06)	(0.04)	(0.08)
2016	12.55	0.01	-0.04	-0.06	-0.00	-0.03
	(53.54)	(0.41)	(0.06)	(0.04)	(0.04)	(0.05)
Village-year fixed effects	Included	Included	Included	Included	Included	Included
Constant	237.83	9.69***	0.77*	0.40*	0.25	0.73**
	(296.49)	(2.21)	(0.42)	(0.23)	(0.20)	(0.30)
R^2 within						
R^2 between	0.21	0.17	0.23	0.20	0.09	0.25
N	922	922	922	922	922	922

Notes: Significant coefficients are indicated with * p < 0.1. ** p < 0.05 or *** p < 0.01. Standard errors are clustered at the village level and reported between parentheses. Income is specified in 1,000 FCFA and refers to income per adult equivalent.

Table A6: Results of Fixed Effects Regressions Estimating the Impact of the Number of Agricultural and Non-agricultural Wage Employees on Income, Poverty (Headcount, Gap and Severity) and Food Insecurity

	Income	Log(Income)	Poverty headcount	Poverty gap	Poverty severity	Food insecurity
Agricultural wage employees	61.31***	0.39**	-0.08**	-0.06**	-0.03*	-0.06
	(20.97)	(0.16)	(0.03)	(0.02)	(0.02)	(0.04)
Non-agricultural wage employees	137.97***	0.23*	-0.10**	-0.05**	-0.03*	-0.08
	(42.16)	(0.13)	(0.04)	(0.03)	(0.02)	(0.07)
Age household head	2.81	0.04	-0.01	-0.00	-0.00	-0.00
	(3.37)	(0.03)	(0.00)	(0.00)	(0.00)	(0.00)
Female household head	294.12**	0.65	-0.23	0.03	0.06	-0.45
	(123.92)	(0.58)	(0.16)	(0.08)	(0.07)	(0.29)
Household head married	28.71	-0.01	0.14	0.09	0.09	-0.15
	(155.18)	(0.82)	(0.19)	(0.11)	(0.11)	(0.23)
Household head finished primary education	1.86	-0.17	0.03	0.00	0.01	0.01
	(99.90)	(0.47)	(0.10)	(0.06)	(0.05)	(0.10)
Household head finished secondary education	159.45	-0.00	-0.06	-0.01	0.02	-0.05
	(148.80)	(0.46)	(0.17)	(0.11)	(0.09)	(0.19)
Number of working age members	-19.59	-0.11	0.01	0.02*	0.01*	0.04*
	(16.94)	(0.08)	(0.02)	(0.01)	(0.01)	(0.02)
Number of dependent members	-8.57	0.07	-0.01	-0.01	-0.01	-0.01
	(13.90)	(0.09)	(0.02)	(0.01)	(0.01)	(0.02)
Share literate working age members	-7.06	-1.18	-0.01	0.03	0.05	-0.11
	(113.57)	(1.06)	(0.09)	(0.07)	(0.09)	(0.15)

Total landholdings	7.49	-0.00	-0.02	-0.01	-0.00	0.00
	(10.25)	(0.05)	(0.02)	(0.01)	(0.01)	(0.01)
(Total landholdings)^2	-0.14	0.00	0.00	0.00	0.00	0.00
	(0.15)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Tropical livestock units	2.97	0.04	-0.01*	-0.00	0.00	-0.01
	(3.72)	(0.03)	(0.00)	(0.00)	(0.01)	(0.00)
(Tropical livestock units)^2	-0.01	-0.00*	0.00**	0.00	-0.00	0.00
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Motorised vehicle	-29.85	0.46	-0.07	-0.07	-0.07	0.13
	(46.90)	(0.36)	(0.15)	(0.07)	(0.05)	(0.10)
Membership organisation	107.07	0.17	-0.11	-0.05	-0.02	0.00
	(87.40)	(0.34)	(0.14)	(0.06)	(0.04)	(0.08)
2016	72.66	-0.12	-0.06	-0.05	-0.01	-0.05
	(74.79)	(0.36)	(0.09)	(0.05)	(0.04)	(0.10)
Village-year fixed effects	Included	Included	Included	Included	Included	Included
Constant	253.97	9.66***	0.76*	0.40*	0.25	0.72**
	(301.15)	(2.21)	(0.42)	(0.23)	(0.21)	(0.29)
R^2 within	0.21	0.17	0.23	0.20	0.09	0.25
R^2 between	0.08	0.03	0.05	0.05	0.07	0.00
N	922	922	922	922	922	922

Notes: Significant coefficients are indicated with * p < 0.1. ** p < 0.05 or *** p < 0.01. Standard errors are clustered at the village level and reported between parentheses. Income is specified in 1,000 FCFA and refers to income per adult equivalent.

Table A7: Results of Fixed Effects Regressions Estimating the Impact of the Number of Casual and Contracted Wage Employees on Income, Poverty (Headcount, Gap and Severity) and Food Insecurity

	Income	Log(Income)	Poverty headcount	Poverty gap	Poverty severity	Food insecurity
Casual wage employees	79.57***	0.39**	-0.10***	-0.06**	-0.04**	-0.08***
	(24.48)	(0.15)	(0.03)	(0.02)	(0.02)	(0.03)
Contracted wage	104.08***	0.19*	-0.07**	-0.04**	-0.03**	-0.04
employees	(31.16)	(0.11)	(0.03)	(0.02)	(0.01)	(0.07)
Age household head	2.97	0.04	-0.01	-0.00	-0.00	-0.00
	(3.27)	(0.03)	(0.00)	(0.00)	(0.00)	(0.00)
Female household head	288.60**	0.74	-0.25	0.02	0.06	-0.48
	(122.26)	(0.59)	(0.16)	(0.08)	(0.07)	(0.29)
Household head married	20.86	0.09	0.12	0.09	0.08	-0.17
	(157.17)	(0.83)	(0.19)	(0.11)	(0.11)	(0.23)
Household head finished	8.27	-0.17	0.03	0.00	0.01	0.01
primary education	(104.16)	(0.47)	(0.10)	(0.06)	(0.05)	(0.10)
Household head finished	175.96	-0.02	-0.07	-0.01	0.02	-0.06
secondary education	(151.73)	(0.46)	(0.17)	(0.12)	(0.09)	(0.18)
Number of working age	-20.45	-0.10	0.01	0.02*	0.01*	0.04*
members	(15.83)	(0.08)	(0.02)	(0.01)	(0.01)	(0.02)
Number of dependent	-8.87	0.07	-0.01	-0.01	-0.01	-0.01
members	(13.95)	(0.09)	(0.02)	(0.01)	(0.01)	(0.02)
Share literate working	6.63	-1.29	0.00	0.04	0.06	-0.09
age members	(121.04)	(1.12)	(0.10)	(0.08)	(0.09)	(0.16)

Total landholdings	7.27	-0.01	-0.02	-0.01	-0.00	0.00
	(10.67)	(0.05)	(0.02)	(0.01)	(0.01)	(0.01)
(Total landholdings)^2	-0.13	0.00	0.00	0.00	0.00	0.00
	(0.16)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Tropical livestock units	3.83	0.04	-0.01*	-0.00	0.00	-0.01
	(3.91)	(0.03)	(0.00)	(0.00)	(0.01)	(0.00)
(Tropical livestock units)^2	-0.01	-0.00*	0.00**	0.00	-0.00	0.00
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Motorised vehicle	-33.99	0.46	-0.07	-0.07	-0.07	0.13
	(46.53)	(0.36)	(0.15)	(0.07)	(0.05)	(0.10)
Membership organisation	103.64	0.17	-0.11	-0.05	-0.02	0.00
	(90.02)	(0.32)	(0.14)	(0.06)	(0.04)	(0.08)
2016	22.37	-0.08	-0.03	-0.05	-0.00	-0.01
	(55.25)	(0.38)	(0.07)	(0.04)	(0.04)	(0.06)
Village-year fixed effects	Included	Included	Included	Included	Included	Included
Constant	240.02	9.67***	0.77*	0.40*	0.25	0.73**
	(298.59)	(2.19)	(0.42)	(0.23)	(0.20)	(0.30)
R^2 within	0.21	0.18	0.23	0.21	0.10	0.26
R^2 between	0.08	0.02	0.05	0.05	0.06	0.00
N	922	922	922	922	922	922

Notes: Significant coefficients are indicated with * p < 0.1. ** p < 0.05 or *** p < 0.01. Standard errors are clustered at the village level and reported between parentheses. Income is specified in 1,000 FCFA and refers to income per adult equivalent.

Table A8: Results of Fixed Effects Regressions Estimating the Impact of Person-days Wage Employed on Income, Poverty (Headcount, Gap and Severity) and Food Insecurity

	Income	Log(Income)	Poverty headcount	Poverty gap	Poverty severity	Food insecurity
Wage employed	0.46427***	0.00128***	-0.00045***	-0.00024***	-0.00015***	-0.00025*
	(0.10717)	(0.00035)	(0.00012)	(0.00006)	(0.00005)	(0.00015)
Age household head	3.16611	0.03959	-0.00521	-0.00320	-0.00259	-0.00401
	(3.20872)	(0.03207)	(0.00481)	(0.00305)	(0.00262)	(0.00295)
Female household head	270.47627**	0.53052	-0.19993	0.04361	0.07287	-0.43577
	(126.35625)	(0.55466)	(0.16381)	(0.07427)	(0.07175)	(0.28987)
Household head married	-11.10514	-0.13580	0.17849	0.11600	0.10136	-0.12978
	(156.86412)	(0.81707)	(0.19285)	(0.10913)	(0.11051)	(0.22643)
Household head finished primary education	37.69070	-0.15967	0.00467	-0.00793	0.00712	0.00184
	(99.25292)	(0.51999)	(0.10583)	(0.06000)	(0.05126)	(0.10034)
Household head finished secondary education	179.31771	-0.08725	-0.06008	-0.00811	0.02068	-0.04804
	(145.61162)	(0.52122)	(0.17087)	(0.11538)	(0.09156)	(0.18026)
Number of working age members	-22.90617	-0.08002	0.01086	0.01516	0.01266*	0.03174
	(16.24691)	(0.06406)	(0.01690)	(0.00906)	(0.00674)	(0.02114)
Number of dependent members	-8.66163	0.07542	-0.00601	-0.01227	-0.01181	-0.00775
	(13.95856)	(0.09222)	(0.01898)	(0.00912)	(0.00766)	(0.02424)
Share literate working age members	-4.19868	-1.16279	-0.01774	0.02736	0.04835	-0.11475
	(118.14222)	(1.08934)	(0.08949)	(0.07587)	(0.09077)	(0.14631)
Total landholdings	4.02766	-0.01195	-0.01562	-0.00628	-0.00313	0.00365
	(9.27909)	(0.03980)	(0.01631)	(0.00855)	(0.00599)	(0.00981)

(Total landholdings)^2	-0.10162	0.00010	0.00037	0.00017	0.00010	0.00013
	(0.14042)	(0.00054)	(0.00026)	(0.00014)	(0.00009)	(0.00017)
Tropical livestock units	3.10374	0.04076	-0.00702*	-0.00363	0.00377	-0.00489
	(3.70447)	(0.02609)	(0.00395)	(0.00347)	(0.00921)	(0.00343)
(Tropical livestock units)^2	-0.00647	-0.00010*	0.00002*	0.00001	-0.00001	0.00001
	(0.00752)	(0.00005)	(0.00001)	(0.00001)	(0.00002)	(0.00001)
Motorised vehicle	-40.85580	0.43411	-0.06318	-0.06399	-0.06518	0.13846
	(43.35615)	(0.36598)	(0.14165)	(0.06432)	(0.04817)	(0.09886)
Membership organisation	98.00168	0.12243	-0.10615	-0.04720	-0.01500	0.01394
	(78.14085)	(0.31134)	(0.13129)	(0.05734)	(0.03628)	(0.08096)
2016	22.91714	-0.10885	-0.04660	-0.04598	-0.00110	-0.00912
	(51.62515)	(0.28724)	(0.05111)	(0.03304)	(0.02858)	(0.06000)
Village-year fixed effects	Included	Included	Included	Included	Included	Included
Constant	287.16044	9.92143***	0.71129	0.36102	0.23120	0.68144**
	(304.51946)	(2.25107)	(0.42154)	(0.22584)	(0.20089)	(0.30538)
R^2 within	0.23	0.17	0.24	0.20	0.10	0.25
R^2 between	0.09	0.03	0.07	0.06	0.07	0.00
N	922	922	922	922	922	922

Notes: Significant coefficients are indicated with * $p < 0.1$. ** $p < 0.05$ or *** $p < 0.01$. Standard errors are clustered at the village level and reported between parentheses. Income is specified in 1,000 FCFA and refers to income per adult equivalent.

Table A9: Results of Fixed Effects Regressions Estimating the Impact of Person-days Agricultural and Non-agricultural Wage Employed on Income, Poverty (Headcount, Gap and Severity) and Food Insecurity

	Income	Log(Income)	Poverty headcount	Poverty gap	Poverty severity	Food insecurity
Agricultural wage employed	0.41217***	0.00162***	-0.00049***	-0.00028***	-0.00019***	-0.00023
	(0.11544)	(0.00041)	(0.00016)	(0.00008)	(0.00006)	(0.00017)
Non-agricultural wage employed	0.51412***	0.00096**	-0.00042***	-0.00019**	-0.00012*	-0.00028
	(0.14853)	(0.00040)	(0.00015)	(0.00007)	(0.00006)	(0.00025)
Age household head	3.02840	0.04048	-0.00531	-0.00332	-0.00269	-0.00395
	(3.29148)	(0.03200)	(0.00483)	(0.00309)	(0.00265)	(0.00290)
Female household head	269.50499**	0.53682	-0.20059	0.04277	0.07211	-0.43532
	(126.20289)	(0.55413)	(0.16430)	(0.07499)	(0.07191)	(0.28842)
Household head married	-14.01554	-0.11694	0.17651	0.1135	0.09909	-0.12841
	(156.70092)	(0.81870)	(0.19195)	(0.10870)	(0.10991)	(0.22495)
Household head finished primary education	34.98695	-0.14215	0.00283	-0.01025	0.00501	0.00311
	(100.04232)	(0.51892)	(0.10553)	(0.06142)	(0.05253)	(0.09979)
Household head finished secondary education	175.36318	-0.06162	-0.06276	-0.0115	0.0176	-0.04618
	(144.57521)	(0.51062)	(0.16971)	(0.11535)	(0.09152)	(0.18374)
Number of working age members	-21.60818	-0.08843	0.01174	0.01628*	0.01367**	0.03113
	(16.53173)	(0.06133)	(0.01667)	(0.00837)	(0.00625)	(0.02084)
Number of dependent members	-8.58790	0.07495	-0.00596	-0.01221	-0.01175	-0.00779
	(13.87596)	(0.09215)	(0.01905)	(0.00916)	(0.00766)	(0.02441)
Share literate working age members	-5.30676	-1.15561	-0.01850	0.02641	0.04749	-0.11423
	(118.20224)	(1.08556)	(0.09078)	(0.07601)	(0.09046)	(0.14638)

Total landholdings	3.71151	-0.00990	-0.01584	-0.00655	-0.00338	0.00379
	(9.19343)	(0.04113)	(0.01677)	(0.00887)	(0.00620)	(0.01010)
(Total landholdings)^2	-0.09576	0.00006	0.00037	0.00018	0.0001	0.00012
	(0.13953)	(0.00056)	(0.00026)	(0.00014)	(0.00010)	(0.00017)
Tropical livestock units	2.94828	0.04177	-0.00713*	-0.00377	0.00364	-0.00482
	(3.65335)	(0.02602)	(0.00394)	(0.00344)	(0.00925)	(0.00338)
(Tropical livestock units)^2	-0.00619	-0.00010*	0.00002**	0.00001	-0.00000	0.00001
	(0.00744)	(0.00005)	(0.00001)	(0.00001)	(0.00002)	(0.00001)
Motorised vehicle	-38.49087	0.41879	-0.06157	-0.06197	-0.06334	0.13735
	(43.07933)	(0.36212)	(0.14248)	(0.06434)	(0.04786)	(0.09942)
Membership organisation	94.92664	0.14235	-0.10824	-0.04984	-0.0174	0.01538
	(78.16342)	(0.31407)	(0.13546)	(0.05933)	(0.03735)	(0.07905)
2016	33.39676	-0.17675	-0.03948	-0.037	0.00706	-0.01403
	(59.91304)	(0.27525)	(0.06313)	(0.03555)	(0.02972)	(0.08217)
Village-year fixed effects	Included	Included	Included	Included	Included	Included
Constant	296.29737	9.86223***	0.71750*	0.36884	0.23832	0.67716**
	(309.77353)	(2.24958)	(0.42255)	(0.22715)	(0.20182)	(0.29573)
R^2 within	0.23	0.17	0.24	0.20	0.10	0.25
R^2 between	0.10	0.03	0.08	0.06	0.07	0.00
N	922	922	922	922	922	922

Notes: Significant coefficients are indicated with * p < 0.1. ** p < 0.05 or *** p < 0.01. Standard errors are clustered at the village level and reported between parentheses. Income is specified in 1,000 FCFA and refers to income per adult equivalent.

Table A10: Results of Fixed Effects Regressions Estimating the Impact of Person-days Casual and Contractual Wage Employed on Income, Poverty (Headcount, Gap and Severity) and Food Insecurity

	Income	Log(Income)	Poverty	Poverty gap	Poverty severity	Food insecurity
Casual wage employed	0.43754***	0.00165***	-0.00052***	-0.00028***	-0.00020**	-0.00046***
	(0.13044)	(0.00049)	(0.00015)	(0.00010)	(0.00007)	(0.00010)
Contractual wage employed	0.49232***	0.00089**	-0.00039***	-0.00019***	-0.00011**	-0.00004
	(0.13914)	(0.00038)	(0.00013)	(0.00005)	(0.00004)	(0.00026)
Age household head	3.08809	0.04068	-0.0054	-0.00332	-0.00271	-0.00461
	(3.27642)	(0.03196)	(0.00480)	(0.00306)	(0.00263)	(0.00276)
Female household head	264.15272**	0.61875	-0.21521	0.03361	0.06274	-0.48444
	(123.10184)	(0.55585)	(0.15960)	(0.07501)	(0.07194)	(0.29428)
Household head married	-15.7629	-0.07081	0.16724	0.10863	0.0939	-0.16563
	(155.98708)	(0.82028)	(0.18777)	(0.10626)	(0.10851)	(0.22803)
Household head finished primary education	35.04856	-0.12281	-0.00172	-0.01211	0.00288	-0.01849
	(102.14278)	(0.50254)	(0.10634)	(0.06181)	(0.05232)	(0.09602)
Household head finished secondary education	177.0652	-0.05582	-0.06552	-0.01167	0.01707	-0.06537
	(146.75575)	(0.49851)	(0.17014)	(0.11528)	(0.09062)	(0.17951)
Number of working age members	-22.811	-0.08135	0.01109	0.01531*	0.01281*	0.03247
	(16.24830)	(0.06531)	(0.01693)	(0.00898)	(0.00676)	(0.01946)
Number of dependent members	-8.53842	0.07371	-0.00571	-0.01208	-0.01161	-0.0068
	(13.85031)	(0.09268)	(0.01950)	(0.00946)	(0.00780)	(0.02226)
Share literate working age members	1.78947	-1.24634	-0.00328	0.03683	0.05794	-0.06866
	(121.58532)	(1.11773)	(0.09322)	(0.07881)	(0.09373)	(0.15650)

Total landholdings	3.8865	-0.00998	-0.01596	-0.0065	-0.00336	0.00256
	(9.05502)	(0.04002)	(0.01659)	(0.00863)	(0.00600)	(0.01005)
(Total landholdings)^2	-0.09739	0.00004	0.00038	0.00018	0.0001	0.00016
	(0.13641)	(0.00054)	(0.00026)	(0.00014)	(0.00010)	(0.00017)
Tropical livestock units	3.13547	0.04032	-0.00694*	-0.00358	0.00382	-0.00465
	(3.68904)	(0.02546)	(0.00388)	(0.00342)	(0.00919)	(0.00327)
(Tropical livestock units)^2	-0.00654	-0.00009*	0.00002*	0.00001	-0.00001	0.00001
	(0.00749)	(0.00005)	(0.00001)	(0.00001)	(0.00002)	(0.00001)
Motorised vehicle	-41.0981	0.43749	-0.06376	-0.06437	-0.06557	0.13659
	(43.22691)	(0.36670)	(0.14225)	(0.06471)	(0.04846)	(0.09848)
Membership organisation	98.57076	0.11449	-0.10477	-0.0463	-0.01409	0.01832
	(79.26065)	(0.30969)	(0.13139)	(0.05804)	(0.03700)	(0.08806)
2016	22.61645	-0.10465	-0.04733	-0.04646	-0.00159	-0.01144
	(51.28674)	(0.29705)	(0.05250)	(0.03418)	(0.02973)	(0.05349)
Village-year fixed effects	Included	Included	Included	Included	Included	Included
Constant	292.2516	9.85039***	0.72359*	0.36906	0.23935	0.72062**
	(304.66787)	(2.24225)	(0.42060)	(0.22673)	(0.20135)	(0.30325)
R^2 within	0.23	0.17	0.25	0.21	0.10	0.26
R^2 between	0.10	0.03	0.07	0.06	0.07	0.00
N	922	922	922	922	922	922

Notes: Significant coefficients are indicated with * p < 0.1. ** p < 0.05 or *** p < 0.01. Standard errors are clustered at the village level and reported between parentheses. Income is specified in 1,000 FCFA and refers to income per adult equivalent.

Table A11: Results of First-differencing Estimation on the Direct and Indirect Impact of Employment on Household Welfare

	Income	Log(Income)	Wage income	Log(wage income)	Self-employment income	Log(self-employment income)
Wage employment entry	272.04***	2.26**	266.14***	11.92***	-45.22	-0.22
	(68.83)	(1.02)	(56.59)	(0.16)	(74.42)	(1.43)
Continued wage employment	235.13***	1.04**	16.18	0.12	144.01*	1.51*
	(72.45)	(0.39)	(29.99)	(0.10)	(73.23)	(0.84)
Wage employment exit	23.51	-0.09	-235.98***	-12.02***	226.23**	3.92**
	(105.75)	(0.68)	(32.94)	(0.22)	(96.25)	(1.67)
Age HH head	3.61	0.04	1.80	0.01	-0.21	-0.01
	(4.05)	(0.03)	(1.40)	(0.01)	(3.86)	(0.06)
Female HH head	261.02**	0.37	143.49***	0.57***	69.44	-1.46
	(110.06)	(0.78)	(48.51)	(0.20)	(110.02)	(1.54)
Household head married	-38.65	-0.61	101.11	0.03	-154.15	-2.12
	(171.47)	(0.76)	(61.41)	(0.20)	(138.57)	(1.60)
Household head finished primary education	25.60	0.00	-32.65	0.06	34.30	0.04
	(75.80)	(0.39)	(38.16)	(0.12)	(90.78)	(1.01)
Household head finished secondary education	151.07	0.09	101.82	0.47*	-35.28	-1.43
	(146.92)	(0.52)	(80.74)	(0.24)	(130.90)	(1.25)
Number of working age members	-0.28	-0.06	19.37*	0.05	-13.40	-0.16
	(17.85)	(0.08)	(10.58)	(0.04)	(10.00)	(0.14)
Number of dependent members	-8.40	0.06	-8.77	-0.01	3.22	0.08
	(12.55)	(0.09)	(6.29)	(0.03)	(9.05)	(0.12)

Share literate working age members	-0.22	-1.24	-24.52	-0.03	72.06	-0.17
	(119.68)	(0.95)	(90.84)	(0.21)	(80.70)	(1.65)
Total land	0.84	0.00	1.66	0.00	-3.13	0.05
	(3.25)	(0.01)	(2.52)	(0.01)	(2.79)	(0.10)
Tropical livestock units	1.56	0.02	0.43	0.00	1.37	0.02
	(1.17)	(0.01)	(0.59)	(0.00)	(1.19)	(0.02)
Motorised vehicle	117.81	0.31	-32.25	-0.22	101.99	-0.38
	(92.04)	(0.36)	(48.73)	(0.20)	(69.50)	(1.20)
Membership organisation	12.75	0.50	-44.56	-0.14	64.10	1.00
	(40.09)	(0.39)	(36.58)	(0.13)	(38.04)	(0.68)
Distance to concrete road	-10.54	0.08	-2.76	-0.06	-7.43	0.03
	(16.57)	(0.09)	(13.17)	(0.04)	(16.70)	(0.18)
Horticultural export company close	76.82	0.20	88.94	0.16	13.58	-1.35
	(50.39)	(0.29)	(67.19)	(0.15)	(38.03)	(1.18)
Constant	-160.28***	-0.98**	-9.23	-0.07**	-65.44	-0.40
	(55.28)	(0.45)	(13.63)	(0.03)	(45.61)	(0.69)
R^2	0.07	0.13	0.22	0.98	0.08	0.07
N	461	461	461	461	461	461

Notes: Significant coefficients are indicated with * p < 0.1. ** p < 0.05 or *** p < 0.01. Standard errors are clustered at the village level and reported between parentheses. Income, wage income and self-employment income is specified in 1,000 FCFA and refers to income per adult equivalent.

Table A12: Results of First-differencing Estimation on the Direct and Indirect Impact of Agricultural – Non-agricultural Wage Employment Categories on Household Welfare

	Income	Log(Income)	Wage income	Log(wage income)	Self-employment income	Log(self-employment income)
Agricultural wage employment entry	260.22***	3.40*	155.04***	11.33***	96.01	1.88
	(87.77)	(1.72)	(49.42)	(0.27)	(88.09)	(2.25)
Continued agricultural wage employment	195.75***	1.00**	1.90	-0.01	141.70**	2.36*
	(58.01)	(0.46)	(44.23)	(0.19)	(69.07)	(1.20)
Non-agricultural wage employment entry	286.82***	1.44***	361.15***	12.40***	-151.50*	-1.85
	(93.83)	(0.50)	(80.41)	(0.16)	(82.06)	(1.15)
Continued non-agricultural wage employment	398.92***	1.35**	86.53**	0.25	199.44	0.66
	(126.64)	(0.49)	(39.82)	(0.17)	(123.83)	(0.80)
Agricultural to non-agricultural wage employment transition	265.73***	1.20***	203.59***	0.90***	37.08	-1.03
	(93.38)	(0.41)	(39.07)	(0.25)	(75.70)	(0.92)
Non-agricultural to agricultural wage employment transition	-321.14*	-2.97*	-568.67***	-12.33***	113.71	2.69
	(180.34)	(1.54)	(135.66)	(0.36)	(197.29)	(2.82)
Agricultural wage employment exit	20.30	-1.23	-72.84***	-10.91***	71.13	0.21
	(96.41)	(1.45)	(21.91)	(0.16)	(85.66)	(1.09)
Non-agricultural wage employment exit	22.33	0.42	-316.33***	-12.52***	298.30**	5.56**
	(142.65)	(0.60)	(35.43)	(0.08)	(124.24)	(2.10)
Age HH head	3.97	0.05	1.37	0.00	0.96	0.01
	(4.17)	(0.03)	(1.23)	(0.01)	(3.73)	(0.06)
Female HH head	274.32**	0.39	93.35**	0.36*	109.49	-0.93
	(113.45)	(0.82)	(36.14)	(0.19)	(98.13)	(1.78)
Household head married	-8.34	-0.29	93.52	-0.05	-115.99	-1.97
	(175.43)	(0.86)	(70.38)	(0.22)	(130.76)	(1.72)

Household head finished	31.55	0.07	-43.47	0.01	50.73	0.20
primary education	(76.27)	(0.35)	(33.84)	(0.09)	(91.03)	(1.03)
Household head finished	164.16	0.33	79.52	0.38*	-0.14	-1.23
secondary education	(145.00)	(0.47)	(69.36)	(0.22)	(129.42)	(1.32)
Number of working	-7.37	-0.06	9.41	0.01	-10.11	-0.05
age members	(17.21)	(0.07)	(9.85)	(0.04)	(10.47)	(0.12)
Number of dependent	-9.93	0.05	-9.14	0.00	2.00	0.07
members	(11.26)	(0.07)	(5.80)	(0.02)	(8.24)	(0.10)
Share literate working	-0.05	-1.31	-5.63	0.07	52.52	-0.54
age members	(113.33)	(0.94)	(79.59)	(0.16)	(78.62)	(1.52)
Total land	0.28	0.00	0.24	0.00	-2.18	0.06
	(3.20)	(0.02)	(1.84)	(0.01)	(3.18)	(0.10)
Tropical livestock	1.60	0.02	0.06	0.00	1.72	0.03
units	(1.18)	(0.01)	(0.45)	(0.00)	(1.13)	(0.02)
Motorised vehicle	-8.85	0.10	-0.66	-0.05	-6.26	0.03
	(18.42)	(0.10)	(15.50)	(0.05)	(17.25)	(0.21)
Membership organisation	67.16	0.18	29.72	-0.04	41.59	-0.88
	(47.36)	(0.31)	(44.11)	(0.11)	(51.35)	(0.85)
Distance to	39.20	0.43	2.39	0.03	44.47	0.42
concrete road	(40.26)	(0.42)	(32.41)	(0.11)	(39.29)	(0.71)
Horticultural export	109.37	0.08	-20.61	-0.13	76.32	-0.67
company close	(89.68)	(0.32)	(50.92)	(0.17)	(63.74)	(1.08)
Constant	-158.76***	-1.01**	-2.16	-0.04	-71.55	-0.50
	(54.89)	(0.46)	(8.62)	(0.03)	(46.00)	(0.65)
R^2	0.10	0.16	0.37	0.98	0.11	0.14
N	461	461	461	461	461	461

Notes: Significant coefficients are indicated with * p < 0.1. ** p < 0.05 or *** p < 0.01. Standard errors are clustered at the village level and reported between parentheses. Income, wage income and self-employment income is specified in 1,000 FCFA and refers to income per adult equivalent.

Table A13: Results of First-differencing Estimation on the Direct and Indirect Impact of Casual – Contractual Wage Employment Categories on Household Welfare

	Income	Log(Income)	Wage income	Log(wage income)	Self-employment income	Log(self-employment income)
Casual wage employment entry	175.82*	2.99*	136.86***	11.23***	31.62	2.43
	(86.69)	(1.68)	(44.78)	(0.19)	(94.35)	(1.77)
Continued casual wage employment	216.08	1.43**	-40.52	0.20	220.74	3.43***
	(130.18)	(0.56)	(80.58)	(0.25)	(150.63)	(1.24)
Contractual wage employment entry	346.92***	1.58***	372.90***	12.51***	-118.83	-2.34**
	(106.09)	(0.47)	(82.95)	(0.16)	(80.35)	(0.99)
Continued contractual wage employment	271.47***	1.14**	49.02	0.17	154.25*	0.19
	(90.14)	(0.42)	(45.81)	(0.10)	(79.31)	(1.07)
Casual to contractual employment transition	292.85***	0.70	49.42	0.17	181.46**	3.37**
	(102.99)	(0.48)	(61.40)	(0.38)	(82.80)	(1.63)
Contractual to casual employment transition	-147.00	-2.22	-232.68***	-11.64***	-73.36	-0.81
	(147.78)	(1.38)	(56.69)	(0.26)	(135.31)	(1.38)
Casual employment exit	34.17	-0.87	-192.93***	-11.52***	180.11**	3.70
	(88.93)	(1.15)	(63.47)	(0.36)	(72.22)	(2.84)
Contractual employment exit	28.03	0.43	-257.89***	-12.35***	266.74*	4.08*
	(155.91)	(0.68)	(31.40)	(0.12)	(141.70)	(2.04)
Age HH head	2.97	0.04	1.09	0.00	-0.05	0.00
	(3.80)	(0.03)	(1.26)	(0.01)	(3.84)	(0.06)
Female HH head	238.59**	0.37	139.88***	0.58**	32.72	-2.31
	(111.91)	(0.74)	(47.96)	(0.22)	(104.59)	(1.71)
Household head married	-90.86	-0.36	48.65	-0.16	-149.74	-1.52
	(171.27)	(0.88)	(66.77)	(0.20)	(131.71)	(1.83)

Household head finished primary education	27.00	0.01	-25.66	0.03	22.86	-0.48
	(81.64)	(0.40)	(33.06)	(0.09)	(86.89)	(0.89)
Household head finished secondary education	144.60	0.08	104.63	0.36	-53.19	-1.92
	(151.64)	(0.49)	(74.71)	(0.24)	(136.74)	(1.21)
Number of working age members	-2.07	-0.03	15.63	0.03	-9.11	-0.10
	(18.53)	(0.07)	(10.59)	(0.04)	(9.75)	(0.15)
Number of dependent members	-7.86	0.06	-7.81	-0.01	2.48	0.02
	(12.18)	(0.08)	(5.45)	(0.02)	(9.12)	(0.09)
Share literate working age members	21.60	-1.38	-5.78	0.05	75.46	0.04
	(118.06)	(0.99)	(89.05)	(0.21)	(77.38)	(1.66)
Total land	1.51	-0.01	2.82	0.01	-4.20	0.02
	(3.71)	(0.01)	(2.21)	(0.01)	(2.70)	(0.09)
Tropical livestock units	1.53	0.02	0.43	0.00	1.32	0.02
	(1.13)	(0.01)	(0.55)	(0.00)	(1.20)	(0.02)
Motorised vehicle	125.72	0.17	-12.95	-0.08	79.35	-1.00
	(94.93)	(0.36)	(50.70)	(0.18)	(68.71)	(1.11)
Membership organisation	16.99	0.37	-32.40	-0.09	47.63	0.76
	(42.61)	(0.39)	(33.25)	(0.11)	(39.47)	(0.64)
Distance to concrete road	-10.53	0.06	-2.87	-0.04	-7.38	0.11
	(16.48)	(0.09)	(11.99)	(0.04)	(17.43)	(0.14)
Horticultural export company close	106.58*	0.16	117.15*	0.27	18.31	-2.08*
	(55.07)	(0.34)	(69.06)	(0.16)	(42.65)	(1.19)
Constant	-158.35***	-1.01**	-7.07	-0.04	-66.01	-0.36
	(55.31)	(0.46)	(12.90)	(0.04)	(45.05)	(0.67)
R^2	0.09	0.14	0.26	0.98	0.10	0.13
N	461	461	461	461	461	461

Notes: Significant coefficients are indicated with * $p < 0.1$. ** $p < 0.05$ or *** $p < 0.01$. Standard errors are clustered at the village level and reported between parentheses. Income, wage income and self-employment income is specified in 1,000 FCFA and refers to income per adult equivalent.

Table A14: Effects of Wage Employment Entry and Continued Wage Employment on Different Sources of Self-employment Income, First-Difference Estimations

	Self-employment income	Log (Self-employment income)	Agricultural self-employment income	Log (Agricultural self-employment income)	Non-agricultural self-employment income	Log(Non-agricultural self-employment income)
Wage employment entry	-45.22	-0.22	9.55	-0.12	-54.77	-1.29
	(74.42)	(1.43)	(50.03)	(1.71)	(56.55)	(1.65)
Continued wage employment	144.01*	1.51*	34.14	0.40	109.87*	0.57
	(73.23)	(0.84)	(57.48)	(1.33)	(58.93)	(1.39)
Agricultural wage employment entry	96.01	1.88	52.49	1.71	43.51	-0.72
	(88.09)	(2.25)	(64.86)	(1.70)	(46.93)	(2.13)
Continued agricultural wage employment	141.70**	2.36*	65.79	0.88	75.91	1.49
	(69.07)	(1.20)	(48.57)	(1.26)	(54.99)	(1.53)
Non-agricultural wage employment entry	-151.50*	-1.85	-19.75	-1.44	-131.75*	-1.72
	(82.06)	(1.15)	(61.65)	(2.02)	(67.99)	(1.97)
Continued non-agricultural wage employment	199.44	0.66	1.58	-1.85	197.85	1.51
	(123.83)	(0.80)	(86.64)	(1.73)	(125.58)	(1.68)
Casual wage employment entry	31.62	2.43	72.29	2.48*	-40.66	0.29
	(94.35)	(1.77)	(61.83)	(1.35)	(74.17)	(1.70)
Continued casual wage employment	220.74	3.43***	188.95*	2.81**	31.80	1.66
	(150.63)	(1.24)	(97.54)	(1.38)	(80.70)	(1.91)
Contractual wage employment entry	-118.83	-2.34**	-48.05	-2.18	-70.79	-2.52
	(80.35)	(0.99)	(57.68)	(1.82)	(55.67)	(1.94)

Continued contractual wage employment	154.25* (79.31)	0.19 (1.07)	12.60 (49.60)	-1.19 (1.26)	141.65 (85.99)	-0.48 (1.98)

Notes: Significant coefficients are indicated with * p < 0.1. ** p < 0.05 or *** p < 0.01. Standard errors are clustered at the village level and reported between parentheses. **S**elf-employment income is specified in 1,000 FCFA and refers to income per adult equivalent.

Chapter 4

Intra-household decision-making and fertility choices: Insights from Sub-Saharan Africa

1. Introduction

Almost every socio-economic parameter that characterises the welfare of a household, be it distribution of income, labour allocation or education and health outcomes, is inherently the result of a bargaining or decision-making process between spouses – or even between all members of the household, including other adults and children. Traditional methods that study the impact of development programs or interventions on household welfare, do not consider the influence of this intra-couple or intra-household decision-making. Survey-based studies usually select one household member, often the household head, and consider his or her answers and preferences to be representative for the household. The theoretical support for this unification of household preferences can be found in the unitary household model (see for example Becker (1974)). This model, which considers the household behaves as a single decision-making unit with uniform preferences and pooled income, has been proven to be deficient both with respect to its theoretical soundness and the empirical applications (Duflo & Udry, 2004; Munro, 2014; Qian, 2008; Vermeulen, 2002). Collective household models explicitly take into account multiple decision-makers and individual preferences when modelling the structure of the household and its behaviour, and are therefore a possible alternative for the unitary household model.

In this study we report on an experiment designed to distinguish between individual and household choices and disentangle intra-household decision-making. We conduct a choice experiment to value preferences with respect to fertility (the household's number of children) and child-raising (the education, nutrition and health care provisioning of the children), using married couples as subjects. We use a samples of 500 couples in two rural areas in Senegal and Uganda. We first implement the

experiment with both spouses separately, and repeat the experiment with the spouses jointly as couple. We analyse spouses' choices and preferences, and calculate a decision-making coefficient based on the method proposed by Beharry-Borg et al. (2009). We distinguish between couples with a dominant spouse and couples where household choices are made using a more collective, balanced decision-making approach, and reflect on the implications of intra-household decision-making for household fertility and child-raising preferences.

Our results are relevant from a methodological perspective – to contribute to a better understanding of the differences and interactions between individual and household choices, which can support and improve further study designs. Previous experiments using a similar approach revealed the divergence between individual and joint preferences with respect to various subjects (Bateman & Munro, 2009; Beck & Rose, 2019; Beharry-Borg et al., 2009; Dosman & Adamowicz, 2006; Marcucci et al., 2011; Mariel et al., 2018). However, to our knowledge, no experiment exists that considers a topic which has such inherent consequences for the household structure as a whole, while highly dependent on the preferences of spouses individually. Moreover, only five other studies[1] calculate a measure that considers intra-household decision-making, only one of them, Wiig et al. (2012), in a rural low-income setting.

Our results are also important from an empirical perspective, as a better understanding of households' fertility and child-raising preferences and the link with intra-household decision-making is important to develop more effective family-planning programs and policies. Especially in Sub-Saharan Africa (SSA), fertility and child-raising are topics high on the agenda of (inter)national governments and organisations as population number are expected to continue to grow, possibly leading to a doubling of the population between 2010 and 2050 (Ezeh et al., 2012; United Nations, 2019), and the adverse effects of high population growth are expected to be numerous (Alexandratos, 2005; Drechsel et al., 2001; Ezeh et al., 2012; Graves et al., 2019). We implement our choice experiment in two case-study regions in rural Senegal and rural Uganda. Both

[1] More specifically the studies of Abdellaoui et al. (2013), Beharry-Borg et al. (2009), Carlsson et al. (2012), Dosman & Adamowicz (2006) and Wiig et al. (2012).

countries are suffering from high fertility rates (4.7 and 5.1 for Senegal and Uganda respectively in 2017), low secondary completion rates, high prevalence of undernourishment, child mortality, and other problems connected to high fertility rates (World Bank, 2020b).

2. Literature review

Collective household models explicitly take into account multiple decision-makers and individual preferences when modelling the structure of the household and its behaviour. These models are an answer to the unitary household model that considers households act as a single decision-making unit with uniform household preferences and pooled resources, even if they consist of multiple members (e.g. Banks, Blundell, & Lewbel, 1997; Becker, 1974; Blundell & Walker, 1986; Browning & Meghir, 1991), and which has been rejected by theoretical and empirical research (Duflo, 2003; Duflo & Udry, 2004; Lundberg, Pollak, & Wales, 1997; Munro, 2014; Qian, 2008). The literature makes a distinction between non-cooperative household models, where individuals maximize their personal utility, taking others' behaviour as given (e.g. Browning, 2000; Chen & Woolley, 2001; Leuthold, 1968), and cooperative models, where individuals bargain to arrive at a specific Pareto efficient intra-household allocation of welfare (e.g. Manser & Brown, 1980; McElroy & Horney, 1981). In cooperative household models, the bargaining or decision-making power of an individual is decisive in the decision-making process. When an individual's bargaining position in the household improves, for example due to an increased relative contribution to the household budget, the household's consumption basket will shift towards the individual's preferences (N. McCarthy & Kilic, 2017; Vermeulen, 2002).

Whether households act in a cooperative (Pareto efficient) or non-cooperative (Pareto inefficient) way, remains an open discussion. While Bobonis (2009) and Attanasio & Lechene (2014) find proof of Pareto-efficient household consumption under shifting bargaining power, Angelucci & Garlick (2014), Duflo & Udry (2004) and Robinson (2012) provide evidence of inefficient household resource allocation. The separate

spheres model of Lundberg & Pollak (1993) combines both cooperative and non-cooperative outcomes. The model builds on the cooperative models of Manser & Brown (1980) and McElroy & Horney (1981), but the authors assume that the threat point for bargaining is not divorce, but a non-cooperative equilibrium, where public goods are undersupplied and gains can be made with cooperation. This non-cooperative equilibrium will reflect traditional, socially established gender roles, where both spouses take up separate responsibilities for gender-specific household tasks. The shift from a divorce threat point, to a non-cooperative separate spheres threat point is very realistic when considering Sub-Saharan African societies (and even more so in rural SSA). Even though divorce numbers are high in SSA, Clark & Brauner-Otto (2015) calculate that one in three marriages are bound to dissolve, options outside of marriage are very unattractive, especially for women, and the impact of divorce on women and their children are proven to be highly negative (Clark & Hamplová, 2013; Thiombiano, LeGrand, & Kobiané, 2013).

Rather than relying on classic survey questions to identify and/or quantify household decision-making and bargaining processes[2], scholars increasingly make use of experiments (Munro, 2018). Such experiments typically first collect individual choices and preferences from each member of the couple or the household, and then asks the couple or the household to make choices jointly to reveal preferences as a group, through collective bargaining and joint decision-making. Some studies use revealed preferences as a proxy for the group decision, see for example Dosman & Adamowicz (2006) and Mariel et al. (2018). The experiments compare individual and group choices and preferences, to reveal how these choices and preferences relate, and how group decisions are taken. Studies have analysed various topics over which households bargain: experiments consider decision-making over consumer goods and household consumption (Beblo & Beninger, 2017; Beck & Rose, 2019; Corfman & Lehmann, 1987; Popov, McNally, & Munro, 2012; Rungie, Scarpa, & Thiene, 2014), valuation

[2] These indices are often focused on measuring female decision-making and female empowerment within the household, and do not actively take decision-making processes into account (see for example (Miedema, Haardörfer, Girard, & Yount, 2018; Yount et al., 2019; Yount, VanderEnde, Dodell, & Cheong, 2016)).

of environmental services (Beharry-Borg et al., 2009; Lindhjem & Navrud, 2009), residential location (Marcucci et al., 2011), schooling choice for children (Mariel et al., 2018), behaviour towards risky and intertemporal decisions often making use of lottery-type experiments (Abdellaoui, L'Haridon, & Paraschiv, 2013; Bateman & Munro, 2009; Braaten & Martinsson, 2015; Carlsson, He, Martinsson, Qin, & Sutter, 2012; De Palma, Picard, & Ziegelmeyer, 2011), holiday destination (Beharry-Borg et al., 2009; Dosman & Adamowicz, 2006). Irrespective of the focus, studies almost unanimously come to the conclusion that household choices cannot be inferred from individual choices, and that research into group or household choices should acquire data from the group as a whole.

While decision-making experiments are common in many scientific fields, the measurement and study of decision-making in the context of fertility decisions and fertility preferences remains largely observational and survey-based. Some studies compare stated preferences of husband and wife, with their fertility outcome, i.e. the actual number of children the couple has. These studies base their measures on straight away asking for a person's preferred fertility but this approach has been proven to result in unreliable, highly variable estimates that overestimate the actual wanted fertility (Bhrolcháin & Beaujouan, 2019; Bongaarts, 1990; Cleland, Machiyama, & Casterline, 2020; Kodzi, Casterline, & Aglobitse, 2010; Trinitapoli & Yeatman, 2018).

The few studies that explore intra-household differences in fertility preferences, find ambiguous effects with respect to which spouse is decisive for fertility outcomes. Bankole (1995) uses data from Nigeria to discuss differences between spouses with respect to fertility preferences, and its effect on subsequent fertility. The study reveals that on average both spouses' preferences are important predictors of the couple's subsequent fertility outcomes. However, the results show that when the couple has a low number of living children, the man's preference is dominant, while the woman's preference is dominant when the couple has a high number of living children. Rasul (2008) uses data from Malaysia to describe how in Malay households both spouses' fertility preferences have an equal, positive and significant effect on fertility outcomes, while in Chinese households, only the wife's preferences determine subsequent fertility.

Gipson & Hindin (2009) show for rural Bangladeshi couples that women's rather than men's fertility preferences are the main driver of subsequent fertility outcomes. On the other hand, if men prefer more children, women are less likely to prevent pregnancy. To our knowledge, no studies consider the link between intra-household decision-making and household's fertility and child-raising choices.

3. Methods

3.1. Background and data

Our analysis relies on data from two study-regions: the Mount Elgon region in Eastern Uganda and the Saint-Louis region in North-Western Senegal. Both regions are rural areas with a connection to a secondary urban center (Saint-Louis town in Senegal and Mbale in Uganda), and are characterized by their high dependence on agriculture, high poverty rates and weak infrastructure development. In Uganda and Senegal, the Gender Inequality Index (GII)[3] is high and highly similar (respectively 0.535 and 0.533, positioning Uganda and Senegal at the 130th and 131st place out of 162 countries (UNDP, 2019)). Also child marriage rates are high in both countries, respectively 34% and 31% of girls are married by the age of 18 years in Uganda and Senegal (UNICEF, 2021), which has been proven to correlate negatively to women's bargaining power within the marriage (Sunder, 2019). Even though civic laws exists that try to reduce discrimination, land ownership and inheritance systems are still widely controlled by customary law in SSA (Djuikom & van de Walle, 2018; Kabahinda, 2018; Koopman, 2009; Richardson, 2004). These customary laws exclude women from land ownership, and married women often only have the use right over land owned by their husband (only 14% and 5% of women indicate to own land individually in respectively Uganda

[3] The GII measures gender inequalities for three aspects of human development: reproductive health (maternal mortality ratio and adolescent birth rates), empowerment (proportion of parliamentary seats occupied by women and proportion of adult women and men aged 25 years and older with at least some secondary education), and economic status (labour force participation rate of women and men aged 15 years and older). As it measures the human development costs of gender inequality, the higher the GII value the more disparities between women and men and thus the more loss to human development (UNDP, 2019).

and Senegal (Doss, Kovarik, Peterman, Quisumbing, & van den Bold, 2015)). Women lose their use right after divorce (Djuikom & van de Walle, 2018; Koopman, 2009), which often means loss of their livelihood.

The Wolof (41.7% of the rural population in Senegal) – traditionally settled farmers – and Peulh (30.4% of the rural population in Senegal) – traditionally pastoralist nomadic traders – ethnicities are the two most prevalent in the Saint-Louis region (ANSD, 2015). While the large majority of the Peulh people are nowadays sedentary, villages continue to be highly ethno-specific, and marriages across ethnicities are uncommon. Both ethnicities have traditional hierarchical customs (Creevey, 1996) that attribute a major importance towards having a large family. Moreover, as the Islam is the dominant religion in the research area (96.5% of the rural population in Senegal is Muslim (ANSD, 2015)), everyday life is ruled by Islamic and customary patrilineal laws[4] (Lambert & Rossi, 2016). Both the introduction of the Islam, and the imposition of the French colonial system[5] that incentivized the growing of cash-crops (mainly peanuts) on large monocrop fields using animal-drawn ploughs, lowered the position and bargaining power of women in the rural Senegalese society, and increased even more the value of having a large household (Alesina, Giuliano, & Nunn, 2013; Creevey, 1996).

The Mount Elgon region in Uganda also knows a patrilineal tradition, and is mainly populated by the Bagisu ethnicity (84.4% of sampled households) – traditionally practicing a mixed economy including agriculture, animal husbandry and trading (Wanyonyi, 2018) – with a minority of people from the Sabiny ethnicity (14.4% of sampled households). The Bagisu and Sabiny attach a high value to children and a woman's status is highly connected to the number of children she bears (Kwagala, 2013; Makwa, 2012). There is a religious diversity in the research area (unrelated to ethnicity), composed of protestants (46.8% of sampled households), Catholics (29.4%

[4] The Wolof's inheritance and family relationships were partially determined by matrilineal decendency patterns, while the Peulh's traditions were highly patrilineal, already before the arrival of the Islam (Creevey, 1996).

[5] The first French settlement in (nowadays) Senegal dates back from the 17th century with the establishment of Saint-Louis town. The French colonial period in Senegal began in 1884 and ended in 1960 with the independence of Senegal (Bawa, 2013).

of sampled households) and born-again Christians (16.5% of the sampled households). Polygamous marriages are common, but wives do not necessarily live under the same roof. In theory, Bagisu women are under control of their father or husband. However, the status of men highly depends on his marital status (more than women), livelihoods in the area are highly dependent on women's labour, and divorce and remarriage is fairly easy for Bagisu women. Women's independence might therefore be larger than expected (Jackson, 2013). British colonial rule[6] (forcibly) introduced the growing of cash-crops, mainly coffee, in the region (Petursson & Vedeld, 2015). However, as the growing of coffee is highly labour-intensive and animal-drawn ploughs are of little use on these steep cultivations, the shift in cropping systems did not significantly alter the position of women in the Bagisu society (Alesina et al., 2013).

We use data from a quantitative household survey and a discrete choice experiment. Survey data were collected in 2016, from respectively 464 and 758 households in Senegal and Uganda. Households were sampled using a multistage[7] stratified random sampling method, with stratification based on distance to an asphalt road and wage employment status in Senegal, and urbanization level and altitude in Uganda. A structured quantitative questionnaire was used to collect data on household demographics, farm production, land and non-land assets, living conditions and employment. The discrete choice experiment (DCE) was implemented in 2017 with 250 households in each region, which were randomly selected from the larger household samples. Within a household, both husband and wife completed the DCE separately, after which they completed the experiment together as a couple. The individual DCE's were followed by questions on attribute non-attendance, and the respondent's current and preferred number of children.

3.2. Design of DCE

Based on Lancaster's consumer theory which argues that consumer preferences are shaped by the individual characteristics a good or service possesses and not by the good

[6] The British colonial rule in the study region began in 1904 and ended in 1962 with the independence of Uganda (Wanyonyi, 2018).
[7] Two-stage sampling design in Senegal and three-stage sampling design in Uganda.

as a whole, discrete choice experiments (DCE) provide a link between observed behaviour and economic theory (K. J. Lancaster, 1966). During this DCE, a respondent is asked to choose between hypothetical scenarios on different situations of child-raising. The choice of the attributes and attribute levels is based on the literature, key informant interviews and focus group discussions in both Senegal and Uganda, to increase the validity of the experiment (Mangham et al., 2009). In total we specify four attributes, with the first referring to the fertility aspect, number of children, and the next three to the child-raising aspect, covering education, nutrition and health care (table 1).

Table 1: Attributes and attribute levels

Attribute	Description	Attribute levels
Children	Number of children	1, 2, 4, 6, 9, 12
Education	Share of children from the household that can obtain a secondary school degree	None (base level), Half, All
Nutrition	Number of days a week a household can eat a complete meal	Zero (base level), Four, Seven
Health care	Quality of the health care institute the household can go for help when a child has a severe fever	Low (base level), Medium, High

The first attribute specifies the number of children and consists of six levels. The range of 1 to 12 children is based on the observed number of children in the study regions, as derived from the quantitative surveys.

The second attribute is defined as the share of children from the household that can complete lower secondary education. The attribute contains three levels: none, half and all of the children. In both countries lower secondary education comprises 4 years (children ages 12 to 15 in Senegal, and 13 to 16 in Uganda), after which a certificate of completion is awarded. In Uganda, we consider private schools that charge high tuition fees, as focus group discussions pointed towards a very low quality of public schooling. In Senegal, we consider public schooling, as private schools are not available in rural areas. While no official tuition fees are charged in Senegalese public schools, costs

remain high as children have to commute or stay overnight, books and school supplies are expensive, and informal "maintenance fees" are charged.

The third attribute is defined as the number of days a week a household can eat a complete meal, including carbohydrates, proteins and vegetables, for the main meal of the day. On the other days an incomplete meal is consumed (e.g. only carbohydrates). The attribute consists of three levels: zero, four and seven days a week. In Senegal, a very known local dish "thieboudienne" is taken as an example, which comprises rice, fish and vegetables. In Uganda, a complete meal is defined as containing posho (maize meal) or matoke (green bananas), beans and green leafy vegetables.

The fourth attribute is defined as the quality of health care institute the household can consult when a child has a severe fever. The attribute contains three levels: low-quality, medium-quality and high-quality. A low-quality health care institute is defined as a small health care facility, located in almost every rural community, with only a health worker or nurse present. Basic treatments can be performed using basic equipment (such as disinfecting wounds, applying bandages, and treating common pathologies, such as acute diarrhoea or malaria), but diseases cannot be diagnosed. A medium-quality health care institute is operated by a larger staff of at least one nurse, one midwife and one assistant nurse. Medical equipment is more advanced and basic disease diagnosis is possible. In a high-quality health care facility, at least one doctor is stationed, often complemented by different specialists. Diagnosis and treatment of more complex or uncommon diseases are possible. The three quality attributes are similar in both countries but are adapted to the local context (e.g. in Senegal low-quality health care is a "case de santé", while in Uganda it is a "health center II facility").

Using a Bayesian design, we account for uncertainties around the true values of the a priori information of the parameters (Kessels, Jones, Goos, & Vandebroek, 2008). We increase efficiency of the design using the D-efficiency criterion that minimizes the determinant of the variance-covariance matrix of the parameter estimators (Kessels, Goos, & Vandebroek, 2006). We hypothesize that the utility derived from the number of children is concavely shaped (positive but diminishing preferences), so priors are higher for 4 and 6 children, and lower for 1, 2, 9 and 12 children. We use small positive

priors for the levels of the child-raising attributes, as we hypothesize that respondents have positive preferences towards a more qualitative child-raising. We use choice sets with three alternatives and visual illustrations to assist illiterate people when making their choice (a choice card is presented in figure 6 of chapter 1). We present the same 12 choice cards to each respondent and randomize the order to avoid learning bias. The experiment was introduced to both spouses together. The attributes were explained in detail and the hypothetical character of the experiment was emphasized (i.e. that the proposed household should be taken as a given, not taking into account possible monetary, social or physical limitations of the actual household). Both spouses were informed that first the individual experiment would take place, after which they would respond to the experiment together. After the introduction, the spouses were interviewed separately by an enumerator of the same gender. The couple experiment was alternately carried out by the male or female enumerator, while the other enumerator remained present.

While the inclusion of an opt-out or status quo option is common practice in DCEs as it increases the realism of the choice task (Carson et al., 1994; Louviere, Hensher, & Swait, 2000; Vanermen, Kessels, Verheyen, Muys, & Vranken, 2021), we did not include an opt-out or status quo option in our choice experiment. This means that respondents are forced to make a choice between the three proposed scenarios. The decision not to include an opt-out option was guided by the fact that an opt-out option reduces the efficiency of the experiment because of a higher number of no-choices (Brazell et al., 2006; Veldwijk, Lambooij, De Bekker-Grob, Smit, & De Wit, 2014), and because the respondents are confronted with these forced choices in daily life, without the possibility to opt-out if characteristics do not match with their preferences. The application of a forced choice structure entails some consequences for the data analysis and interpretation of the results. As research shows that individual willingness to pay is different in forced and unforced choice sets (Penn, Hu, & Cox, 2019), we do not calculate welfare estimates based on the estimated coefficients. Moreover, we need to remain cautious when interpreting the results.

As we implemented the choice experiment with the spouses individually and jointly, we obtained information on 54,000 observations in total. We drop three households from the analysis, as they did not complete the couple experiment. Information on one choice card is missing for the experiments of one man, one woman, and one couple, and for two couple experiments information on two choice cards are missing. We therefore retain 53,655 observations for the analysis.

3.3. Analysis of DCE

The random utility theory framework – in which DCEs are embedded – assumes that respondents choose the alternative that yields the highest utility level from each choice set (Louviere et al., 2000). Following this framework, the utility respondent *i* derives from alternative *j* (U_{ij}) can be divided into an observable deterministic component (V) – linearly depending on the attributes of the alternative (Z_j) and individual-specific socioeconomic characteristics (X_i) – and a stochastic component (ε) capturing unobserved heterogeneity across alternatives and individuals (equation 1) (Hensher, Rose, & Greene, 2005b).

$$U_{ij} = V(Z_j, X_i) + \varepsilon(Z_j, X_i) \tag{1}$$

We use the probability that respondent *i* chooses alternative *j*, expressed in terms of a logistic distribution, as an approximation of the unobservable respondent *i*'s utility (Hensher et al., 2005b; Louviere et al., 2000). We use mixed logit models (MXL) combined with maximum likelihood estimation, as they are most common and allow for preferences to be heterogeneous across respondents (Train, 2003). We estimate different specifications of the MXL, treating all attributes as random and using 1500 Halton draws. In a first analysis, we discuss fertility and child-raising preferences based on the overall preference structures of the three samples: men individually, women individually, and the couples' experiment. We identify three model specifications. First, we include only the individual samples (men and women) and add an interaction term for women (equation 2).

$$U_{ij} = \beta_1 Z_{ij} + \beta_2 Z_{ij} * Women_i + \varepsilon_{ij} \;\; if \; i = man \; or \; woman \tag{2}$$

Second, we use the three samples (men, women and couples) and include an interaction term for couples (equation 3).

$$U_{ij} = \beta_3 Z_{ij} + \beta_4 Z_{ij} * Couples_i + \varepsilon_{ij} \;\; if\; i = man, woman\; or\; couple \qquad (3)$$

Third, we include respectively the samples of men and couples, and the samples of women and couples, and add an interaction term for couples (equations 4 and 5).

$$U_{ij} = \beta_5 Z_{ij} + \beta_6 Z_{ij} * Couples_i + \varepsilon_{ij} \;\; if\; i = man\; or\; couple \qquad (4)$$

$$U_{ij} = \beta_7 Z_{ij} + \beta_8 Z_{ij} * Couples_i + \varepsilon_{ij} \;\; if\; i = woman\; or\; couple \qquad (5)$$

The first two specifications allow us to discern inherent differences in preference structures between the different samples, while the third specification gives an indication about whether it is mainly men's or women's preference structure that is reflected in the couples' preference structure. We cluster standard errors at the household level, to control for the specific household-based structure of the data.

In a second analysis, we reflect on the implications of intra-household decision-making for household fertility and child-raising preferences. We generate a decision-making coefficient based on the method proposed by Beharry-Borg et al. (2009) which relies on the premise that the individual preferences of the spouses are at the origin of household decision-making. The basic collective model defined by Browning & Chiappori (1998) includes a "distribution of power" coefficient δ (equations 6 and 7).

$$U(p, x, \delta) = \max_{q,Q,p,x} [\delta U^m(q, Q, p, x) + (1 - \delta) U^w(q, Q, p, x)] \qquad (6)$$

Subject to

$$p(q^m + q^w + Q) = x \qquad (7)$$

Where a man *m* and a woman *w* maximize the utility of the household, taking into account prices *p* and income *x*, and consuming both private *q* and public *Q* goods. The coefficient δ is limited to values between 0 and 1. When $\delta = 1$, the household behaves as if the man always gets his way, whereas when $\delta = 0$, the woman always gets her way. Intermediate values indicate that both man and woman hold some decision-making power. Beharry-Borg et al. (2009) operationalise this framework using the

random utility theory (equation 1). Making abstraction of the stochastic component of utility, the indirect utility *V* of the collective choice (the household choice) of each alternative *j* by couple *n* is framed as a convex combination of the individuals' utilities (equation 8).

$$V_{jn} = \delta_n V\left(Z_j, \beta_n^m\right) + (1 - \delta_n) V\left(Z_j, \beta_n^w\right) \quad (8)$$

Couple *n*'s indirect utility derived from alternative *j* is composed of the weighted combination of individual utilities described on the basis of the alternative's attributes *Z* and the individual taste parameters for the man β_n^m and woman β_n^w. The couple-specific weight δ_n – the *decision-making coefficient* – can be interpreted as above: as δ_n approaches 1, more weight is given to the man's utility in the couple's joint decision, i.e. the man is more dominant during the couple experiment.

Assuming linearity in the parameters and a Gumbel distributed error term with $\lambda = 1$, we can set up a basic logit model that defines the probability of couple *n* to select alternative *i* from all alternatives *j* (equation 9).

$$Pr(i,n) = \frac{exp(V_{i,n})}{\sum_j exp(V_{j,n})} = \frac{exp(\delta_n \beta_n^m Z_i + (1-\delta_n)\beta_n^w Z_i)}{\sum_j exp(\delta_n \beta_n^m Z_j + (1-\delta_n)\beta_n^w Z_j)} \quad (9)$$

We use the R package *Apollo* to model the following indirect utility response function, from which we derive the couple-specific decision-making coefficient δ_n (equation 10):

$$V(\cdot) = \begin{cases} \lambda^m \beta_n^m Z_j & if\ man \\ \lambda^w \beta_n^w Z_j & if\ woman \\ \lambda^j \left[\delta_n \beta_n^m Z_j + (1 - \delta_n)\beta_n^w Z_j\right] & if\ couple \end{cases} \quad (10)$$

The intra-household decision-making coefficient is constrained to values between 0 and 1, with a value closer to 0 or 1 indicating more decision-making power for respectively the woman or the man, while a value around 0.5 indicates more balance in the decision-making power. For ease of interpretation and comparison, we use dummy specifications by dividing the sample in three decision-making groups: couples with man-dominant choices where the husband has a larger decision-making power ($x > 0.6$) (equation 11), couples with woman-dominant choices where the wife has a larger decision-making

power ($x \leq 0.4$) (equation 12), and couples with balanced choices where the decision-making power is more balanced between both spouses ($0.4 < x \leq 0.6$) (equation 13). For this second analysis we only consider the experiment with the couples, as we are interested in the effect of intra-household decision-making on decisions taken as a couple.

$$U_{ij} = \beta_{11} Z_{ij} + \beta_{12} Z_{ij} * man - dominant_i + \varepsilon_{ij} \;\; if \; i = couple \quad (11)$$

$$U_{ij} = \beta_{9} Z_{ij} + \beta_{10} Z_{ij} * woman - dominant_i + \varepsilon_{ij} \;\; if \; i = couple \quad (12)$$

$$U_{ij} = \beta_{9} Z_{ij} + \beta_{10} Z_{ij} * balanced \; decision - making_i + \varepsilon_{ij} \;\; if \; i = couple \quad (13)$$

3.4. Limiting potential bias

A DCE is a stated preference method and is inherently subject to hypothetical and social desirability bias (Menapace & Raffaelli, 2020). However, we expect this bias to be low in our DCE. The choices that the respondents are forced to make are similar to the decisions they have to face in daily life (i.e. do we invest in sending more children to school, or do we invest in more nutritious food). In addition, enumerators were carefully selected such that they share the same gender and ethnicity as the people they interview, with the survey taking place in the private setting of the own household with husband and wife interviewed separately.

On the other hand, DCEs are typically used to infer preferences on consumer goods or in an environmental valuation setting. These choices can be considered to be more trivial or independent from the choices you previously made in life, and are less likely influenced by hypothetical or social desirability bias. For example, the hypothetical character of choosing between a conventional or an organic apple might be less influenced by the fact that you actually bought conventional apples a week ago, than that the choice between a hypothetical household of two or eight children might be influenced by the fact that you actually have seven children. Moreover, buying apples in the supermarket is likely to be less of a taboo topic when compared to a household's fertility. Enumerators were trained to emphasize the hypothetical character of the experiment, such that respondents focus on the characteristics of the household

presented on the choice cards, and to not take into account characteristics of their actual living conditions, or possible social, monetary or physical limitations.

Even though we tried to reduce the hypothetical bias to a maximum, complete mitigation is impossible. The remaining hypothetical bias could inflate the preference for the number of children in cases where the respondents' actual number of children is bigger than the number of children they would have preferred. On the other hand, the hypothetical bias could deflate the preference for the number of children, in cases where the respondents' actual number of children is lower than the number of children they would have preferred.

We find other studies that use a DCE to infer preferences on more difficult, unconventional or "once in a lifetime" choices, or taboo topics. Baert et al. (2020) and Vlaeminck et al. (2016) infer resettlement preferences of smallholder farmers away from landslide prone areas in respectively Cameroon and Uganda. Carlson (2015) uses a DCE to report on the link between Ugandan voters' ethnicity and their voting preferences in presidential elections. Malhotra, Farooqui, Kanesvaran, Bilger & Finkelstein (2015) infer the willingness to pay of palliative cancer patients and their caretakers to extend the patients' life with one year. Sculpher et al. (2004) infer preferences of cancer patients on the trade-off between life expectancy and troublesome side effects such as limitations in physical energy. Boyden et al. (2021) explore how parents rate and prioritize different domains regarding their child's palliative and hospice care in the home setting. Tsuge, Kishimoto & Takeuchi (2005) even use a DCE to quantify the monetary value of a person's life-year.

We control for attribute non-attendance, as previous studies show that ignoring one or more attributes could lead to biased estimates (Hensher & Greene, 2010; Hensher, Rose, & Greene, 2005a; Hole, Kolstad, & Gyrd-Hansen, 2013), by using the information on respondents' attribute non-attendance statements[8]. We test for scale

[8] We test for attribute non-attendance with respect to the *number of children* attribute, as less than 1% of the respondents indicated to have ignored another attributes. In addition, we only test in the Senegalese sample, as less than 1% of Ugandan respondents indicated to have ignored an attribute.

heterogeneity, using the generalized multinomial logit model developed by (Fiebig, Keane, Louviere, & Wasi, 2010). We cluster standard errors at the respondent level. The results of the stated attribute non-attendance models are presented in table A1 in appendix, the results of the models including scale heterogeneity are presented in tables A2 and A3 in appendix. The estimates of both the stated attribute non-attendance and the scale heterogeneity models are similar in magnitude, sign and significance level compared to the estimates of the basic MXL model estimates. We therefore conclude that none of the subsamples are sensitive to attribute non-attendance and scale heterogeneity, and continue our analysis using the MXL models.

4. Results

4.1. Sample-specific preference structures

The results from the sample-specific analysis are summarized in tables 2 and 3. We find that men have a different preference structure than women (tables 2 and 3, model 1). Men in the Senegal sample have a higher preference for having more children, and have a lower preference for a better nutrition than Senegalese women. In the Uganda sample, we find that men have a lower preference for having more children, and to provide a better education and health care, compared to women. These results suggest that the unitary household model's assumption of uniform household preferences is unlikely to be valid, as we find that preferences differ between individuals that compose a household.

Preferences differ when we compare the individual experiments with the couple experiment (tables 2 and 3, model 2). For the Senegal sample, we find significant differences for all attributes and attribute-levels. This is less the case for the Uganda sample, where only the coefficients for high-quality education and medium-quality health care and nutrition differ significantly for the couples' sample. This suggests that insights on the individual fertility preferences of men and women do not suffice to understand fertility choices couples make.

Models 3 and 4 from table 2 reveal that men's preferences for the number of children matter more for the fertility choices made by couples in the Senegal sample. We find that the choice structures of couples concerning education, (high-quality) health care and (medium-quality) nutrition in Senegal are not in line with the individual choices of men nor women. Couples attribute a significantly higher preference to these child-raising outcomes, than spouses do separately. This could be an indication of the *group polarization phenomenon* as described by Beharry-Borg et al. (2009), where decisions taken in group are stronger or weaker than individual decisions. Models 3 and 4 from table 3 show that individual choices of women concerning education and health care are more alike to the choices couples make in the Uganda sample. We find that choices made by individual men and women, compared to choices made by couples concerning (medium-quality) nutrition, also display the *group polarization phenomenon* in the Uganda sample.

Table 2: Estimation results for the MXL models using split samples (men, women and joint) and interaction terms using sample-specific dummies for the Senegal sample

Interaction term X	(1) Men versus women (X)	(2) Individual [a] versus joint (X)	(3) Men versus joint (X)	(4) Women versus joint (X)
Mean preferences				
Children	0.220***	0.123***	0.221***	0.034
	(0.033)	(0.022)	(0.033)	(0.032)
Children^2	-0.014***	-0.007***	-0.014***	-0.000
	(0.003)	(0.002)	(0.003)	(0.002)
Education half	1.775***	1.698***	1.779***	1.691***
	(0.110)	(0.073)	(0.107)	(0.110)
Education all	2.969***	2.851***	2.967***	2.792***
	(0.127)	(0.090)	(0.126)	(0.135)
Health care medium	0.707***	0.630***	0.714***	0.567***
	(0.091)	(0.062)	(0.091)	(0.080)
Health care high	1.584***	1.455***	1.579***	1.365***
	(0.101)	(0.075)	(0.098)	(0.101)
Nutrition half	1.752***	1.755***	1.750***	1.780***
	(0.103)	(0.084)	(0.103)	(0.115)
Nutrition all	2.079***	2.242***	2.081***	2.414***
	(0.123)	(0.096)	(0.122)	(0.137)
Preference heterogeneity				
X * Children	-0.184***	0.069**	-0.028	0.156***
	(0.047)	(0.033)	(0.038)	(0.043)
X * Children^2	0.014***	-0.006**	0.002	-0.012***
	(0.004)	(0.003)	(0.003)	(0.003)
X * Education half	-0.032	0.613***	0.536***	0.592***
	(0.160)	(0.121)	(0.138)	(0.168)
X * Education all	-0.095	0.622***	0.517***	0.636***
	(0.175)	(0.145)	(0.163)	(0.200)
X * Health care medium	-0.121	0.186**	0.093	0.231**
	(0.116)	(0.083)	(0.088)	(0.105)
X * Health care high	-0.190	0.340***	0.208**	0.411***
	(0.134)	(0.098)	(0.096)	(0.132)
X * Nutrition half	0.105	0.356***	0.366***	0.313**
	(0.146)	(0.114)	(0.115)	(0.148)
X * Nutrition all	0.428**	0.336**	0.525***	0.147
	(0.193)	(0.131)	(0.142)	(0.162)
N	17778	26655	17766	17766
AIC	8389.996	12337.968	8072.761	8141.197
BIC	8639.139	12600.071	8321.882	8390.319
Log-likelihood	-4162.998	-6136.984	-4004.380	-4038.599

Notes: Standard errors are reported between parentheses. Significant differences are indicated with * p < 0.1, ** p < 0.05 or *** p < 0.01. Full regression results including standard deviations are reported in table A4 in appendix. [a] The individual experiments of both men and women.

Table 3: Estimation results for the MXL models using split samples (men, women and joint) and interaction terms using sample-specific dummies for the Uganda sample

Interaction term X	(1) Men versus women (X)	(2) Individual [a] versus joint (X)	(3) Men versus joint (X)	(4) Women versus joint (X)
Mean preferences				
Children	0.114***	0.147***	0.111***	0.206***
	(0.034)	(0.024)	(0.033)	(0.033)
Children^2	-0.009***	-0.012***	-0.009***	-0.016***
	(0.003)	(0.002)	(0.003)	(0.003)
Education half	1.428***	1.853***	1.392***	2.385***
	(0.124)	(0.099)	(0.129)	(0.121)
Education all	2.966***	3.304***	2.832***	3.835***
	(0.198)	(0.157)	(0.185)	(0.180)
Health care medium	0.417***	0.744***	0.404***	1.088***
	(0.076)	(0.064)	(0.073)	(0.100)
Health care high	0.754***	1.010***	0.747***	1.347***
	(0.080)	(0.063)	(0.088)	(0.095)
Nutrition half	1.761***	1.617***	1.709***	1.529***
	(0.126)	(0.090)	(0.128)	(0.113)
Nutrition all	2.060***	1.824***	2.031***	1.669***
	(0.150)	(0.110)	(0.145)	(0.128)
Preference heterogeneity				
X * Children	0.122**	-0.016	0.024	-0.066
	(0.049)	(0.032)	(0.042)	(0.040)
X * Children^2	-0.009**	0.002	-0.001	0.006*
	(0.004)	(0.003)	(0.003)	(0.003)
X * Education half	1.141***	0.231	0.936***	-0.215
	(0.191)	(0.154)	(0.176)	(0.173)
X * Education all	1.259***	0.527***	1.045***	0.128
	(0.237)	(0.170)	(0.222)	(0.217)
X * Health care medium	0.784***	0.165*	0.527***	-0.164
	(0.125)	(0.088)	(0.106)	(0.113)
X * Health care high	0.683***	0.153*	0.418***	-0.139
	(0.126)	(0.090)	(0.119)	(0.109)
X * Nutrition half	-0.102	0.287**	0.249*	0.386***
	(0.157)	(0.130)	(0.147)	(0.149)
X * Nutrition all	-0.203	0.187	0.100	0.348**
	(0.199)	(0.128)	(0.170)	(0.166)
N	18000	27000	18000	18000
AIC	8147.691	12145.048	8129.786	7735.560
BIC	8397.231	12407.563	8379.326	7985.100
Log-likelihood	-4041.846	-6040.524	-4032.893	-3835.780

Notes: Standard errors are reported between parentheses. Significant differences are indicated with * p < 0.1, ** p < 0.05 or *** p < 0.01. Full regression results including standard deviations are reported in table A5 in appendix. [a] The individual experiments of both men and women.

4.2. Intra-household decision-making

We summarize the intra-household decision-making coefficient in table 4 and figure 1. We find a mean decision-making coefficient of 0.64 for Senegal and 0.45 for Uganda. This implies a stronger decision-making position for men in the couple experiment in the Senegal sample, while the couple experiment is the result of rather balanced decision-making in the Uganda sample. As we find that the individual samples of Ugandan men and women showcase highly dissimilar preference structures (table 3 model 1), the balanced decision-making coefficient suggests that couple choices are the result of bargaining between spouses. Figure 1 illustrates the distribution of the country-specific decision-making coefficients with a kernel density plot. We find that there is more variation in the coefficient of the Uganda sample, with a particularly long right tail, compared to the coefficient of the Senegal sample which is centred around the mean. When we split up the sample in decision-making groups, we find that the couples' choices are dominated by the husband's preferences for the large majority of sampled Senegalese couples (86.2%). The remaining Senegalese couples make choices that are more balanced towards the preferences of both spouses. There are no woman-dominant couples present in the Senegal sample. In the Uganda sample, more than half of the couples make balanced choices (52%), a large share of the couples' choices (37.2%) are dominated by women's preferences, and only 10.8% of the couples' choices are male-dominated.

We characterize the decision-making groups on the basis of observable socio-economic and demographic characteristics (table A6 in appendix). While we do not find many significant differences between the groups, the results point towards some differences with respect to the husbands' education level and households' sources of income, for both the Senegal and Uganda sample. We find in Senegal that balanced decision-making couples are more likely to report income from cropping activities, and less likely to report income from unearned sources when compared to man-dominant households. In addition, the husband in balanced decision-making couples is more likely to hold a primary education diploma compared to man-dominant couples where the husband is more likely to be uneducated. In Uganda, woman-dominant couples'

villages are less likely to be located next to a surfaced road and the husband has less likely received higher education, compared to man-dominant[9] or balanced decision-making couples. As in Senegal, Ugandan man-dominant couples are more likely to receive income from unearned sources. Remarkably, we do not find any correlation between the decision-making groups and socio-economic characteristics typically associated with increased or decreased decision-making power of women, such as having a polygamous marriage, the woman's education level, or the age and education difference between spouses[10], nor do we find differences across ethnicities.

Table 4: Characteristics of the decision-making coefficient

	Senegal	***Uganda***
Number of observations	247	250
Decision-making coefficient	0.641	0.45
	(0.044)	(0.124)
Decision-making dominated by:		
Woman (0/1) [a]	0	0.372
Man (0/1) [b]	0.862	0.108
Balanced decision-making (0/1) [c]	0.138	0.52

Notes: Standard deviations are reported between parentheses. [a] Decision-making coefficient ≤ 0.4. [b] Decision-making coefficient > 0.6. [c] Decision-making coefficient > 0.4 and ≤ 0.6.

[9] Non-significant differences, likely because of the man-dominant group's small size.

[10] As the Senegalese database is more detailed, we also checked for differences in the woman's employment sector, knowledge and use of contraception, and self-reported happiness and richness. None of these indicators were significantly different across decision-making groups.

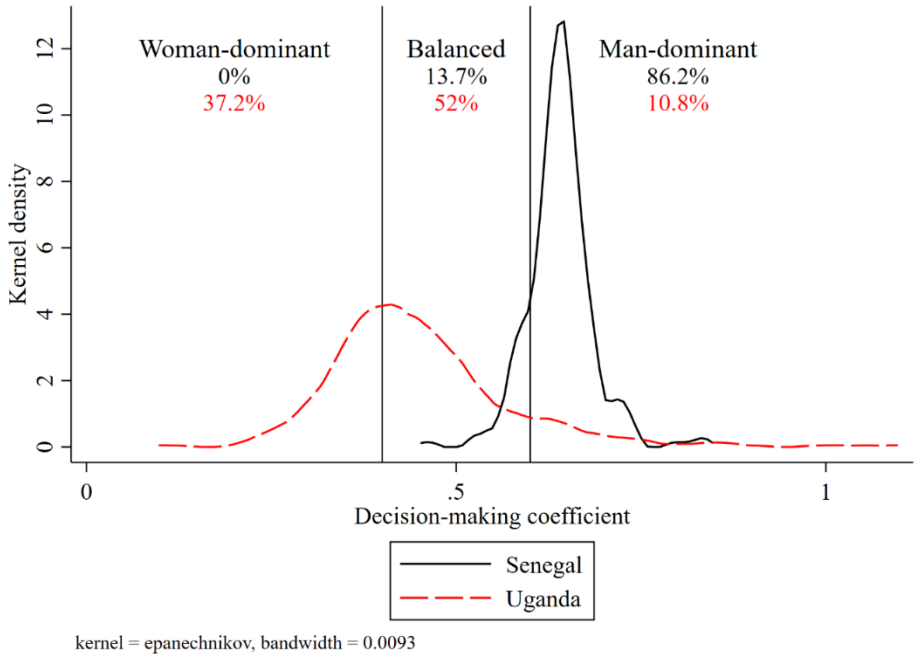

Figure 1: Country-specific kernel density visualisation of decision-making coefficient. Decision-making groups' cut-offs are visualised at x = 0.4 and x = 0.6, and couple-specific decision-making group categorisations are indicated (Source: authors' calculations).

We are interested in the link between intra-household decision-making and the choices couples make, as these will represent most the decisions couples will take in real life. We therefore only use the couples sample in the following analysis (table 5). For the Senegal sample, we find that in general, couples deciding in a more balanced way have a lower preference for the attribute number of children compared to couples in which the husband dominates the couple's decision. On the other hand, while man-dominant couples' preference for the number of children is concavely shaped – marginal utility decreases for each additional child – balanced decision-making couples' preference for the number of children is convexly shaped – when the number of children increases these couples continue to prefer having an additional child. These results suggest that

man-dominant couples pay more attention or attach more value to the attribute "number of children" in general, irrespective of the number of children this attribute represents. On the other hand, balanced decision-making couples derive positive marginal utility from each additional child, meaning that in general they prefer larger households to smaller, but the attribute "number of children" in general contributes less to their preference structure. Secondly, we find that balanced decision-making couples derive a lower preference for being able to provide secondary education to half of their children or being able to provide high-quality health care, compared to couples where the man dominates the couple's decisions. This could point towards a separate spheres society where men decide over education and health care (more expensive relative to nutrition), such that men care considerably more for, or are considerably more invested in these child-raising areas.

For the Uganda sample, in line with the results from the individual and couple experiments in table 3, we find that when the wife dominates the couple's experiment, preferences for education and health care are higher, and preferences for nutrition are lower, than when the husband dominates or when there is balanced decision-making. We find that the preference structure of balanced decision-making couples does not differ greatly from the preference structure of single-spouse dominant couples. They only have a higher preference for being able to provide a better nutrition for their children or being able to provide secondary education to all of their children. When we compare the decision-making groups in a pairwise manner (table A7 in appendix), we find that balanced decision-making couples demonstrate higher preferences for education when compared to man-dominant couples, and higher preferences for nutrition when compared to woman-dominant couples. Woman-dominant couples show higher preferences for education and lower preferences for nutrition compared to man-dominant couples.

Table 5: Country-specific estimation results for the MXL models using the couple sample, and interaction terms with the decision-making groups. In the Senegal sample, balanced decision-making couples are compared with man-dominant couples (2); in the Uganda sample respectively man-dominant couples (4), woman-dominant couples (5) and balanced decision-making couples (6) are compared with the other two decision-making groups.

Couple sample only	***Senegal***		***Uganda***			
	(1)	(2)	(3)	(4)	(5)	(6)
Interaction term X		d-m balanced (0/1)		d-m man (0/1)	d-m woman (0/1)	d-m balanced (0/1)
Mean preferences						
Children	0.187***	0.231***	0.127***	0.136***	0.119***	0.127***
	(0.036)	(0.039)	(0.034)	(0.035)	(0.043)	(0.046)
Children^2	-0.012***	-0.016***	-0.009***	-0.009***	-0.008**	-0.010***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
Education half	2.229***	2.421***	2.025***	2.108***	1.706***	2.033***
	(0.119)	(0.133)	(0.161)	(0.166)	(0.167)	(0.197)
Education all	3.380***	3.525***	3.864***	3.966***	3.698***	3.429***
	(0.146)	(0.164)	(0.212)	(0.226)	(0.241)	(0.271)
Health care medium	0.784***	0.854***	0.884***	0.846***	0.763***	0.982***
	(0.092)	(0.102)	(0.093)	(0.100)	(0.112)	(0.122)
Health care high	1.757***	1.841***	1.122***	1.133***	0.960***	1.195***
	(0.105)	(0.116)	(0.094)	(0.100)	(0.103)	(0.131)
Nutrition half	2.054***	2.026***	1.822***	1.741***	2.085***	1.499***
	(0.115)	(0.119)	(0.139)	(0.152)	(0.165)	(0.182)
Nutrition all	2.481***	2.451***	1.996***	1.876***	2.265***	1.557***
	(0.134)	(0.143)	(0.158)	(0.159)	(0.190)	(0.183)
Preference heterogeneity						
X * Children		-0.265***		-0.016	0.054	0.008
		(0.092)		(0.144)	(0.077)	(0.070)
X * Children^2		0.027***		-0.002	-0.005	0.002
		(0.007)		(0.011)	(0.006)	(0.005)
X * Education half		-0.818***		-0.585	1.300***	0.141
		(0.295)		(0.415)	(0.348)	(0.279)
X * Education all		-0.542		-0.635	1.329***	0.788**
		(0.339)		(0.464)	(0.430)	(0.400)
X * Health care medium		-0.337		0.262	0.375*	-0.226
		(0.235)		(0.240)	(0.204)	(0.182)
X * Health care high		-0.519*		-0.131	0.461**	-0.131
		(0.270)		(0.222)	(0.207)	(0.179)
X * Nutrition half		0.285		0.902**	-0.632**	0.804**
		(0.387)		(0.389)	(0.276)	(0.314)
X * Nutrition all		0.511		0.792	-0.674**	0.736**
		(0.426)		(0.501)	(0.303)	(0.288)
N	8877	8877	9000	9000	9000	9000
AIC	3909.423	3881.949	3859.392	3853.384	3815.106	3859.649
BIC	4022.883	4108.868	3973.072	4080.744	4042.465	4087.009
Log-likelihood	-1938.712	-1908.975	-1913.696	-1894.692	-1875.553	-1897.825

Notes: Standard errors are reported between parentheses. Significant differences are indicated with * p < 0.1, ** p < 0.05 or *** p < 0.01. d.m. = decision-making. Full regression results including standard deviations are reported in table A8 in appendix.

5. Discussion and conclusion

Our results can be summarized with respect to three main themes. First, based on the comparison of the men's and women's subsample preference structures, we find that the assumptions of the unitary household model and the practice of traditional survey-based data collections – to select one member from the household for preference elicitation and to treat that member's choice as a reliable substitute for the overall household choice – should be used in a more considerate way and results should be interpreted with more caution. Moreover, while the choices that couples make are somewhat more in line with the choices men make individually and hence with men's preferences, our results show that a representative mix of husbands and wives cannot substitute for choices made at the household level. These findings are in line with many other experiments from varying disciplines (e.g. Beblo & Beninger (2017), Beck & Rose (2019), Beharry-Borg et al. (2009), Braaten & Martinsson (2015), Mariel et al. (2018)). In both the Ugandan and the Senegalese subsamples we find proof of the group polarization phenomenon as described by Beharry-Borg et al. (2009), as we find that couples' preferences are more extreme than the preferences found for the men's or women's subsamples.

Second, the country-specific decision-making coefficients show that in Uganda the couples experiments were implemented in a rather balanced and cooperative way (mean decision-making coefficient 0.45), while in Senegal the majority of the couples experiments were dominated by the husband (mean decision-making coefficient 0.64). While we hypothesized that socio-economic variables typically associated with increased or decreased decision-making power of women – such as having a polygamous marriage, the woman's education level, or the age and education difference between spouses – could explain at least partially the differences between the decision-making groups, we do not find socio-economic drivers that are comparable across countries. Deeply rooted cultural, ethnic or religious identity and social norms could possibly explain the observed differences between Senegal and Uganda to some extent. While we find that some contemporary indicators of female empowerment, such as the Gender Inequality Index or the child marriage rate, are highly similar in Senegal and

Uganda, both countries have a distinct religious (Senegal is mainly Islamic, while Uganda is mainly Christian) and colonial background. Anthropological insights could be helpful in clarifying our findings, but studying such aspects is beyond the scope of this dissertation.

Still, our finding supports a recent report on bodily autonomy and integrity for women and girls (UNFPA, 2021). It reports on three dimensions regarding bodily autonomy and integrity (being able to individually decide on health care, contraception and sex with their partners), and shows that Senegal stands amongst the worst scoring countries, together with Niger and Mali, considering bodily integrity and autonomous reproductive health care decision-making of women. While overall in SSA around 50% of women can decide autonomously, only 7% can in Senegal, compared to 62% in Uganda. This lack of autonomy in reproductive health decision-making is reflected in our decision-making coefficient.

Third, when we link fertility and child-raising choices of couples with the underlying intra-household decision-making, we find that results are highly country-specific. In Senegal, preference structures differ greatly when we compare man-dominant and balanced decision-making couples. Couples that decide in a more balanced, cooperative way care less about the fertility in the household, however, they derive positive marginal utility for each additional child, meaning they prefer larger households to smaller. Man-dominant couples, on the other hand, care considerably more about the size of the household. However, when the number of children increases, the marginal utility these couples derive from an extra child decreases. The results show that Senegalese man-dominant couples have a higher preference for education and health care compared to couples with more balanced decision-making. As being the responsible for children's education and health care is traditionally the husband's task in SSA, while women are in charge of catering to daily needs which require lower financial investments (Deschênes, Dumas, & Lambert, 2020), our results suggest a link with the separate spheres household model of Lundberg & Pollak (1993) that considers the non-cooperative equilibrium in a marriage to lead to a consolidation of traditional gender roles. Still, we should remain cautious when deriving implications from this

result, as the balanced decision-making group is small relative to the man-dominant group (34 vs 213 couples).

In Uganda, we find that especially couples where the wife dominates the couple's decisions have diverging preference structures. These couples have a higher preference for education and health care, and a lower preference for nutrition, compared to man-dominant couples and couples relying on more balanced decision-making. This finding supports evidence from Uganda showing that mothers care more about their children's health compared to fathers (Nyqvist & Jayachandran, 2017; Sunder, 2019). Remarkably, we do not find important differences in preference structures (except for the greater importance of nutrition) when we compare balanced decision-making couples with individual decision-making couples. This goes against existing studies that show that household are better off when decision-making is spread more evenly between spouses (Iversen, Jackson, Kebede, Munro, & Verschoor, 2011; G. Lancaster, Maitra, & Ray, 2006; A. S. McCarthy, 2019; N. McCarthy & Kilic, 2017).

In line with the critiques of Munro (2018) on the interpretation of the decision-making coefficient used in several experiments, we must remain cautious when interpreting our results. While we find differences in fertility and child-raising preferences across the decision-making groups, we do not find proof of differences in socio-demographic characteristics between groups. Munro (2018) attributes the lack of clear patterns in preference structures when considering Beharry-Borg et al. (2009)'s experiment, to the impossibility of the experiment to disentangle respondents who answered the individual experiment from an egocentric perspective from respondents who already considered their spouses' preferences during the individual experiment. Our experiment is not able to disentangle these two lines of thought either, which may therefore have a confounding effect on our results. We do not account for differences in scale parameter between the individual and couples experiments, which – as Munro (2018) explains – could result in the wrong attribution of randomness in choices to a difference in decision-making power. However, as we do not find evidence for scale heterogeneity in the country-specific subsamples, we do not expect our results to be biased by a high level of randomness in respondents' answers. We must not mistake decision-making

power in the domestic sphere with female empowerment, as Williams & Chen (2014) reveal that an increased decision-making power on household-related topics may increase women's acceptance of a status quo in which they have less power overall, outside their traditional role.

Our study on the impact of intra-couple decision-making on fertility and child-raising preferences reveals the importance of considering the adequate decision-making unit when considering family planning and child-centred programs. While we find that Senegalese women have different preferences from their partners, they do not have the agency to act on these preferences (86.2% of the couples experiments are dominated by the husband). As Senegalese women do not have proper autonomy over their own body, fertility and child-raising outcomes in rural Senegal will most likely follow men's preferences. Family planning and child-centred programs in Senegal must therefore – apart from triggering an increase in the decision-making power of women – incentivize men to participate in these programs. In Uganda, on the other hand, women seem to be much better able to decide and act on their own preferences, as the majority of the couples experiments (52%) was implemented using cooperative decision-making, and another 37.6% of the couples experiments was dominated by the woman. Here, programs focussing on women as the main beneficiary will likely be more efficient if the program addresses child education or health care, while couples should be addressed when the main goal is to trigger changes in child nutrition.

6. Appendix

Table A1: Results of the attribute non-attendance analysis for the Senegalese individual subsamples

	Men sample		Women sample	
	Basic	SANA	Basic	SANA
Mean effects				
Children	0.220***	0.248***	0.033	0.045
	(0.034)	(0.038)	(0.031)	(0.033)
Children^2	-0.014***	-0.015***	-0.000	-0.001
	(0.003)	(0.003)	(0.002)	(0.003)
Education half	1.758***	1.808***	1.700***	1.657***
	(0.106)	(0.124)	(0.106)	(0.112)
Education all	2.938***	2.964***	2.865***	2.814***
	(0.125)	(0.146)	(0.133)	(0.132)
Health care medium	0.699***	0.602***	0.570***	0.579***
	(0.090)	(0.099)	(0.080)	(0.084)
Health care high	1.600***	1.457***	1.366***	1.364***
	(0.108)	(0.110)	(0.098)	(0.102)
Nutrition half	1.754***	1.669***	1.788***	1.816***
	(0.105)	(0.116)	(0.113)	(0.126)
Nutrition all	2.100***	1.961***	2.399***	2.405***
	(0.121)	(0.137)	(0.134)	(0.146)
Ignored number of children [a] * Children		-0.115		-0.077
		(0.080)		(0.105)
Ignored number of children [a] * Children^2		0.006		0.010
		(0.006)		(0.008)
Ignored number of children [a] * Education half		-0.006		0.539
		(0.264)		(0.408)
Ignored number of children [a] * Education all		0.235		0.466

		(0.303)		(0.629)
Ignored number of children [a] * Health care medium		0.590**		-0.250
		(0.267)		(0.261)
Ignored number of children [a] * Health care high		0.942***		0.092
		(0.313)		(0.313)
Ignored number of children [a] * Nutrition half		0.586*		-0.092
		(0.308)		(0.287)
Ignored number of children [a] * Nutrition all		0.971**		-0.310
		(0.418)		(0.313)
Standard deviation				
Children	0.048	-0.029	0.027	-0.017
	(0.032)	(0.036)	(0.018)	(0.018)
Children^2	-0.000	-0.003	-0.001	-0.001
	(0.006)	(0.003)	(0.001)	(0.001)
Education half	0.394**	0.331**	0.279*	-0.293
	(0.168)	(0.168)	(0.162)	(0.200)
Education all	0.777***	0.806***	0.751***	0.796***
	(0.104)	(0.112)	(0.098)	(0.095)
Health care medium	-0.307*	-0.256	0.091**	0.108**
	(0.179)	(0.177)	(0.043)	(0.049)
Health care high	0.954***	0.927***	0.821***	0.808***
	(0.090)	(0.085)	(0.101)	(0.107)
Nutrition half	-0.371**	-0.373***	-0.474***	-0.398***
	(0.156)	(0.129)	(0.105)	(0.146)
Nutrition all	0.720***	0.643***	0.927***	0.913***
	(0.122)	(0.152)	(0.105)	(0.101)
Ignored number of children [a] * Children		0.062		0.022
		(0.108)		(0.056)
Ignored number of children [a] * Children^2		-0.003		-0.002
		(0.005)		(0.004)
Ignored number of children [a] * Education half		-0.175		-0.251

		(0.252)		(0.224)
Ignored number of children [a] * Education all		0.438***		0.221
		(0.147)		(0.213)
Ignored number of children [a] * Health care medium		0.286		-0.397
		(0.243)		(0.328)
Ignored number of children [a] * Health care high		0.884***		0.786
		(0.169)		(0.531)
Ignored number of children [a] * Nutrition half		0.225		-0.269
		(0.409)		(0.198)
Ignored number of children [a] * Nutrition all		0.751**		-0.224
		(0.309)		(0.257)
N	8889	8889	8889	8889
AIC	4176.021	4163.772	4219.415	4237.924
BIC	4289.503	4390.734	4332.896	4464.886
Log likelihood	-2072.011	-2049.886	-2093.708	-2086.962

Notes: Standard errors are reported between parentheses. Significant differences are indicated with * $p < 0.1$, ** $p < 0.05$ or *** $p < 0.01$. SANA = stated attribute non-attendance. [a] Respondent indicated to have ignored the attribute "number of children" after the completion of the individual choice experiment, meaning that they did not take this attribute actively into account when making their decision.

Table A2: Results of the scale heterogeneity analysis for the Senegalese individual and couple subsamples

	Men sample		Women sample		Couple sample	
	Basic	Scale heterogeneity	Basic	Scale heterogeneity	Basic	Scale heterogeneity
Mean preferences						
Children	0.220***	0.229***	0.033	0.041	0.180***	0.186***
	(0.034)	(0.037)	(0.031)	(0.035)	(0.035)	(0.038)
Children^2	-0.014***	-0.014***	-0.000	-0.000	-0.012***	-0.012***
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)
Education half	1.758***	1.835***	1.700***	1.886***	2.185***	2.351***
	(0.106)	(0.122)	(0.106)	(0.163)	(0.114)	(0.145)
Education all	2.938***	3.071***	2.865***	3.139***	3.277***	3.501***
	(0.125)	(0.162)	(0.133)	(0.229)	(0.135)	(0.167)
Health care medium	0.699***	0.766***	0.570***	0.661***	0.763***	0.836***
	(0.090)	(0.106)	(0.080)	(0.099)	(0.088)	(0.100)
Health care high	1.600***	1.679***	1.366***	1.487***	1.716***	1.839***
	(0.108)	(0.124)	(0.098)	(0.120)	(0.104)	(0.125)
Nutrition half	1.754***	1.841***	1.788***	2.011***	1.994***	2.140***
	(0.105)	(0.123)	(0.113)	(0.197)	(0.108)	(0.130)
Nutrition all	2.100***	2.168***	2.399***	2.659***	2.415***	2.592***
	(0.121)	(0.148)	(0.134)	(0.218)	(0.127)	(0.146)
Standard deviation						
Children	0.048	0.017	0.027	0.004	0.052***	0.020
	(0.032)	(0.066)	(0.018)	(0.058)	(0.018)	(0.034)
Children^2	-0.000	0.002	-0.001	-0.001	0.001	-0.002
	(0.006)	(0.004)	(0.001)	(0.002)	(0.002)	(0.002)
Education half	0.394**	-0.499***	0.279*	-0.313	0.197	0.185
	(0.168)	(0.131)	(0.162)	(0.332)	(0.169)	(0.257)
Education all	0.777***	0.818***	0.751***	0.853***	0.792***	0.856***
	(0.104)	(0.140)	(0.098)	(0.106)	(0.113)	(0.142)
Health care medium	-0.307*	0.141	0.091**	0.104*	0.054	0.088

	(0.179)	(0.361)	(0.043)	(0.062)	(0.107)	(0.158)
Health care high	0.954***	0.992***	0.821***	0.869***	0.890***	0.986***
	(0.090)	(0.095)	(0.101)	(0.111)	(0.097)	(0.109)
Nutrition half	-0.371**	0.216	-0.474***	-0.410***	-0.190	-0.105
	(0.156)	(0.162)	(0.105)	(0.132)	(0.186)	(0.495)
Nutrition all	0.720***	0.764***	0.927***	0.984***	0.647***	0.681***
	(0.122)	(0.123)	(0.105)	(0.114)	(0.115)	(0.129)
τ		0.254**		-0.371***		-0.294***
		(0.110)		(0.099)		(0.073)
N	8889	8889	8889	8889	8877	8877
AIC	4176.021	4171.765	4219.415	4207.524	3924.716	3917.546
BIC	4289.503	4292.339	4332.896	4328.098	4038.175	4038.097
Log likelihood	-2072.011	-2068.882	-2093.708	-2086.762	-1946.358	-1941.773

Notes: Standard errors are reported between parentheses. Significant differences are indicated with * $p < 0.1$, ** $p < 0.05$ or *** $p < 0.01$.

Table A3: Results of the scale heterogeneity analysis for the Ugandan individual and couple subsamples

	Men sample		Women sample		Couple sample	
	Basic	Scale heterogeneity	Basic	Scale heterogeneity	Basic	Scale heterogeneity
Mean preferences						
Children	0.105***	0.214***	0.207***	0.213***	0.126***	0.143***
	(0.033)	(0.062)	(0.036)	(0.033)	(0.033)	(0.039)
Children^2	-0.009***	-0.016***	-0.016***	-0.017***	-0.009***	-0.010***
	(0.003)	(0.005)	(0.003)	(0.003)	(0.003)	(0.003)
Education half	1.339***	1.980***	2.356***	2.321***	1.986***	2.259***
	(0.127)	(0.313)	(0.137)	(0.127)	(0.168)	(0.247)
Education all	2.713***	3.807***	3.709***	3.708***	3.699***	4.001***
	(0.220)	(0.653)	(0.171)	(0.188)	(0.192)	(0.373)
Health care medium	0.411***	0.457***	1.104***	1.101***	0.863***	0.921***
	(0.073)	(0.097)	(0.100)	(0.097)	(0.092)	(0.120)
Health care high	0.742***	0.845***	1.345***	1.343***	1.095***	1.164***
	(0.084)	(0.129)	(0.097)	(0.096)	(0.088)	(0.127)
Nutrition half	1.712***	2.600***	1.540***	1.531***	1.742***	2.067***
	(0.124)	(0.370)	(0.112)	(0.114)	(0.135)	(0.248)
Nutrition all	2.037***	2.934***	1.681***	1.681***	1.928***	2.141***
	(0.155)	(0.405)	(0.140)	(0.132)	(0.145)	(0.231)
Standard deviation						
Children	-0.058***	0.096***	-0.037	-0.068**	-0.042***	0.016
	(0.016)	(0.021)	(0.147)	(0.032)	(0.012)	(0.026)
Children^2	0.001	0.003**	0.006	0.006***	0.000	0.002
	(0.002)	(0.001)	(0.006)	(0.002)	(0.001)	(0.002)
Education half	-0.868***	0.551***	-1.075***	0.683***	-1.371***	1.287***
	(0.176)	(0.198)	(0.167)	(0.201)	(0.194)	(0.310)
Education all	1.696***	1.969***	1.624***	1.688***	2.052***	2.066***
	(0.154)	(0.241)	(0.181)	(0.144)	(0.153)	(0.241)
Health care medium	0.043	-0.253	-0.146	0.109	0.064	0.213

	(0.199)	(0.242)	(0.295)	(0.200)	(0.147)	(0.201)
Health care high	0.551***	-0.508**	-0.052	0.136	-0.109	-0.192
	(0.165)	(0.240)	(0.287)	(0.203)	(0.233)	(0.185)
Nutrition half	-0.203	-0.096	-0.469**	0.403**	0.528***	0.353***
	(0.209)	(0.256)	(0.195)	(0.164)	(0.156)	(0.131)
Nutrition all	0.837***	-1.060***	0.731***	0.711***	0.835***	0.858***
	(0.119)	(0.286)	(0.175)	(0.123)	(0.113)	(0.152)
τ		0.735***		0.006		0.457***
		(0.147)		(0.127)		(0.124)
N	9000	9000	9000	9000	9000	9000
AIC	4322.150	4288.312	3899.874	3911.740	3861.729	3891.292
BIC	4435.829	4409.096	4013.553	4032.524	3975.408	4012.077
Log likelihood	-2145.075	-2127.156	-1933.937	-1938.870	-1914.864	-1928.646

Notes: Standard errors are reported between parentheses. Significant differences are indicated with * $p < 0.1$, ** $p < 0.05$ or *** $p < 0.01$.

Table A4: Complete estimation results for the MXL models using split samples (men, women and joint) and interaction terms using sample-specific dummies for the Senegal sample

Interaction term X	(1) Men versus women (X)	(2) Individual [a] versus joint (X)	(3) Men versus joint (X)	(4) Women versus joint (X)
Mean preferences				
Children	0.220***	0.123***	0.221***	0.034
	(0.033)	(0.022)	(0.033)	(0.032)
Children^2	-0.014***	-0.007***	-0.014***	-0.000
	(0.003)	(0.002)	(0.003)	(0.002)
Education half	1.775***	1.698***	1.779***	1.691***
	(0.110)	(0.073)	(0.107)	(0.110)
Education all	2.969***	2.851***	2.967***	2.792***
	(0.127)	(0.090)	(0.126)	(0.135)
Health care medium	0.707***	0.630***	0.714***	0.567***
	(0.091)	(0.062)	(0.091)	(0.080)
Health care high	1.584***	1.455***	1.579***	1.365***
	(0.101)	(0.075)	(0.098)	(0.101)
Nutrition half	1.752***	1.755***	1.750***	1.780***
	(0.103)	(0.084)	(0.103)	(0.115)
Nutrition all	2.079***	2.242***	2.081***	2.414***
	(0.123)	(0.096)	(0.122)	(0.137)
Preference heterogeneity				
X * Children	-0.184***	0.069**	-0.028	0.156***
	(0.047)	(0.033)	(0.038)	(0.043)
X * Children^2	0.014***	-0.006**	0.002	-0.012***
	(0.004)	(0.003)	(0.003)	(0.003)
X * Education half	-0.032	0.613***	0.536***	0.592***
	(0.160)	(0.121)	(0.138)	(0.168)
X * Education all	-0.095	0.622***	0.517***	0.636***
	(0.175)	(0.145)	(0.163)	(0.200)
X * Health care medium	-0.121	0.186**	0.093	0.231**
	(0.116)	(0.083)	(0.088)	(0.105)
X * Health care high	-0.190	0.340***	0.208**	0.411***
	(0.134)	(0.098)	(0.096)	(0.132)
X * Nutrition half	0.105	0.356***	0.366***	0.313**
	(0.146)	(0.114)	(0.115)	(0.148)
X * Nutrition all	0.428**	0.336**	0.525***	0.147
	(0.193)	(0.131)	(0.142)	(0.162)
Standard deviation				
Children	-0.023	-0.034**	-0.055***	0.027
	(0.053)	(0.014)	(0.013)	(0.017)
Children^2	0.003	-0.001	0.002*	0.000
	(0.003)	(0.001)	(0.001)	(0.002)
Education half	-0.352**	0.284*	-0.197	0.336
	(0.165)	(0.160)	(0.195)	(0.211)
Education all	0.784***	0.797***	0.752***	0.727***
	(0.078)	(0.076)	(0.094)	(0.092)

Health care medium	0.133	-0.006	0.135	0.010
	(0.124)	(0.066)	(0.131)	(0.054)
Health care high	0.908***	0.840***	0.938***	0.864***
	(0.077)	(0.072)	(0.087)	(0.188)
Nutrition half	0.369*	0.414***	0.440***	0.449***
	(0.190)	(0.094)	(0.101)	(0.122)
Nutrition all	0.840***	0.787***	0.722***	0.794***
	(0.083)	(0.076)	(0.094)	(0.093)
X * Children	-0.013	0.035	-0.044***	-0.016
	(0.017)	(0.038)	(0.013)	(0.072)
X * Children^2	0.001	0.004*	-0.000	-0.004*
	(0.001)	(0.002)	(0.001)	(0.002)
X * Education half	0.162	-0.200	-0.355*	0.131
	(0.994)	(0.320)	(0.200)	(0.265)
X * Education all	-0.269	-0.154	-0.459***	-0.449**
	(0.548)	(0.361)	(0.138)	(0.183)
X * Health care medium	0.207**	0.289***	0.281***	0.264**
	(0.082)	(0.099)	(0.088)	(0.109)
X * Health care high	-0.118	0.596***	0.367	0.202
	(0.408)	(0.165)	(0.272)	(1.673)
X * Nutrition half	-0.393**	-0.188	0.105	-0.049
	(0.189)	(0.199)	(0.153)	(0.204)
X * Nutrition all	-0.027	-0.242	-0.205	-0.197
	(0.681)	(0.166)	(0.237)	(0.398)
N	17778	26655	17766	17766
AIC	8389.996	12337.968	8072.761	8141.197
BIC	8639.139	12600.071	8321.882	8390.319
Log-likelihood	-4162.998	-6136.984	-4004.380	-4038.599

Notes: Standard errors are reported between parentheses. Significant differences are indicated with * $p < 0.1$, ** $p < 0.05$ or *** $p < 0.01$. [a] The individual experiments of both men and women.

Table A5: Complete estimation results for the MXL models using split samples (men, women and joint) and interaction terms using sample-specific dummies for the Uganda sample

Interaction term X	(1) Men versus women (X)	(2) Individual [a] versus joint (X)	(3) Men versus joint (X)	(4) Women versus joint (X)
Mean preferences				
Children	0.114***	0.147***	0.111***	0.206***
	(0.034)	(0.024)	(0.033)	(0.033)
Children^2	-0.009***	-0.012***	-0.009***	-0.016***
	(0.003)	(0.002)	(0.003)	(0.003)
Education half	1.428***	1.853***	1.392***	2.385***
	(0.124)	(0.099)	(0.129)	(0.121)
Education all	2.966***	3.304***	2.832***	3.835***
	(0.198)	(0.157)	(0.185)	(0.180)
Health care medium	0.417***	0.744***	0.404***	1.088***
	(0.076)	(0.064)	(0.073)	(0.100)
Health care high	0.754***	1.010***	0.747***	1.347***
	(0.080)	(0.063)	(0.088)	(0.095)
Nutrition half	1.761***	1.617***	1.709***	1.529***
	(0.126)	(0.090)	(0.128)	(0.113)
Nutrition all	2.060***	1.824***	2.031***	1.669***
	(0.150)	(0.110)	(0.145)	(0.128)
Preference heterogeneity				
X * Children	0.122**	-0.016	0.024	-0.066
	(0.049)	(0.032)	(0.042)	(0.040)
X * Children^2	-0.009**	0.002	-0.001	0.006*
	(0.004)	(0.003)	(0.003)	(0.003)
X * Education half	1.141***	0.231	0.936***	-0.215
	(0.191)	(0.154)	(0.176)	(0.173)
X * Education all	1.259***	0.527***	1.045***	0.128
	(0.237)	(0.170)	(0.222)	(0.217)
X * Health care medium	0.784***	0.165*	0.527***	-0.164
	(0.125)	(0.088)	(0.106)	(0.113)
X * Health care high	0.683***	0.153*	0.418***	-0.139
	(0.126)	(0.090)	(0.119)	(0.109)
X * Nutrition half	-0.102	0.287**	0.249*	0.386***
	(0.157)	(0.130)	(0.147)	(0.149)
X * Nutrition all	-0.203	0.187	0.100	0.348**
	(0.199)	(0.128)	(0.170)	(0.166)
Standard deviation				
Children	-0.018	0.014	0.035	0.055***
	(0.025)	(0.038)	(0.069)	(0.017)
Children^2	0.005***	-0.005***	0.003	0.004**
	(0.001)	(0.001)	(0.006)	(0.002)
Education half	1.102***	1.064***	0.956***	-1.017***
	(0.125)	(0.155)	(0.172)	(0.121)
Education all	1.745***	1.888***	1.624***	1.686***
	(0.095)	(0.100)	(0.104)	(0.122)

Health care medium	0.236	0.140	-0.281***	-0.281***
	(0.144)	(0.205)	(0.104)	(0.083)
Health care high	0.476***	0.423***	0.512***	0.004
	(0.093)	(0.097)	(0.099)	(0.200)
Nutrition half	-0.079	-0.156	-0.212	0.527***
	(0.194)	(0.200)	(0.160)	(0.086)
Nutrition all	0.910***	0.844***	0.878***	0.791***
	(0.083)	(0.084)	(0.081)	(0.124)
X * Children	0.029	0.003	0.004	0.001
	(0.020)	(0.009)	(0.018)	(0.025)
X * Children^2	0.009***	-0.002	0.002	0.001
	(0.002)	(0.001)	(0.002)	(0.001)
X * Education half	0.560***	-1.099***	1.353***	1.179***
	(0.154)	(0.332)	(0.181)	(0.253)
X * Education all	0.531**	0.054	2.166***	1.755***
	(0.225)	(0.556)	(0.293)	(0.210)
X * Health care medium	-0.106	0.248	0.163	0.175
	(0.241)	(0.347)	(0.154)	(0.165)
X * Health care high	0.002	-0.020	0.264***	0.401***
	(0.117)	(0.131)	(0.098)	(0.139)
X * Nutrition half	0.562***	-0.813***	0.631***	-0.475***
	(0.105)	(0.167)	(0.124)	(0.154)
X * Nutrition all	-0.247**	-0.573***	-0.328	0.646***
	(0.104)	(0.173)	(0.278)	(0.241)
N	18000	27000	18000	18000
AIC	8147.691	12145.048	8129.786	7735.560
BIC	8397.231	12407.563	8379.326	7985.100
Log-likelihood	-4041.846	-6040.524	-4032.893	-3835.780

Notes: Standard errors are reported between parentheses. Significant differences are indicated with * $p < 0.1$, ** $p < 0.05$ or *** $p < 0.01$. [a] The individual experiments of both men and women.

Table A6: Mean comparison of household and individual characteristics between couples with man-dominant, woman-dominant and balanced decision-making

	Senegal			*Uganda*					
	d-m men (1)	d-m balanced (2)	Comparison of means (1) - (2)	d-m men (4)	d-m women (5)	d-m balanced (6)	Comparison of means (4) - (5)	(4) - (6)	(5) - (6)
Number of observations	213	34		27	93	130			
Per adult equivalent household size	5.68 (2.675)	6.335 (2.582)	-0.655	3.263 (0.695)	3.119 (0.913)	3.278 (1.025)	0.144	-0.015	-0.159
Polygamous relation (0/1)	0.277 (0.449)	0.353 (0.485)	-0.076	0.185 (0.396)	0.204 (0.405)	0.192 (0.396)	-0.019	-0.007	0.012
Household ethnicity Wolof (0/1)	0.465 (0.5)	0.324 (0.475)	0.141						
Household ethnicity Peulh (0/1)	0.437 (0.497)	0.588 (0.5)	-0.152						
Household ethnicity Bagisu (0/1)				0.815 (0.396)	0.892 (0.311)	0.831 (0.376)	-0.078	-0.016	0.062
Wife's actual number of children	3.808 (2.177)	4.088 (2.327)	-0.281	6.815 (2.219)	6.269 (2.655)	6.085 (2.252)	0.546	0.73	0.184
Distance to the main road	2.333 (2.873)	2.588 (3.115)	-0.255	2.678 (1.534)	3.606 (3.533)	3.078 (2.967)	-0.929	-0.4	0.529
Village next to main road (0/1)	0.408 (0.493)	0.471 (0.507)	-0.062	0.148 (0.362)	0.065 (0.247)	0.177 (0.383)	0.084	-0.029	-0.112**
Women groups active in village (0/1)	0.93 (0.256)	0.971 (0.171)	-0.041	0.519 (0.509)	0.538 (0.501)	0.585 (0.495)	-0.019	-0.066	-0.047
Household income from cropping activities (0/1)	0.709 (0.455)	0.882 (0.327)	-0.173**	0.963 (0.192)	0.914 (0.282)	0.954 (0.211)	0.049	0.009	-0.04

Household income from livestock rearing activities (0/1)	0.859 (0.349)	0.794 (0.41)	0.065	0.778 (0.424)	0.828 (0.379)	0.785 (0.413)	-0.05	-0.007	0.043
Household income from wage-employment activities (0/1)	0.662 (0.474)	0.676 (0.475)	-0.014	0.074 (0.267)	0.054 (0.227)	0.108 (0.311)	0.02	-0.034	-0.054
Household income from self-employment activities (0/1)	0.554 (0.498)	0.5 (0.508)	0.054	0.185 (0.396)	0.183 (0.389)	0.131 (0.338)	0.002	0.054	0.052
Household receives unearned income (0/1)	0.366 (0.483)	0.206 (0.41)	0.16*	0.63 (0.492)	0.441 (0.499)	0.454 (0.5)	0.189*	0.176*	-0.013
Per adult equivalent total household income (1,000 PPP)	461.268 (461.831)	423.431 (333.541)	37.837	972.587 (1209.861)	1031.382 (1223.247)	879.327 (867.391)	-58.795	93.26	152.055
Household is moderately poor (0/1) [i]	0.347 (0.477)	0.412 (0.5)	-0.064	0.741 (0.447)	0.688 (0.466)	0.738 (0.441)	0.053	0.002	-0.05
Age husband	45.407 (10.798)	43.199 (11.792)	2.208	50.296 (13.697)	51.892 (12.181)	51.862 (13.968)	-1.595	-1.565	0.03
Age wife	33.572 (8.157)	32.265 (6.916)	1.307	43.963 (12.227)	43.942 (10.982)	44.477 (11.803)	0.021	-0.515	-0.536
Age difference between husband and wife	11.835 (7.811)	10.934 (8.168)	0.901	6.333 (4.067)	7.95 (7.777)	7.384 (7.515)	-1.617	-1.051	0.566
Husband is non-educated (0/1)	0.648 (0.479)	0.5 (0.508)	0.148*	0.37 (0.492)	0.548 (0.5)	0.523 (0.501)	-0.178	-0.153	0.025
Husband holds primary education diploma (0/1)	0.352 (0.479)	0.5 (0.508)	-0.148*	0.63 (0.492)	0.452 (0.5)	0.477 (0.501)	0.178	0.153	-0.025
Husband holds secondary education diploma (0/1)	0.103 (0.305)	0.088 (0.288)	0.015	0.259 (0.447)	0.151 (0.36)	0.238 (0.428)	0.109	0.021	-0.088
Husband received higher education (0/1)	0.028 (0.166)	0.029 (0.171)	-0.001	0.111 (0.32)	0.043 (0.204)	0.108 (0.311)	0.068	0.003	-0.065*
Wife is non-educated (0/1)	0.756 (0.431)	0.824 (0.387)	-0.068	0.778 (0.424)	0.731 (0.446)	0.685 (0.466)	0.047	0.093	0.047
Wife holds primary education diploma (0/1)	0.244 (0.431)	0.176 (0.387)	0.068	0.222 (0.424)	0.269 (0.446)	0.315 (0.466)	-0.047	-0.093	-0.047

Wife holds secondary education diploma (0/1)	0.047 (0.212)	0	0.047	0.111 (0.32)	0.108 (0.311)	0.131 (0.338)	0.004	-0.02	-0.023
Wife received higher education (0/1)	0.019 (0.136)	0	0.019	0.037 (0.192)	0.022 (0.146)	0.046 (0.211)	0.016	-0.009	-0.025
Husband and wife have a different level of education (0/1)	0.366 (0.483)	0.382 (0.493)	-0.016	0.593 (0.501)	0.462 (0.501)	0.431 (0.497)	0.13	0.162	0.032

Notes: We use two-sided t-tests. Standard deviations are reported between parentheses. Significant differences are indicated with * $p < 0.1$, ** $p < 0.05$ or *** $p < 0.01$. d.m. = decision-making. [i] Dummy equal to one if household's per capita income lies below the international moderate poverty line of $3.1 per person per day.

Table A7: Country-specific estimation results for the MXL models using the couple sample, and interaction terms with the decision-making groups. In the Senegal sample, men-dominant couples are compared with balanced decision-making couples (2); In the Uganda sample, man-dominant couples are compared with respectively balanced decision-making and woman-dominant couples (4), and woman-dominant couples are compared with respectively balanced decision-making and man-dominant couples (5)

Couple sample only	***Senegal***		***Uganda***		
	(1)	(2)	(3)	(4)	(5)
Category of comparison		d-m man		d-m man	d-m woman
Mean preferences					
Children	0.187***	0.231***	0.127***	0.084	0.173***
	(0.036)	(0.039)	(0.034)	(0.121)	(0.055)
Children^2	-0.012***	-0.016***	-0.009***	-0.009	-0.013***
	(0.003)	(0.003)	(0.003)	(0.009)	(0.004)
Education half	2.229***	2.421***	2.025***	1.241***	2.604***
	(0.119)	(0.133)	(0.161)	(0.280)	(0.287)
Education all	3.380***	3.525***	3.864***	3.137***	3.895***
	(0.146)	(0.164)	(0.212)	(0.431)	(0.335)
Health care medium	0.784***	0.854***	0.884***	0.927***	0.998***
	(0.092)	(0.102)	(0.093)	(0.219)	(0.150)
Health care high	1.757***	1.841***	1.122***	0.924***	1.329***
	(0.105)	(0.116)	(0.094)	(0.196)	(0.163)
Nutrition half	2.054***	2.026***	1.822***	2.228***	1.319***
	(0.115)	(0.119)	(0.139)	(0.345)	(0.213)
Nutrition all	2.481***	2.451***	1.996***	2.658***	1.383***
	(0.134)	(0.143)	(0.158)	(0.465)	(0.204)
Preference heterogeneity					
d-m balanced * Children		-0.265***		0.049	-0.039
		(0.092)		(0.132)	(0.074)
d-m balanced * Children^2		0.027***		-0.000	0.004
		(0.007)		(0.010)	(0.006)
d-m balanced * Education half		-0.818***		0.680*	-0.683*
		(0.295)		(0.368)	(0.351)
d-m balanced * Education all		-0.542		1.208***	0.230
		(0.339)		(0.427)	(0.401)
d-m balanced * Health care medium		-0.337		-0.180	-0.269
		(0.235)		(0.255)	(0.201)
d-m balanced * Health care high		-0.519*		0.121	-0.250
		(0.270)		(0.227)	(0.199)
d-m balanced * Nutrition half		0.285		-0.017	0.860***
		(0.387)		(0.392)	(0.287)
d-m balanced * Nutrition all		0.511		-0.238	0.911***
		(0.426)		(0.499)	(0.297)
d-m women * Children				0.089	
				(0.136)	
d-m women * Children^2				-0.004	
				(0.011)	
d-m women * Education half				1.559***	
				(0.390)	
d-m women * Education all				1.521***	
				(0.464)	

d-m women * Health care medium				0.149	
				(0.269)	
d-m women * Health care high				0.490*	
				(0.255)	
d-m women * Nutrition half				-0.732*	
				(0.393)	
d-m women * Nutrition all				-1.149**	
				(0.504)	
d-m men * Children					0.003
					(0.011)
d-m men * Children^2					0.035
					(0.281)
d-m men * Education half					-0.076
					(0.143)
d-m men * Education all					-1.417***
					(0.405)
d-m men * Health care medium					-0.748
					(0.528)
d-m men * Health care high					-0.343
					(0.264)
d-m men * Nutrition half					1.060***
					(0.402)
d-m men * Nutrition all					1.400***
					(0.457)
Standard deviation					
Children	-0.053***	0.053**	0.025	0.029	0.014
	(0.019)	(0.022)	(0.025)	(0.026)	(0.016)
Children^2	0.003*	0.001	0.000	0.002	-0.000
	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
Education half	-0.323**	-0.006	-1.514***	1.258***	1.071***
	(0.139)	(0.399)	(0.179)	(0.181)	(0.148)
Education all	0.831***	0.836***	2.024***	1.971***	2.007***
	(0.117)	(0.130)	(0.165)	(0.170)	(0.225)
Health care medium	-0.023	0.071	0.158	0.344***	-0.412***
	(0.097)	(0.074)	(0.182)	(0.122)	(0.120)
Health care high	0.893***	0.926***	0.241	0.297***	-0.255
	(0.090)	(0.094)	(0.167)	(0.104)	(0.181)
Nutrition half	0.299**	0.293**	-0.746***	-0.155	0.696***
	(0.127)	(0.147)	(0.185)	(0.180)	(0.155)
Nutrition all	0.666***	0.594***	-0.997***	-0.898***	0.479***
	(0.109)	(0.119)	(0.153)	(0.148)	(0.134)
d-m balanced * Children		0.076		-0.056**	0.054**
		(0.048)		(0.028)	(0.022)
d-m balanced * Children^2		-0.003**			
		(0.002)			
d-m balanced * Education half		0.612***		0.958***	1.344***
		(0.196)		(0.247)	(0.203)
d-m balanced * Education all		-0.323		1.505***	-1.262***
		(0.307)		(0.291)	(0.212)
d-m balanced * Health care medium		0.377*			
		(0.222)			
d-m balanced * Health care high		0.548*		0.139	0.244**
		(0.322)		(0.124)	(0.118)
d-m balanced * Nutrition half		-0.086		0.465**	0.010
		(0.433)		(0.235)	(0.226)

d-m balanced * Nutrition all		0.823***		0.804***	0.848***
		(0.249)		(0.242)	(0.128)
d-m women * Children				-0.004	
				(0.025)	
d-m women * Children^2					
d-m women * Education half				0.851***	
				(0.174)	
d-m women * Education all				0.843**	
				(0.366)	
d-m women * Health care medium					
d-m women * Health care high				0.095	
				(0.287)	
d-m women * Nutrition half				0.926***	
				(0.195)	
d-m women * Nutrition all				0.214	
				(0.264)	
d-m men * Children					0.079***
					(0.027)
d-m men * Children^2					
d-m men * Education half					-0.374**
					(0.151)
d-m men * Education all					0.537
					(0.423)
d-m men * Health care medium					
d-m men * Health care high					-0.049
					(0.170)
d-m men * Nutrition half					-0.169
					(0.248)
d-m men * Nutrition all					1.229***
					(0.147)
N	8877	8877	9000	9000	9000
AIC	3924.716	3902.908	3861.729	3820.741	3819.111
BIC	4038.175	4129.827	3975.408	4133.360	4131.731
Log-likelihood	-1946.358	-1919.454	-1914.864	-1866.371	-1865.556

Notes: Standard errors are reported between parentheses. Significant differences are indicated with * $p < 0.1$, ** $p < 0.05$ or *** $p < 0.01$. d.m. = decision-making.

Table A8: Complete country-specific estimation results for the MXL models using the couple sample, and interaction terms with the decision-making groups. In the Senegal sample, balanced decision-making couples are compared with man-dominant couples (2); In the Uganda sample respectively man-dominant couples (4), woman-dominant couples (5) and balanced decision-making couples (6) are compared with the other two decision-making groups.

Couple sample only	***Senegal***		***Uganda***			
	(1)	(2)	(3)	(4)	(5)	(6)
Interaction term X		d-m balanced (0/1)		d-m man (0/1)	d-m woman (0/1)	d-m balanced (0/1)
Mean preferences						
Children	0.187***	0.231***	0.127***	0.136***	0.119***	0.127***
	(0.036)	(0.039)	(0.034)	(0.035)	(0.043)	(0.046)
Children^2	-0.012***	-0.016***	-0.009***	-0.009***	-0.008**	-0.010***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
Education half	2.229***	2.421***	2.025***	2.108***	1.706***	2.033***
	(0.119)	(0.133)	(0.161)	(0.166)	(0.167)	(0.197)
Education all	3.380***	3.525***	3.864***	3.966***	3.698***	3.429***
	(0.146)	(0.164)	(0.212)	(0.226)	(0.241)	(0.271)
Health care medium	0.784***	0.854***	0.884***	0.846***	0.763***	0.982***
	(0.092)	(0.102)	(0.093)	(0.100)	(0.112)	(0.122)
Health care high	1.757***	1.841***	1.122***	1.133***	0.960***	1.195***
	(0.105)	(0.116)	(0.094)	(0.100)	(0.103)	(0.131)
Nutrition half	2.054***	2.026***	1.822***	1.741***	2.085***	1.499***
	(0.115)	(0.119)	(0.139)	(0.152)	(0.165)	(0.182)
Nutrition all	2.481***	2.451***	1.996***	1.876***	2.265***	1.557***
	(0.134)	(0.143)	(0.158)	(0.159)	(0.190)	(0.183)
Preference heterogeneity						
X * Children		-0.265***		-0.016	0.054	0.008
		(0.092)		(0.144)	(0.077)	(0.070)
X * Children^2		0.027***		-0.002	-0.005	0.002
		(0.007)		(0.011)	(0.006)	(0.005)
X * Education half		-0.818***		-0.585	1.300***	0.141
		(0.295)		(0.415)	(0.348)	(0.279)
X * Education all		-0.542		-0.635	1.329***	0.788**
		(0.339)		(0.464)	(0.430)	(0.400)
X * Health care medium		-0.337		0.262	0.375*	-0.226
		(0.235)		(0.240)	(0.204)	(0.182)
X * Health care high		-0.519*		-0.131	0.461**	-0.131
		(0.270)		(0.222)	(0.207)	(0.179)
X * Nutrition half		0.285		0.902**	-0.632**	0.804**
		(0.387)		(0.389)	(0.276)	(0.314)
X * Nutrition all		0.511		0.792	-0.674**	0.736**
		(0.426)		(0.501)	(0.303)	(0.288)
Standard deviation						
Children	-0.053***	0.053**	0.025	-0.015	0.028	-0.024
	(0.019)	(0.022)	(0.025)	(0.012)	(0.019)	(0.024)
Children^2	0.003*	0.001	0.000	0.003***	0.002*	0.001
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)
Education half	-0.323**	-0.006	-1.514***	1.302***	1.184***	1.358***
	(0.139)	(0.399)	(0.179)	(0.199)	(0.164)	(0.189)

Education all	0.831***	0.836***	2.024***	2.076***	2.106***	1.487***
	(0.117)	(0.130)	(0.165)	(0.176)	(0.165)	(0.172)
Health care medium	-0.023	0.071	0.158	0.022	-0.076	-0.052
	(0.097)	(0.074)	(0.182)	(0.153)	(0.167)	(0.209)
Health care high	0.893***	0.926***	0.241	0.192	-0.208	0.200
	(0.090)	(0.094)	(0.167)	(0.170)	(0.211)	(0.161)
Nutrition half	0.299**	0.293**	-0.746***	0.702***	0.425	0.586***
	(0.127)	(0.147)	(0.185)	(0.173)	(0.265)	(0.168)
Nutrition all	0.666***	0.594***	-0.997***	0.889***	0.940***	0.777***
	(0.109)	(0.119)	(0.153)	(0.139)	(0.112)	(0.096)
X * Children		0.076		-0.064	-0.050**	-0.034
		(0.048)		(0.041)	(0.024)	(0.022)
X * Children^2		-0.003**		-0.005***	0.001	0.004*
		(0.002)		(0.002)	(0.002)	(0.002)
X * Education half		0.612***		0.028	1.240***	-0.568**
		(0.196)		(0.381)	(0.296)	(0.270)
X * Education all		-0.323		0.729***	0.683**	2.188***
		(0.307)		(0.282)	(0.267)	(0.378)
X * Health care medium		0.377*		-0.693***	0.215	-0.377**
		(0.222)		(0.139)	(0.368)	(0.189)
X * Health care high		0.548*		-0.451***	-0.487	-0.147
		(0.322)		(0.132)	(0.305)	(0.169)
X * Nutrition half		-0.086		0.464*	0.941***	0.285
		(0.433)		(0.241)	(0.192)	(0.289)
X * Nutrition all		0.823***		1.388***	-0.495**	0.934***
		(0.249)		(0.347)	(0.227)	(0.217)
N	8877	8877	9000	9000	9000	9000
AIC	3924.716	3902.908	3861.729	3903.946	3856.057	3887.288
BIC	4038.175	4129.827	3975.408	4131.305	4083.416	4114.648
Log-likelihood	-1946.358	-1919.454	-1914.864	-1919.973	-1896.028	-1911.644

Notes: Standard errors are reported between parentheses. Significant differences are indicated with * $p < 0.1$, ** $p < 0.05$ or *** $p < 0.01$. d.m. = decision-making.

Chapter 5

Small family, happy family? Fertility preferences and the quantity-quality trade-off in Sub-Saharan Africa

1. Introduction

The adverse effects of high population growth are numerous. Pressure on land and natural resources, accelerating climate change, persistent food insecurity, insufficient availability and quality of public infrastructure, and increased infant and maternal mortality are amongst the major sustainable development challenges aggravated by large population numbers and high fertility rates (Alexandratos, 2005; Drechsel et al., 2001; Ezeh et al., 2012; Graves et al., 2019; Headey & Jayne, 2014; O'Sullivan, 2020; Shi, 2003; Wendt et al., 2012; World Bank, 2005). In Asia and Latin America the demographic transition – the process in which countries evolve from high mortality and fertility rates to low mortality and fertility rates – started in the 1950s, with a drop in total fertility rates (TFR)[1] from 6 to 2 births per woman between 1950 and 2015 (United Nations, 2019; World Bank, 2020b). Sub-Saharan Africa's (SSA) demographic transition on the other hand, started significantly later and is proceeding at a slower pace, leading to a total fertility rate still as high as 5 births per woman in 2015. As a consequence, SSA's population numbers are projected to continue to grow for the next several decades. This will result in a doubling of the population between 2010 and 2050 – in some countries possibly even tripling – and ultimately leading to a more than quadrupling of its population over the short period of one century (Ezeh et al., 2012; United Nations, 2019).

[1] The number of childbirths a woman would have if she were to live to the end of her reproductive life and bear children in accordance with age-specific fertility rates of the specified year.

In the last decades, scholars have intensively studied the drivers behind reductions in TFR. Household income, parents' education and the changing position of women within the household and society have been put forward as major drivers, but the mechanisms are not well understood. The quantity-quality (Q-Q) trade-off theory assumes that a lower TFR will improve the quality of child-raising (e.g. in terms of education, nutrition and health care). However, empirical evidence does not always support this, as it is difficult to disentangle the factors that jointly determine the quantity and quality aspects of child-raising. Investigating preferences for child-raising might shed more light on the mechanisms. This holds especially for rural SSA, where actual fertility might diverge from desired fertility because of insufficient access to family planning. Yet, few studies investigate parents' preferences for child-raising, mainly due to the difficulty of accurately measuring preferences and the trade-offs that parents are willing to make.

In this study, we use a discrete choice experiment (DCE) to assess men's and women's preferences for child-raising in rural Senegal and Uganda. To our knowledge, we are the first to empirically investigate Q-Q trade-offs in fertility decisions from a preferences perspective and to apply a DCE method within the framework of the Q-Q trade-off theory. Respondents are asked to choose between different hypothetical scenarios, which describe the number of children, and how they would be raised in terms of education, health care and nutrition. Using mixed logit models and interaction terms between the attributes, we quantitatively evaluate the trade-offs that people make in their choices. In addition, we test whether preferences for fertility rates and the Q-Q trade-off differ according to household poverty status, parental education and mono- or polygamous nature of the relation, thereby contributing to the literature on the drivers behind the demographic transition.

Understanding child-raising preferences of households in SSA is important from both a theoretical perspective, to understand the factors influencing the demographic transition, and from a policy perspective to develop more effective family-planning programs and policies. The case-study regions – rural Senegal and rural Uganda – are relevant, as both countries are suffering from high TFR (4.7 and 5.1 for Senegal and

Uganda respectively in 2017), therefore remaining in the pre-demographic dividend[2] phase. Moreover, both countries experience low secondary completion rates, high prevalence of undernourishment, child mortality, and other problems connected to high fertility rates (World Bank, 2020b).

2. Literature review

The demographic transition theory describes the evolution in society from high mortality and fertility rates, to low mortality and fertility rates. The driving forces behind the demographic transition, and especially those that reduce fertility, continue to be a source of discussion among demographers and economists. Three main models are put forward: economic and investment models, risk and mortality models, and cultural transmission models (Shenk, Towner, Kress, & Alam, 2013). Economic and investment models mainly focus on the inverse correlation between income and population growth. Risk and mortality models consider fertility reduction to be the logical consequence of the reduction in infant mortality. When the chances of children surviving the first five dangerous years are higher, parents will reduce their fertility accordingly. Cultural transmission models explain the demographic transition through societies' perception of children and preferences for ideal family size, the transformation of social structures and networks such as polygamy, and prestige-seeking behaviour (Shenk et al., 2013). In this paper, we combine insights from economic and investment models – and more specifically the Q-Q trade-off theory – with insights from cultural transmission models, which emphasise the importance of the preferences of individuals, households and societies with regards to fertility.

The Q-Q trade-off theory, founded by Becker and colleagues (Becker, 1960; Becker & Lewis, 1973; Becker & Tomes, 1976), relies on the premise that the quantity and quality of children are related, because the shadow price of quantity (the cost of having a certain

[2] The demographic dividend corresponds to a period in a country's demographic transition when the ratio of work age population to young dependents increases rapidly due to a fast decline in the country's fertility. This leads to a window of opportunity for rapid economic growth as there are more people in the labour force and less people to support.

number of children) depends on the quality of child-raising of these children (sending children to school, providing them nutritious food, etc. is costly), and vice versa, the shadow price of quality of child-raising depends on the quantity of children a household has to raise (Becker & Lewis, 1973). The theory explains why fertility reduces when incomes rise, and why a negative correlation might exist between the quantity and quality of child-raising (Rosenzweig & Wolpin, 1980). Some models, however, assume that children do not only imply a cost to the household, because of mutual help between siblings in extended families (Baland, Bonjean, Guirkinger, & Ziparo, 2016), children helping with productive and reproductive tasks in the household (Marteleto & de Souza, 2013; Mueller, 1984) or economies of scale concerning child-raising (Guang & Van Wey, 1999; Qian, 2009; Rosenzweig & Zhang, 2009; Steelman, Powell, Werum, & Carter, 2002).

The empirical literature demonstrating the existence of the Q-Q trade-off remains inconclusive (Alidou & Verpoorten, 2019). The main bottleneck in studying the Q-Q trade-off empirically exists in removing confounding factors that jointly determine the number of children and the quality of the children's upbringing – these are parents' and society's characteristics such as education and income level, labour market opportunities, social norms, pension schemes or education policies. Many studies rely on semi-natural experiments such as unanticipated twin births (Alidou & Verpoorten, 2019; Angrist, Lavy, & Schlosser, 2010; Black, Devereux, & Salvanes, 2005; Marteleto & de Souza, 2012; Rosenzweig & Zhang, 2009), the Chinese one child policy (Argys & Averett, 2019; B. Li & Zhang, 2017; Liang & Gibson, 2018; Liu, 2014; Zhong, 2017), miscarriages (Maralani, 2008), gender of previous children (Angrist et al., 2010; Fitzsimons & Malde, 2014; Kugler & Kumar, 2017; Lee, 2008; J. Li, Dow, & Rosero-Bixby, 2017), or the roll-out or discontinuation of family planning programs (Dumas & Lefranc, 2019; Joshi & Schultz, 2013) to demonstrate the existence of the Q-Q trade-off. Some studies find consistent or heterogeneous proof of the Q-Q trade-off; others do not. In addition, scholars are highly critical of the methods used to identify the Q-Q trade-off empirically, showing that family size effects cannot be distinguished from birth order effects, and warning for bias caused by sample truncation and selection into twin birth (Bhalotra & Clarke, 2020; Guo, Yi, & Zhang, 2017).

Many studies describe fertility outcomes and their socioeconomic drivers, theoretically as well as empirically. The literature points to fertility reducing effects of parents' education (F. R. M. Ali & Gurmu, 2018; Masuda & Yamauchi, 2020; Osili & Long, 2008; Snopkowski et al., 2016; Wang & Sun, 2016), household economic welfare (Amin et al., 1994; Beegle & Christiaensen, 2019; Garenne, 2015; Handa, 2000), or mothers' employment (Jensen, 2012; Tiruneh et al., 2016; Van den Broeck & Maertens, 2015) and autonomy (Abadian, 1996). The literature studying fertility preferences and their socioeconomic drivers is much less comprehensive, however, especially for SSA. This gap could to some extent reflect data limitations, as preferences are difficult to measure, and the usual method – to ask for a respondents' desired number of children – has been proven to overestimate respondents' actual wanted fertility (Bongaarts, 1990). But it is also linked to the general idea of unreliability and variability of stated fertility preferences (Bhrolcháin & Beaujouan, 2019; Trinitapoli & Yeatman, 2018). Still, several studies show that desired fertility rates can be highly predictive of later fertility outcomes (Cleland et al., 2020; Günther & Harttgen, 2016; Kodzi, Johnson, & Casterline, 2010; Yeatman, Trinitapoli, & Garver, 2020). The few studies that analyse fertility preferences show that desired family size is lower on average for women (Bankole & Singh, 1998; Matovu et al., 2017; Westoff, 2010), for better educated individuals (Bongaarts, 2011; Muhoza, 2019; Westoff, 2010), for households with higher economic welfare (Muhoza, 2019), and in a context of higher population density and lower child mortality (Headey & Jayne, 2014; Muhoza, 2019).

3. Background and data

We focus on two regions: the Mount Elgon region in Eastern Uganda and the Saint-Louis region in North-Western Senegal. The Mount Elgon region is located in the humid tropics and is a densely populated mountainous area dominated by smallholder farmers and a coffee-banana farming system. The Saint-Louis region is located in the semi-arid tropics and is a diverse area including agricultural communities focussing on small-scale commercial horticulture and rice production, livestock communities relying on rather extensive and semi-nomadic grazing systems, and large-scale horticultural companies hiring labourers from nearby communities. Both regions are rural areas with a high dependence on agriculture, high poverty rates and weak infrastructure development. Population density is higher in the Mount Elgon region (838/km^2) than in the Saint-Louis region (49/km^2), but both regions are characterized by high population growth rates, respectively 3.9% and 3.4% in the Mount Elgon and Saint-Louis region (ANSD, 2015; Uganda Bureau of Statistics, 2017).

The Wolof (41.7% of the rural population in Senegal) and Peulh (30.4% of the rural population in Senegal) ethnicities are the two most prevalent in the Saint-Louis region (ANSD, 2015). Both ethnicities have traditional hierarchical customs (Creevey, 1996) that attribute a major importance towards having a large family and where polygamous households are common. The Islam is the dominant religion in the research area (96.5% of the rural population in Senegal is Muslim (ANSD, 2015)), and everyday life is ruled by Islamic and customary patrilineal laws[3] (Lambert & Rossi, 2016) reducing the position and bargaining power of women in the rural Senegalese society, and increasing the value of having a large household (Alesina et al., 2013; Creevey, 1996).

The Mount Elgon region in Uganda also knows a patrilineal tradition, and is mainly populated by the Bagisu ethnicity (84.4% of sampled households), with a minority of people from the Sabiny ethnicity (14.4% of sampled households). The Bagisu and Sabiny attach a high value to children and a woman's status is highly connected to the

[3] The Wolof's inheritance and family relationships were partially determined by matrilineal lineage patterns, while the Peulh's traditions were highly patrilineal, already before the arrival of the Islam (Creevey, 1996).

number of children she bears (Kwagala, 2013; Makwa, 2012). There is a religious diversity in the research area (unrelated to ethnicity), composed of protestants (46.8% of sampled households), Catholics (29.4% of sampled households) and born-again Christians (16.5% of the sampled households). Polygamous marriages are common, but wives do not necessarily live under the same roof.

While in both countries family planning programs have been high on the political agenda since 2010, contraceptive uptake remains low, especially in rural areas. In 2011, Senegal signed the "Ouagadougou Call to Action" and thereby committed to double the budget for family planning programs (Sidibe, Kadetz, & Hesketh, 2020). This resulted in the *National Action Plan for Family Planning* and a government commitment to increase contraceptive uptake to 45% by 2020 (FP2020, 2020). Still, recent figures show that the uptake of modern contraceptives among married women remains as low as 28% (Track20 Project, 2020a). In 2012, Uganda committed to providing universal access to family planning, to reduce the unmet need for family planning from 40% to 10% by 2022, and to increase the modern contraceptive prevalence rate to 50% by 2020; resulting in the launch of the *Family Planning Costed Implementation Plan* (FP2020, 2021). Modern contraceptive uptake among married women is currently 39% in Uganda (Track20 Project, 2020b).

We use data from a quantitative household survey and a discrete choice experiment. Survey data were collected in 2016, from respectively 464 and 758 households in Senegal and Uganda. Households were sampled using a multistage[4] stratified random sampling method, with stratification based on distance to an asphalt road and wage employment status in Senegal, and urbanization level and altitude in Uganda. A structured quantitative questionnaire was used to collect data on household demographics, farm production, land and non-land assets, living conditions and employment. The discrete choice experiment (DCE) was implemented in 2017 with 250 households in each region, which were randomly selected from the household survey sample. Within a household, both husband and wife completed the DCE

[4] Two-stage sampling design in Senegal and three-stage sampling design in Uganda.

separately, resulting in a total sample of 1000 respondents[5]. The DCE was followed by questions on attribute non-attendance and attribute ranking, and the respondent's current and preferred number of children.

Table 1 describes the socio-economic characteristics of the sampled households and respondents. The average household size, as well as the variation in household size, is larger in the Senegal sample than in the Uganda sample, which relates to multiple generations living together in extended families in Senegal versus a singular couple plus children living in nuclear households in Uganda. Households in the Senegal sample live closer to the main surfaced road compared to households in the Uganda sample. Polygamy is common in both regions but is slightly more prevalent in the Senegal sample. Only 7% and 16% of the respondents have completed lower secondary education in respectively the Senegal and Uganda sample – which is lower than the national averages of 18% for Senegal (2017 data) and 24% for Uganda (2012 data) (World Bank, 2020b). The majority of the sampled households is poor[6], with a higher incidence of poverty in the Uganda sample than in the Senegal sample. There is a gap between respondents' preferred number of children (9.5 on average) and their actual number of children (4.6 on average) in the Senegal sample, which could relate to uncompleted fertility or undesired infertility. In Uganda, respondents' preferred number of children (5.8 on average) is below their actual number of children (6.9 on average), which could relate to an unmet need for family planning and contraceptives. Female and poor respondents are on average less likely to have completed lower secondary education compared to male and non-poor respondents. Male respondents and polygamous respondents prefer and actually have on average a higher number of children than respectively female respondents and monogamous respondents. However, when we combine both characteristics (gender and polygamous relation), we find that the latter only holds for male respondents[7]. Monogamous women do not have

[5] The original Ugandan sample consisted of 265 couples, of which we dropped two because of outlying data and 13 because the couples' mean age was older than 80 years.
[6] A household is defined as poor when per adult equivalent total household income falls below the international moderate poverty line of $3.1 per person per day.
[7] Monogamous men actually have 5.659 children and would prefer to have 8.717 children, while polygamous men actually have 8.762 children and would prefer to have 11.82 children. These

a higher number of actual or preferred children, when compared to polygamous women[8]. Secondary educated respondents actually have on average the same number of children compared to non-secondary educated respondents. Moreover, secondary educated respondents are able to realize their preferred household size, as they do not experience a significant gap between the number of children they would prefer and the number of children they actually have. For respondents who do not hold a secondary education diploma, the preferred number of children is higher than their actual number of children[9].

differences between monogamous and polygamous men are significant at the 1% significance level.

[8] Monogamous women actually have 5.058 children and would prefer to have 5.815 children, while polygamous women actually have 5.025 children and would prefer to have 5.893 children.

[9] Difference significant at the 1% significance level.

Table 1: Socio-economic characteristics of sampled households and respondents

Variable	Total sample	Country		Gender of respondent		Mono-/polygamous household [a]		Lower secondary education [b]		Poverty status [c]	
		Senegal	Uganda	Men	Women	Mono	Poly	Uneducated	Educated	Poor	Non-poor
N	*1000*	*500*	*500*	*500*	*500*	*756*	*244*	*885*	*115*	*536*	*464*
Age	43.671	39.38	47.963***	48.489	38.855***	42.566	47.099***	43.708	43.391	46.02	40.96***
	(12.907)	(11.35)	(12.953)	(12.647)	(11.272)	(12.358)	(13.955)	(13.049)	(11.805)	(12.984)	(12.284)
Distance to main road (km)	2.8	2.368	3.231***	2.8	2.8	2.730	3.016	2.733	3.314*	3.156	2.388***
	(3.024)	(2.904)	(3.082)	(3.025)	(3.025)	(2.798)	(3.632)	(2.807)	(4.325)	(3.14)	(2.832)
Next to main road (0/1)	0.276	0.420	0.132***	0.276	0.276	0.265	0.311	0.276	0.278	0.213	0.349***
	(0.447)	(0.494)	(0.339)	(0.447)	(0.447)	(0.441)	(0.464)	(0.447)	(0.45)	(0.41)	(0.477)
Household size	9.76	13.048	6.472***	9.76	9.76	9.127	11.721***	9.903	8.661**	9.082	10.543***
	(5.855)	(6.431)	(2.367)	(5.858)	(5.858)	(5.175)	(7.254)	(5.908)	(5.328)	(5.334)	(6.32)
Polygamous (1/0)	0.244	0.292	0.196***	0.244	0.244			0.247	0.217	0.243	0.246
	(0.43)	(0.455)	(0.397)	(0.43)	(0.43)			(0.432)	(0.414)	(0.429)	(0.431)
Educated (1/0)	0.115	0.066	0.164***	0.15	0.08***	0.119	0.102			0.091	0.142**
	(0.319)	(0.249)	(0.371)	(0.357)	(0.272)	(0.324)	(0.304)			(0.288)	(0.35)
Non-poor (1/0)	0.464	0.648	0.28***	0.464	0.464	0.463	0.467	0.45	0.574**		
	(0.499)	(0.478)	(0.449)	(0.499)	(0.499)	(0.499)	(0.5)	(0.498)	(0.497)		
Actual N of children	5.733	4.58	6.886***	6.416	5.05***	5.358	6.893***	5.795	5.252	6.437	4.92***
	(3.388)	(3.209)	(3.164)	(3.917)	(2.588)	(2.901)	(4.387)	(3.401)	(3.252)	(3.372)	(3.223)
Preferred N of children	7.654	9.494	5.814***	9.474	5.834***	7.266	8.857***	7.889	5.843***	7.222	8.153**
	(6.105)	(7.66)	(3.024)	(7.689)	(2.973)	(5.626)	(7.276)	(6.247)	(4.493)	(5.517)	(6.691)

Notes: Standard deviations are reported between parentheses. We used two-sided t-tests. Significant differences between men and women; uneducated and educated respondents; poor and non-poor respondents; and Senegalese and Ugandan respondents are indicated with * $p < 0.1$, ** $p < 0.05$ or *** $p < 0.01$. [a] Dummy equal to one if respondent's relation is polygamous. [b] Dummy equal to one if respondent completed lower secondary education. [c] Dummy equal to one if respondent's household's per capita income lies above the international moderate poverty line of $3.1 per person per day.

4. Methods

4.1. Design of DCE

Discrete DCEs provide a link between observed behaviour and economic theory. They are based on Lancaster's consumer theory which posits that consumer preferences are shaped by the individual characteristics a good or service possesses and not by the good as a whole (K. J. Lancaster, 1966). During a DCE, a respondent is asked to choose between hypothetical scenarios that consist of attributes with varying attribute levels. In our study, the alternatives describe different situations of child-raising, with, in line with the Q-Q trade-off theory, specific emphasis on the quantity of children and the quality of child-raising. As the validity of a DCE largely depends on the choice of the attributes (Mangham et al., 2009), a detailed literature review, and multiple key informant interviews and focus group discussions in Senegal and Uganda were implemented prior to the design of the experiment to identify and select attributes that represent the quality of child-raising. In total we specify four attributes, with the first referring to the quantity aspect of child-raising, and the next three to the quality aspect, covering education, nutrition and health care (table 2).

Table 2: Attributes and attribute levels

Attribute	Description	Attribute levels
Children	Number of children	1, 2, 4, 6, 9, 12
Education	Share of children from the household that can obtain a secondary school degree	None (base level), Half, All
Nutrition	Number of days a week a household can eat a complete meal	Zero (base level), Four, Seven
Health care	Quality of the health care institute the household can go for help when a child has a severe fever	Low (base level), Medium, High

The first attribute specifies the number of children and consists of six levels. The range of 1 to 12 children is based on the observed number of children in the study regions, as derived from the quantitative surveys. The second attribute is defined as the share of

children from the household that can complete lower secondary education. The attribute contains three levels: none, half and all of the children. The third attribute is defined as the number of days a week a household can eat a complete meal, including carbohydrates, proteins and vegetables, for the main meal of the day. On the other days an incomplete meal is consumed (e.g. only carbohydrates). The attribute consists of three levels: zero, four and seven days a week. The fourth attribute is defined as the quality of health care institute the household can consult when a child has a severe fever. The attribute contains three levels: low-quality, medium-quality and high-quality. The three child-raising attributes are similar in both countries but are adapted to the local context (e.g. in Senegal low-quality health care is a "case de santé", while in Uganda it is a "health center II facility")[10].

We use choice sets with three alternatives and visual illustrations to assist illiterate people with making their choice (a choice card is presented in figure 6 of chapter 1). We present 12 choice cards to each respondent and randomize the order to avoid learning bias. Hence, we obtain 36,000 observations in total. As information is missing on one choice card of two respondents, we retain 35,994 observations for the DCE analysis. We use a Bayesian design, which accounts for uncertainties around the true values of the a priori information of the parameters (Kessels et al., 2008). Using the D-efficiency criterion, the determinant of the variance-covariance matrix of the parameter estimators is minimized and the efficiency of the design is increased (Kessels et al., 2006). As we hypothesize that respondents have positive preferences for the quality attributes, we use small positive priors for these levels. We hypothesize a positive but diminishing preference for the number of children, so priors are higher for 4 and 6 children, and lower for 1, 2, 9 and 12 children.

While the inclusion of an opt-out or status quo option is common practice in DCEs as it increases the realism of the choice task (Carson et al., 1994; Louviere et al., 2000; Vanermen et al., 2021), we used a forced choice structure in our choice experiment. This means that respondents are not able to opt-out from the three proposed scenarios

[10] More detailed country-specific definitions of the three child-raising attributes can be found in the methods section of chapter 4.

or cannot default to the status quo. As research shows that individual willingness to pay is different in forced and unforced choice sets (Penn et al., 2019), we are not able to calculate welfare estimates based on the estimated coefficients. Moreover, we need to remain cautious when interpreting the results[11].

The experiment was introduced to both spouses together. The attributes were explained in detail and the hypothetical character of the experiment was emphasized[12] (i.e. that the proposed household should be taken as given, not taking into account possible economic, social or physical limitations, or the actual composition of the household). After the introduction, the spouses were interviewed separately by an enumerator of the same gender. Each experiment started with a test card, to check whether the respondent understood the rationale of the study[13].

4.2. Analysis of DCE

Discrete choice modelling is embedded in the random utility theory framework and assumes that respondents choose the alternative that yields the highest utility level from each choice set (Louviere et al., 2000). Following this framework, we separate the utility respondent *i* derives from alternative *j* (U_{ij}) into an observable deterministic component (V) – linearly depending on the attributes of the alternative (Z_j) and individual-specific socioeconomic characteristics (X_i) – and a stochastic component (ε) capturing unobserved heterogeneity across alternatives and individuals (equation 1) (Hensher et al., 2005b).

$$U_{ij} = V(Z_j, X_i) + \varepsilon(Z_j, X_i) \quad (1)$$

As utility is a latent variable, we cannot directly observe the utility the respondent derives from a specific alternative. Therefore, we use the probability that respondent *i*

[11] A more extensive paragraph containing the rationale behind the non-inclusion of an opt-out option can be found in the methods section of chapter 4.
[12] A more detailed explanation on hypothetical and social desirability bias in choice experiments can be found in the methods section of chapter 4.
[13] The test card contained three scenarios of which one scenario dominated the other two. If the respondent did not choose the dominant scenario, every aspect of the experiment was explained again.

chooses alternative *j* as an approximation, expressed in terms of a logistic distribution (Hensher et al., 2005b; Louviere et al., 2000). We use a mixed logit model (MXL), which is most common and allows for preferences to be heterogeneous across respondents, and maximum likelihood estimation (Train, 2003). We estimate different specifications of the MXL, treating all attributes as random and using 1500 Halton draws, to analyse respondents' fertility preferences as well as the Q-Q trade-off. A first model specification is a basic MXL, including only main effects (1). In a second specification, we add a quadratic term of the quantity attribute to control for non-linear preferences (2). In models three to five, we test whether respectively education level, poverty status and the monogamous or polygamous status of the relation are correlated with fertility preferences by adding interaction terms with three binary variables in separate models: owner of a lower secondary education diploma (3), household poverty status (4) and polygamous relation (6). In a fourth model specification, we assess the Q-Q trade-off by adding interaction terms between the quantity attribute and the three quality attributes (7). In models (8) to (10), we test whether education level, poverty status and polygamy are correlated with the Q-Q trade-off by adding double- and triple-interaction terms with these three variables.

4.3. Attribute non-attendance and scale-heterogeneity

As previous studies show that ignoring one or more attributes during the experiment could lead to biased estimates (Hensher & Greene, 2010; Hensher, Rose, & Greene, 2005a; Hole, Kolstad, & Gyrd-Hansen, 2013), we identify attribute non-attendance in the individual experiments with men and women in Senegal[14] by using the information on respondents' attribute non-attendance statements. We test for scale heterogeneity in the country-specific experiments with men, women and couples, using the generalized multinomial logit model developed by Fiebig, Keane, Louviere, & Wasi (2010). The results of the stated attribute non-attendance and scale heterogeneity checks are presented in table A1 in appendix. The estimates of both the stated attribute non-

[14] We test for attribute non-attendance with respect to the *number of children* attribute, as less than 1% of the respondents indicated to have ignored another attributes. In addition, we only test in the Senegalese sample, as less than 1% of Ugandan respondents indicated to have ignored an attribute.

attendance and the scale heterogeneity models are similar in magnitude, sign and significance level compared to estimates of the basic MXL model estimates. We therefore conclude that the MXL model estimations are not sensitive to attribute non-attendance and scale heterogeneity, and base our results and interpretation on these estimates.

5. Results

Estimation results for the first six MXL specifications are presented in table 3. In general, we find that respondents derive positive utility from more children as well as from the three quality attributes. The model including a quadratic term (2) shows that respondents' marginal utility derived from an additional child increases with the number of children at a diminishing rate. The number of children at which utility is maximized is 7.5. From all the attributes related to quality of child-raising, children's education contributes most to respondents' utility, followed by nutrition and health care.

Models (3) to (5) show that the interaction terms with the education, poverty and polygamy dummies are significant, partially explaining preference heterogeneity, while main effects are robust to the inclusion of the interaction terms. We find that respondents who completed lower secondary education have stronger preferences for education and nutrition than respondents who did not; non-poor respondents prefer fewer children (figure 1) and have stronger preferences for health care and nutrition than poor respondents; and respondents in a polygamous relation prefer to have more children, compared to monogamous respondents (figure 2).

Table 3: Estimation results for the basic MXL (1), non-linear specified MXL (2) and MXL models including interaction terms with lower secondary education (3), poverty (4) and polygamy (5)

	(1)	(2)	(3)	(4)	(5)
X =			Lower secondary educated	Non-poor household	Polygamous relation
Mean preferences					
Children	0.023***	0.146***	0.154***	0.177***	0.128***
	(0.005)	(0.017)	(0.018)	(0.023)	(0.019)
Children^2		-0.010***	-0.010***	-0.012***	-0.009***
		(0.001)	(0.001)	(0.002)	(0.002)
Education half	1.848***	1.846***	1.832***	1.889***	1.823***
	(0.063)	(0.062)	(0.063)	(0.091)	(0.073)
Education all	3.157***	3.204***	3.110***	3.237***	3.136***
	(0.081)	(0.085)	(0.084)	(0.117)	(0.097)
Health care medium	0.716***	0.708***	0.693***	0.608***	0.745***
	(0.044)	(0.045)	(0.047)	(0.059)	(0.051)
Health care high	1.308***	1.305***	1.306***	1.142***	1.284***
	(0.052)	(0.051)	(0.054)	(0.067)	(0.057)
Nutrition half	1.733***	1.772***	1.698***	1.548***	1.781***
	(0.060)	(0.061)	(0.063)	(0.074)	(0.070)
Nutrition all	2.056***	2.129***	2.044***	1.788***	2.086***
	(0.070)	(0.072)	(0.074)	(0.090)	(0.082)
Preference heterogeneity					
X * Children			-0.085	-0.065*	0.078*
			(0.061)	(0.034)	(0.044)
X * Children^2			0.003	0.005*	-0.004
			(0.005)	(0.003)	(0.003)
X * Education half			0.235	-0.050	0.135
			(0.219)	(0.130)	(0.166)
X * Education all			1.194***	-0.009	0.335
			(0.324)	(0.149)	(0.217)
X * Health care medium			0.137	0.229**	-0.172
			(0.151)	(0.090)	(0.105)
X * Health care high			-0.046	0.373***	0.067
			(0.165)	(0.099)	(0.130)
X * Nutrition half			0.780***	0.536***	-0.048
			(0.218)	(0.114)	(0.141)
X * Nutrition all			0.945***	0.804***	0.141
			(0.262)	(0.135)	(0.171)
N	35994	35994	35994	35994	35994
AIC	17078.000	17028.803	16997.631	16966.920	17023.332
BIC	17196.876	17164.661	17269.347	17238.635	17295.047
Log likelihood	-8525.000	-8498.402	-8466.816	-8451.460	-8479.666

Notes: Standard errors are reported between parentheses. Significant coefficients are indicated with * $p < 0.1$, ** $p < 0.05$ or *** $p < 0.01$. Full regression results including standard deviations are reported in Table A2 in appendix.

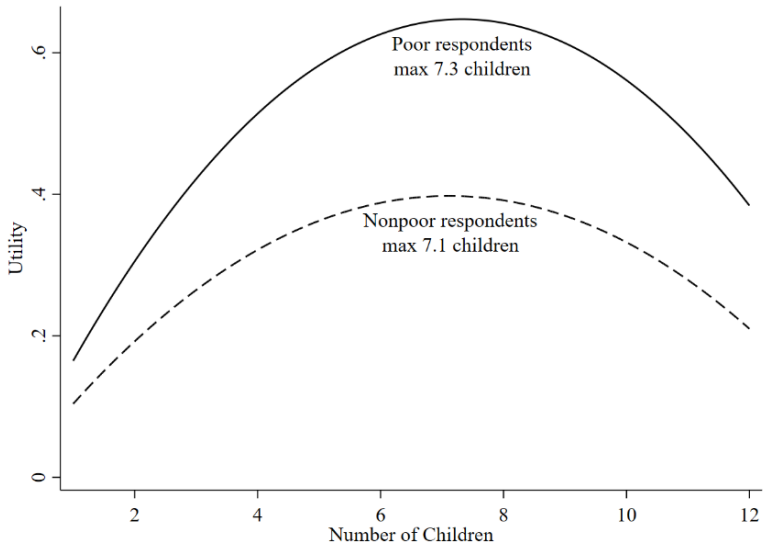

Figure 1: Utility curve indicating the utility maximizing number of children for poor and nonpoor respondents. (Source: authors' calculations).

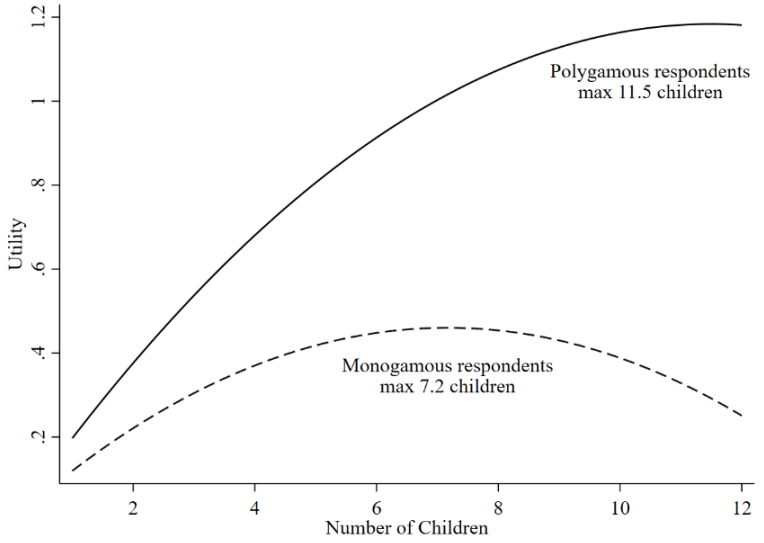

Figure 2: Utility curve indicating the utility maximizing number of children for monogamous and polygamous respondents. (Source: authors' calculations).

Table 4 presents the results of the Q-Q trade-off analysis. The basic model (7) shows that main effects are robust to the inclusion of interaction terms between *Children* and the other attributes. All interaction terms (except for the interaction with all children completing lower secondary education) have significantly negative coefficients, implying that parents are willing to have fewer children if they can raise them under better circumstances. Hence, our results point to the existence of a Q-Q trade-off in fertility preferences. The estimates indicate strong effects. When half of the children can complete lower secondary education, compared to none of the children, respondents' marginal utility of an additional child reduces from 0.13 to 0.03, a decrease of 79%. With access to high-quality health care, compared to low-quality health care, the marginal utility of an additional child reduces to 0.01, a drop of 91%. However, the interaction term between the number of children and all children completing lower secondary education is significantly positive. When all children can complete lower secondary education, compared to none of the children, respondents' marginal utility of an additional child increases from 0.13 to 0.19, an increase of 35%. The latter effect implies that respondents want to have more children if they can assure all of them will obtain a lower secondary degree.

We do not find evidence for differences in the Q-Q trade-off between non- or primary- and secondary-educated respondents (8). We find that the non-poor make a trade-off between the number of children and medium-quality health care while the poor do not (9). Model (10) shows that respondents in a monogamous relation make a trade-off between the number of children and high-quality nutrition, while respondents in a polygamous relation reverse this relation such that the number of children and high-quality nutrition become complementary.

Table 4: Estimation results for the basic Q-Q trade-off MXL model (7) and the Q-Q trade-off MXL models including interaction terms with lower secondary education (8), poverty (9) and polygamy (10)

X =	(7)	(8) Lower secondary educated	(9) Non-poor household	(10) Polygamous relation
Mean preferences				
Children	0.125***	0.131***	0.096***	0.132***
	(0.024)	(0.025)	(0.031)	(0.028)
Education half	2.573***	2.608***	2.570***	2.550***
	(0.122)	(0.129)	(0.160)	(0.132)
Education all	2.927***	2.851***	2.863***	2.913***
	(0.144)	(0.153)	(0.198)	(0.162)
Health care medium	0.985***	0.974***	0.611***	1.043***
	(0.124)	(0.132)	(0.158)	(0.144)
Health care high	2.077***	2.127***	1.752***	2.041***
	(0.118)	(0.125)	(0.148)	(0.132)
Nutrition half	2.134***	2.041***	1.902***	2.149***
	(0.117)	(0.121)	(0.153)	(0.135)
Nutrition all	2.284***	2.235***	1.971***	2.331***
	(0.128)	(0.135)	(0.160)	(0.150)
Preference heterogeneity				
X * Children		-0.058	0.043	-0.047
		(0.079)	(0.046)	(0.053)
X * Education half		-0.149	0.033	0.075
		(0.355)	(0.235)	(0.297)
X * Education all		0.809**	0.130	-0.001
		(0.400)	(0.287)	(0.346)
X * Health care medium		0.185	0.749***	-0.293
		(0.390)	(0.246)	(0.270)
X * Health care high		-0.399	0.650***	0.088
		(0.350)	(0.222)	(0.267)
X * Nutrition half		0.983**	0.534**	-0.052
		(0.399)	(0.222)	(0.257)
X * Nutrition all		0.554	0.612**	-0.274
		(0.396)	(0.239)	(0.285)
Quantity – quality trade-off				
Children * Education half	-0.099***	-0.104***	-0.093***	-0.100***
	(0.017)	(0.018)	(0.022)	(0.019)
Children * Education all	0.068***	0.071***	0.077**	0.056**
	(0.024)	(0.027)	(0.032)	(0.028)
Children * Health care medium	-0.047*	-0.048*	0.003	-0.054*
	(0.024)	(0.026)	(0.031)	(0.028)
Children * Health care high	-0.114***	-0.121***	-0.083***	-0.115***
	(0.018)	(0.020)	(0.024)	(0.022)
Children * Nutrition half	-0.059***	-0.051***	-0.066***	-0.057**
	(0.019)	(0.019)	(0.025)	(0.022)

Children * Nutrition all	-0.050**	-0.053**	-0.051*	-0.065***
	(0.020)	(0.021)	(0.026)	(0.023)
Quantity – quality trade-off heterogeneity				
X * Children * Education half		0.030	-0.010	0.016
		(0.034)	(0.033)	(0.043)
X * Children * Education all		-0.012	-0.025	0.057
		(0.051)	(0.048)	(0.060)
X * Children * Health care medium		0.000	-0.095*	0.040
		(0.049)	(0.046)	(0.054)
X * Children * Health care high		0.065	-0.055	0.009
		(0.036)	(0.034)	(0.041)
X * Children * Nutrition half		-0.073	0.012	-0.010
		(0.036)	(0.034)	(0.043)
X * Children * Nutrition all		0.039	0.022	0.078*
		(0.040)	(0.037)	(0.046)
N	35994	35994	35994	35994
AIC	16882.860	16871.190	16828.215	16899.573
BIC	17103.629	17253.289	17210.315	17281.673
Log likelihood	-8415.430	-8390.595	-8369.107	-8404.787

Notes: Standard errors are reported between parentheses. Significant coefficients are indicated with * $p < 0.1$, ** $p < 0.05$ or *** $p < 0.01$. Full regression results including standard deviations are reported in Table A3 in appendix.

6. Discussion and conclusion

The results of the choice experiment on fertility preferences and the quantity-quality trade-off point to four main findings. First, our results confirm that Sub-Saharan African households prefer to have many children – which is reflected in a utility-maximizing point around 7.6 children. This number is similar to the survey response on the preferred number of children, indicating that the choice experiment reflects people's preferences accurately. This utility-maximizing point resulting from the choice experiment does not correspond to an economic optimum as costs of child-raising are not taken into account, so we cannot directly compare this with the prevailing TFR of 4.7 in Senegal or 5.1 in Uganda. Yet, it is worrying that desired fertility rates remain very high, despite many family planning campaigns in both countries.

Second, we do not find proof of a negative correlation between parents' education and preferences for more children. This contradicts various existing studies (e.g. Bongaarts, 2010; Muhoza, 2019; Masuda & Yamauchi, 2020). Yet, our results are in line with a study that finds lower fertility rates among more educated women in Egypt, and attribute this to an older age at marriage, and not to changes in fertility preferences (F. R. M. Ali & Gurmu, 2018).

Third, the results show that poor households prefer to have more children, which supports other studies that find proof of higher fertility rates among the poor (Gillespie, Ahmed, Tsuia, & Radloff, 2007; Gupta & Dubey, 2006; Schoumaker, 2004). We find that respondents in a polygamous relation prefer to have more children than those in a monogamous relation. However, this does not necessarily translate into a higher fertility of polygamous women, as we find that monogamous and polygamous women actually have the same number of children. The preference of polygamous men to have many children is most likely accomplished through having multiple wives. Still, macroeconomic studies demonstrate that in general the fertility of women in polygamous societies lies higher because of the economic incentive polygamy (and the tradition of paying a bride price) provides to invest in a high quantity of children (Gould, Moav, & Simhon, 2008; Tertilt, 2005).

We need to note that, in our sample, socio-demographic characteristics such as education, poverty status and polygamy are correlated with ethnicity. In the Senegal sample, Wolof respondents are more likely to be secondary educated compared to respondents from other ethnicities (9% versus 4% respectively)[15]. In the Uganda sample, Bagisu respondents are less likely to be secondary educated (14% versus 26% respectively), more likely to be poor (78% versus 36% respectively) and more likely to be in a polygamous relation (22% versus 4% respectively) compared to Sabiny respondents[16]. In addition, there is a possible link between reproductive characteristics (including fertility and fertility preferences) and ethnicity, especially in rural SSA, where ethnic identity continues to have major implications for social mechanisms. The empirical literature finds ambiguous evidence for the role of ethnicity on reproductive characteristics. While Kollehlon (2003) shows significant fertility differentials across different ethnicities in Nigeria, even after controlling for other socio-economic characteristics, other scholars find that the onset of parenthood (which is highly linked with fertility) and contraceptive use in Ghana can mainly be explained by socio-economic characteristics such as education and age, while ethnicity (controlling for socio-economic characteristics) does not have a significant explanatory power (Addai, 1999; Takyi & Addai, 2002). Given the correlation between ethnicity and other socio-demographic characteristics in our sample and the possible link between ethnicity and fertility, it would be interesting to further unravel fertility preferences and the Q-Q trade-off by jointly controlling for multiple socio-demographic characteristics such as ethnicity, education and poverty status. This was however not possible in our analysis due to modelling restrictions and the large number of interaction terms this requires.

Fourth, our results imply that the Q-Q trade-off is a two-sided story. On the one hand, for most of the quality attributes, we find evidence of the existence of a trade-off with the quantity of children. The preference to have many children is found to decrease with access to better education, nutrition and health care. These results add a fertility preferences perspective to the many empirical studies that prove the existence of the Q-

[15] Tested with two-sided t-test. Difference significant at the 10% significance level.
[16] Tested with two-sided t-tests. All differences are significant at the 1% significance level.

Q trade-off (Argys & Averett, 2019; Dumas & Lefranc, 2019; Kang, 2011; Lee, 2008; Liang & Gibson, 2018; Mogstad & Wiswall, 2016; Rosenzweig & Zhang, 2009). On the other hand, quantity and quality are found to be complementary to some extent. When all children in the household can attain a lower secondary school diploma, parents in our sample prefer more children. These findings could be explained by the type of human capital investments associated with the quality of child-raising. Short-run investments for more basic quality aspects, like better nutrition and health care, seem to induce parents to prefer fewer children, while investments with a higher return in the long run, like education, seem to increase parents' desired number of children. This dual finding can to some extent explain why previous studies find ambiguous effects concerning the existence of the Q-Q trade-off (Alidou & Verpoorten, 2019), and shows why an elaborate analysis considering preferences and multiple aspects of child-raising can bring important nuances in the study of the Q-Q trade-off in fertility.

We deduce two important policy implications. First, our results imply that policies, aiming at increasing access to education free of charge or based on a general taxation system, can unintentionally result in increased household fertility, as parents this could reduce parents' Q-Q trade-off. Such unintended fertility effects have been demonstrated by other studies (Azarnert, 2010; de la Croix & Doepke, 2004; Palivos & Scotese, 1996). Second, family planning programs are considered to be an important instrument for population reduction and control, and are often centred around the availability of and awareness on contraceptives. Our results show that fertility preferences in SSA continue to be biased towards large families but that important differences exist in fertility preferences related to poverty and polygamous status of the relation. A narrow focus on contraception in family planning programs might reduce the effectiveness of such programs in regions with high fertility preferences. A broader focus of family planning programs, such that also changes in fertility preferences are triggered, and more specific targeting of these programs might strengthen their effectiveness.

As a DCE is a stated preference method, it is inherently subject to hypothetical and social desirability bias. While the enumerators were trained to emphasize the hypothetical character of the choice experiment, focussing on the importance of

considering the hypothetical household as presented without taking into account possible monetary, social or physical limitations of the actual household, we cannot be 100% sure that respondents did not consider their actual reality when choosing between scenarios. As children remain an important asset in SSA, both from a labour perspective and from an old-age support and insurance perspective (Hoddinott, 1992; Lambert & Rossi, 2016), preferences with respect to the quantity of children could have been inflated because of these considerations, especially for (poor) households who do not have savings in other forms (monetary, land, livestock, etc.).

Moreover, our findings on fertility preferences and the Q-Q trade-off are derived from specific regions in rural Uganda and Senegal. Chapter 4 provides evidence on preference heterogeneity between the two countries. Care is needed in generalising results, as preferences most likely differ in diverging spatial and temporal contexts. Studies have proven that fertility preferences can be highly variable over the course of a lifetime, but we did not specifically target young people who have not started their child-bearing years yet (Kodzi, Casterline, et al., 2010; Trinitapoli & Yeatman, 2018; Yeatman, Sennott, & Culpepper, 2013). Moreover, as described by Libois & Somville (2018) in Nepal, when nucleus households are strongly rooted in the extended family – as is often the case in SSA – social norms can counter the Q-Q trade-off, as households with a lower number of children may be morally required to host kin. The analysis of fertility preferences and the Q-Q trade-off in light of these life-time dynamics and extended kinship networks could be an interesting avenue for further research.

7. Appendix

Table A1: Results attribute non-attendance (A1.2) and scale heterogeneity analysis (A1.3)

	(1) Basic	(A1.2) Stated attribute non-attendance	(A1.3) Scale heterogeneity
Mean effects			
Children	0.022***	0.019***	0.024***
	(0.004)	(0.005)	(0.005)
Education half	1.716***	1.733***	1.820***
	(0.060)	(0.064)	(0.071)
Education all	2.927***	2.955***	3.111***
	(0.073)	(0.077)	(0.112)
Health care medium	0.679***	0.667***	0.726***
	(0.042)	(0.044)	(0.047)
Health care high	1.226***	1.183***	1.298***
	(0.048)	(0.050)	(0.056)
Nutrition half	1.634***	1.620***	1.746***
	(0.054)	(0.057)	(0.083)
Nutrition all	1.953***	1.913***	2.074***
	(0.066)	(0.067)	(0.090)
Ignored number of children [a] * Children		0.034**	
		(0.016)	
Ignored number of children [a] * Education half		0.017	
		(0.183)	
Ignored number of children [a] * Education all		0.034	
		(0.251)	
Ignored number of children [a] * Health care medium		0.283	
		(0.192)	
Ignored number of children [a] * Health care high		0.837***	
		(0.215)	
Ignored number of children [a] * Nutrition half		0.383*	
		(0.202)	
Ignored number of children [a] * Nutrition all		0.795***	
		(0.239)	
Standard deviation			
Children	0.053***	0.049***	0.042**
	(0.009)	(0.010)	(0.020)
Education half	0.625***	-0.692***	-0.722***
	(0.084)	(0.082)	(0.087)
Education all	1.290***	1.266***	1.298***
	(0.060)	(0.052)	(0.059)
Health care medium	-0.074	-0.076	-0.067
	(0.137)	(0.138)	(0.206)
Health care high	0.732***	0.698***	0.765***
	(0.055)	(0.054)	(0.064)
Nutrition half	0.194	0.260**	0.150
	(0.235)	(0.103)	(0.229)

Nutrition all	0.879***	0.869***	0.890***
	(0.056)	(0.056)	(0.058)
Ignored number of children [a] * Children		0.018	
		(0.061)	
Ignored number of children [a] * Education half		0.003	
		(0.127)	
Ignored number of children [a] * Education all		0.009	
		(0.169)	
Ignored number of children [a] * Health care medium		0.405***	
		(0.156)	
Ignored number of children [a] * Health care high		1.054***	
		(0.256)	
Ignored number of children [a] * Nutrition half		-0.382	
		(0.258)	
Ignored number of children [a] * Nutrition all		-0.085	
		(0.457)	
τ			-0.296***
			(0.082)
N	35994	35994	35994
AIC	17198.441	17158.727	17182.781
BIC	17317.316	17396.478	17310.148
Log likelihood	-8585.220	-8551.364	-8576.391

Notes: Standard errors are reported between parentheses. Significant coefficients are indicated with * p < 0.1, ** p < 0.05 or *** p < 0.01. [a] Respondent indicated to have ignored the attribute "number of children" after the completion of the individual choice experiment, meaning that they did not take this attribute actively into account when making their decision.

Table A2: Full estimation results for the basic MXL (1), non-linear specified MXL (2) and MXL models including interaction terms with lower secondary education (3), poverty (4) and polygamy (5)

	(1)	(2)	(3)	(4)	(5)
X =			Lower secondary educated	Non-poor household	Polygamous relation
Mean preferences					
Children	0.023***	0.146***	0.154***	0.177***	0.128***
	(0.005)	(0.017)	(0.018)	(0.023)	(0.019)
Children^2		-0.010***	-0.010***	-0.012***	-0.009***
		(0.001)	(0.001)	(0.002)	(0.002)
Education half	1.848***	1.846***	1.832***	1.889***	1.823***
	(0.063)	(0.062)	(0.063)	(0.091)	(0.073)
Education all	3.157***	3.204***	3.110***	3.237***	3.136***
	(0.081)	(0.085)	(0.084)	(0.117)	(0.097)
Health care medium	0.716***	0.708***	0.693***	0.608***	0.745***
	(0.044)	(0.045)	(0.047)	(0.059)	(0.051)
Health care high	1.308***	1.305***	1.306***	1.142***	1.284***
	(0.052)	(0.051)	(0.054)	(0.067)	(0.057)
Nutrition half	1.733***	1.772***	1.698***	1.548***	1.781***
	(0.060)	(0.061)	(0.063)	(0.074)	(0.070)
Nutrition all	2.056***	2.129***	2.044***	1.788***	2.086***
	(0.070)	(0.072)	(0.074)	(0.090)	(0.082)
Preference heterogeneity					
X * Children			-0.085	-0.065*	0.078*
			(0.061)	(0.034)	(0.044)
X * Children^2			0.003	0.005*	-0.004
			(0.005)	(0.003)	(0.003)
X * Education half			0.235	-0.050	0.135
			(0.219)	(0.130)	(0.166)
X * Education all			1.194***	-0.009	0.335
			(0.324)	(0.149)	(0.217)
X * Health care medium			0.071	0.137	0.229**
			(0.151)	(0.090)	(0.105)
X * Health care high			-0.046	0.373***	0.067
			(0.165)	(0.099)	(0.130)
X * Nutrition half			0.780***	0.536***	-0.048
			(0.218)	(0.114)	(0.141)
X * Nutrition all			0.945***	0.804***	0.141
			(0.262)	(0.135)	(0.171)
Standard deviation					
Children	0.066***	-0.026	0.023	-0.034***	-0.036***
	(0.008)	(0.034)	(0.023)	(0.011)	(0.011)
Children^2		0.005***	0.005***	-0.005***	-0.005***
		(0.001)	(0.001)	(0.001)	(0.001)
Education half	0.831***	-0.830***	0.725***	0.833***	0.809***
	(0.066)	(0.071)	(0.065)	(0.066)	(0.065)
Education all	1.359***	1.375***	1.270***	1.385***	1.360***

	(0.063)	(0.066)	(0.062)	(0.068)	(0.079)
Health care medium	0.316***	-0.345***	0.323***	-0.325***	0.296***
	(0.082)	(0.079)	(0.087)	(0.107)	(0.113)
Health care high	0.821***	0.825***	0.813***	0.805***	0.746***
	(0.053)	(0.054)	(0.054)	(0.060)	(0.054)
Nutrition half	0.481***	0.493***	0.427***	0.397***	0.359***
	(0.066)	(0.071)	(0.083)	(0.127)	(0.106)
Nutrition all	0.943***	0.953***	0.967***	0.919***	0.930***
	(0.058)	(0.061)	(0.062)	(0.081)	(0.072)
X * Children			0.024	0.000	0.010
			(0.047)	(0.007)	(0.035)
X * Children^2			-0.001	-0.001	0.000
			(0.004)	(0.001)	(0.002)
X * Education half			1.715***	-0.003	-0.083
			(0.411)	(0.115)	(0.146)
X * Education all			-2.085***	0.119	0.322
			(0.251)	(0.101)	(0.637)
X * Health care medium			0.253	0.205	0.178
			(0.171)	(0.191)	(0.722)
X * Health care high			-0.279	-0.261	0.713***
			(0.243)	(0.189)	(0.183)
X * Nutrition half			0.613***	-0.469***	0.678***
			(0.206)	(0.170)	(0.170)
X * Nutrition all			-0.103	-0.401*	-0.484
			(0.292)	(0.223)	(0.362)
N	35994	35994	35994	35994	35994
AIC	17078.000	17028.803	16997.631	16966.920	17023.332
BIC	17196.876	17164.661	17269.347	17238.635	17295.047
Log likelihood	-8525.000	-8498.402	-8466.816	-8451.460	-8479.666

Notes: Standard errors are reported between parentheses. Significant coefficients are indicated with * $p < 0.1$, ** $p < 0.05$ or *** $p < 0.01$.

Table A3: Full estimation results for the basic Q-Q trade-off MXL model (7) and the Q-Q trade-off MXL models including interaction terms with lower secondary education (8), poverty (9) and polygamy (10)

X =	(7)	(8) Lower secondary educated	(9) Non-poor household	(10) Polygamous relation
Mean preferences				
Children	0.125***	0.131***	0.096***	0.132***
	(0.024)	(0.025)	(0.031)	(0.028)
Education half	2.573***	2.608***	2.570***	2.550***
	(0.122)	(0.129)	(0.160)	(0.132)
Education all	2.927***	2.851***	2.863***	2.913***
	(0.144)	(0.153)	(0.198)	(0.162)
Health care medium	0.985***	0.974***	0.611***	1.043***
	(0.124)	(0.132)	(0.158)	(0.144)
Health care high	2.077***	2.127***	1.752***	2.041***
	(0.118)	(0.125)	(0.148)	(0.132)
Nutrition half	2.134***	2.041***	1.902***	2.149***
	(0.117)	(0.121)	(0.153)	(0.135)
Nutrition all	2.284***	2.235***	1.971***	2.331***
	(0.128)	(0.135)	(0.160)	(0.150)
Preference heterogeneity				
X * Children		-0.058	0.043	-0.047
		(0.079)	(0.046)	(0.053)
X * Education half		-0.149	0.033	0.075
		(0.355)	(0.235)	(0.297)
X * Education all		0.809**	0.130	-0.001
		(0.400)	(0.287)	(0.346)
X * Health care medium		0.185	0.749***	-0.293
		(0.390)	(0.246)	(0.270)
X * Health care high		-0.399	0.650***	0.088
		(0.350)	(0.222)	(0.267)
X * Nutrition half		0.983**	0.534**	-0.052
		(0.399)	(0.222)	(0.257)
X * Nutrition all		0.554	0.612**	-0.274
		(0.396)	(0.239)	(0.285)
Quantity – quality trade-off				
Children * Education half	-0.099***	-0.104***	-0.093***	-0.100***
	(0.017)	(0.018)	(0.022)	(0.019)
Children * Education all	0.068***	0.071***	0.077**	0.056**
	(0.024)	(0.027)	(0.032)	(0.028)
Children * Health care medium	-0.047*	-0.048*	0.003	-0.054*
	(0.024)	(0.026)	(0.031)	(0.028)
Children * Health care high	-0.114***	-0.121***	-0.083***	-0.115***
	(0.018)	(0.020)	(0.024)	(0.022)
Children * Nutrition half	-0.059***	-0.051***	-0.066***	-0.057**
	(0.019)	(0.019)	(0.025)	(0.022)

Children * Nutrition all	-0.050**	-0.053**	-0.051*	-0.065***
	(0.020)	(0.021)	(0.026)	(0.023)
Quantity – quality trade-off heterogeneity				
X * Children * Education half		0.030	-0.010	0.016
		(0.053)	(0.034)	(0.043)
X * Children * Education all		-0.012	-0.025	0.057
		(0.069)	(0.051)	(0.060)
X * Children * Health care medium		0.000	-0.095*	0.040
		(0.079)	(0.049)	(0.054)
X * Children * Health care high		0.065	-0.055	0.009
		(0.058)	(0.036)	(0.041)
X * Children * Nutrition half		-0.073	0.012	-0.010
		(0.069)	(0.036)	(0.043)
X * Children * Nutrition all		0.039	0.022	0.078*
		(0.067)	(0.040)	(0.046)
Standard deviation				
Children	0.062***	0.058***	0.064***	0.062***
	(0.010)	(0.011)	(0.011)	(0.010)
Education half	0.772***	0.764***	0.796***	0.827***
	(0.075)	(0.075)	(0.081)	(0.072)
Education all	1.360***	1.363***	1.409***	1.397***
	(0.069)	(0.069)	(0.074)	(0.073)
Health care medium	0.328***	0.335***	0.393***	0.290**
	(0.115)	(0.100)	(0.070)	(0.124)
Health care high	0.834***	0.839***	-0.807***	0.802***
	(0.059)	(0.059)	(0.063)	(0.068)
Nutrition half	0.415***	0.422***	-0.435***	-0.469***
	(0.090)	(0.083)	(0.094)	(0.078)
Nutrition all	0.992***	0.995***	0.983***	1.008***
	(0.061)	(0.062)	(0.062)	(0.064)
Children * Education half	-0.040**	-0.035**	0.029	-0.003
	(0.016)	(0.015)	(0.031)	(0.028)
Children * Education all	0.088***	0.087***	0.065*	-0.073*
	(0.024)	(0.023)	(0.039)	(0.038)
Children * Health care medium	0.024	0.023	-0.009	0.039**
	(0.028)	(0.024)	(0.017)	(0.017)
Children * Health care high	0.037**	0.033*	0.002	0.033
	(0.018)	(0.019)	(0.017)	(0.028)
Children * Nutrition half	-0.059***	-0.057***	-0.024	0.046**
	(0.014)	(0.015)	(0.058)	(0.022)
Children * Nutrition all	0.026**	0.031**	0.004	0.017
	(0.013)	(0.013)	(0.026)	(0.016)
X * Children * Education half		0.103***	-0.015	0.007
		(0.031)	(0.011)	(0.027)
X * Children * Education all		0.121***	-0.003	0.081
		(0.045)	(0.038)	(0.061)
X * Children * Health care medium		-0.042**	-0.002	-0.011
		(0.018)	(0.034)	(0.026)
X * Children * Health care high		0.017	0.084***	0.071**
		(0.018)	(0.021)	(0.028)

X * Children * Nutrition half		-0.043**	0.075***	-0.030
		(0.019)	(0.029)	(0.040)
X * Children * Nutrition all		0.003	-0.010	0.009
		(0.011)	(0.012)	(0.039)
N	35994	35994	35994	35994
AIC	16882.860	16871.190	16828.215	16899.573
BIC	17103.629	17253.289	17210.315	17281.673
Log likelihood	-8415.430	-8390.595	-8369.107	-8404.787

Notes: Standard errors are reported between parentheses. Significant coefficients are indicated with * $p < 0.1$, ** $p < 0.05$ or *** $p < 0.01$.

Chapter 6

General conclusion

1. Main findings

In the second chapter of my dissertation I descriptively investigate the Covid-19 pandemic's early impact on the fresh fruit and vegetable supply chain in Senegal, using trade statistics and survey data collected through online questionnaires and telephone interviews with all relevant FFV supply chain actors. The results point to major differences in how Covid-19 and containment measures disrupt supply chains between the modern export-oriented supply chain, centred around a few large vertically integrated agro-industrial companies, and the more traditional domestic-oriented supply chain with a large number of smallholder farmers and informal traders. The former shows to be more resilient to the Covid-19 shock. I show that both the modern and the traditional supply chain innovate to cope with the Covid-19 containment measures. While the study is subject to some limitations, the findings bring nuance in the debate on the resilience of food system to the pandemic, and have important policy and research implications toward international trade, social safety measures, and food and nutrition security.

In the third chapter of my dissertation I asses conceptually and empirically the direct and indirect welfare effects of entry and continuation in different types of wage employment in the Senegal River Delta region in rural Senegal. I use panel data, fixed effects and first-difference estimation, and show substantial positive welfare and linkage effects. I find that participation in wage employment increases per capita income by 143%, and reduces poverty, poverty gap and food insecurity by, respectively, 63%, 89% and 48%. While the direct effect on income is larger for non-agricultural and contractual wage employment, the indirect income effects through self-employment are more pronounced for agricultural and casual wage employment. The results imply that job creation is important for rural development, that wage

employment in agriculture can lead to considerable growth multiplier effects, and that synergies exist between large-scale and small-scale agriculture.

In the fourth chapter of my dissertation I use choice experimental data that values preferences with respect to fertility (the household's number of children) and child-raising (the education, nutrition and health care provisioning of the children), using a sample of married couples living in the SRD region in Senegal and the Mount Elgon region in Uganda. As the experiment was first implemented with both spouses separately, and repeated with the spouses jointly as couple, I am able to distinguish between individual and household choices, to analyse spouses' preferences on fertility and child-raising, and to calculate a decision-making coefficient based on the method proposed by Beharry-Borg et al. (2009). The results show that the assumptions of the basic unitary household model and the practice of traditional survey-based data collections – to select one member from the household for preference elicitation and to treat that member's choice as a reliable substitute for the overall household choice – should be used in a more considerate way and interpreted with more caution. Moreover, while the choices that couples make are somewhat more in line with the choices men make individually and hence with men's preferences, I find that a representative mix of husbands and wives cannot substitute for choices made at the household level. The results reveal that fertility and child-raising choices of spouses, accounting for their underlying intra-household decision-making, are highly country-specific. While in Uganda the couples experiments were implemented in a rather balanced and cooperative way, in Senegal the majority of the couples experiments was dominated by the husband. This study on the impact of intra-couple decision-making on fertility and child-raising preferences reveals the importance of considering the adequate decision-making unit when designing family planning and child-centred programs, and to use a country- or region-specific approach.

In the fifth chapter of my dissertation I use the same choice experimental data collected in the SRD region in Senegal and the Mount Elgon region in Uganda, to add to the knowledge on rural fertility preferences and the existence of a quantity-quality trade-off between the number of children and child-raising quality. The choice experiment

considers three quality and one quantity aspect of child-raising, and I add three important socio-economic drivers of fertility to the analysis (education level, poverty level and polygamy status of the relation). The results show that rural households prefer to have many children, but non-poor and monogamous respondents demonstrate a lower preference for many children than poor and polygamous respondents. I find that the quantity-quality trade-off is a two-sided story. On the one hand, for most of the quality attributes, I confirm the existence of a trade-off. On the other hand, quantity and quality are complementary when all children in the household can attain a lower secondary school diploma. The results imply that broadening the currently narrow focus on contraceptive uptake in family planning programs, and more specific targeting of such programs to people with low fertility preferences, could improve their effectiveness.

2. Limitations

I discuss this dissertation's limitations and weaknesses in the following section. First, I will discuss some limitations linked to the data and data collection methods used. Next, I will reflect on the case-study approach of this dissertation.

2.1. Limitations of the data

The analyses of this dissertation mainly build on primary, quantitative survey data. During the household survey data collection, enumerators visited rural households and interviewed them for several hours to collect quantitative data on household and individual characteristics. During the remote survey data collection, enumerators made telephone calls to interview respondents or respondents reacted to self-administered online surveys. While this is a standard method used in many academic fields, different types of bias can distort the information, the most important ones in this context being measurement error, recall bias, respondent fatigue bias and social desirability bias. When measurement error is random, it will not bias the estimates. However, systematic measurement error generally bias the estimates in an analysis, especially when the error is correlated to the variable of interest. For example, it could be the case that

respondents consequently underreport income, as talking about income is still highly taboo in SSA society and income hiding (women hiding money from their husbands, or households hiding money from their extended families) is an often used strategy in rural households. Moreover, respondents could underreport income or valuable assets with the hope of receiving social aid from the government or one of the many development aid programs active in the study region. To reduce measurement error, the different sources of income were split up in different modules, and all employment income was calculated based on the frequency of employment and daily wage rates. I am therefore optimistic about the mitigation of systematic measurement error and the quality of the income data, and believe that remaining measurement error is mainly random.

While recall questions are commonly used in surveys[1], they are prone to bias as the accuracy of respondents' memories cannot be controlled for. During the household surveys information is collected on employment activities for up to a year before the survey. Therefore, the data might suffer from recall bias. I tried to reduce this bias by asking about employment activities on a seasonal basis, but still, I cannot fully exclude the presence of recall bias in the household survey data. In addition, as questions on employment of all household members are answered by only one respondent "the most knowledgeable", this recall bias might be aggravated. In the data collected for chapter 2, bias might be limited, as several scholars indicate that there is little proof of recall bias for cash crops harvested or handled over short periods of time at specific moments of the year (Beegle et al., 2012; Carletto et al., 2013), the main topic for which we rely on recall questions in these surveys. Moreover, events are recalled that happened a maximum of four months before the survey, the recall period is linked to a very specific and important event that everybody is aware of (the introduction of the state of emergency), and the survey asks for quantitative information about the production and marketing of high value cash crops and other important aspects of respondents' daily life – which may refresh respondents' memory.

[1] See for example recent studies by Bernard et al. (2017) and Hirvonen et al. (2021).

In the household survey I supervised in 2016, I tried to reduce respondent fatigue bias by using a computer-assisted personal interviewing technique instead of the traditional pen-and-paper interviewing technique (used in 2013), as it has been proven that it reduces the time consumption of a quantitative survey (Caeyers, Chalmers, & De Weerdt, 2012). Social desirability bias is more difficult to proactively mitigate, as it refers to the tendency of respondents to answer questions in a manner that will be viewed favourably by others. By stressing the confidentiality and anonymity of the data collection, and interviewing the respondent individually without bystanders, I tried to reduce social desirability bias to a minimum.

The analyses in chapters 2 and 3 could be most affected by the described biases, as they rely solely on quantitative survey data. However, in chapter 2 our analysis relies on a comparison of events right before and right after the state of emergency. If recall bias in the data runs in the same direction for the two sets of events, the comparative analysis may partially reduce bias in the data. In chapter 3, I mainly use fixed effects regressions. Therefore, I am able to control for time-constant unobserved heterogeneity, which thus also cancels out recall bias and social desirability bias.

An important general limitation to the data used in this dissertation is the lack of qualitative data and ex-post validation of the results. The qualitative data would have allowed me to better understand and describe some of the findings of the dissertation. Especially the findings of chapters 2, 4 and 5 would have benefitted from an ex-post qualitative data collection and validation of the results. There was a field trip planned to Senegal in the summer of 2020, but the Covid-19 pandemic put a spoke in the wheels. If not, I could have discussed the findings of these chapters with the respective actors (FFV supply chain actors or rural households) during focus group discussions and key informant interviews.

2.2. Case-study approach

The research in this dissertation is based on data collected in two research areas, the Senegal River Delta region (and the Niayes region) in Senegal, and the Mount Elgon region in Uganda. This means that all findings are case-study specific. While this

approach definitely has some advantages, there are also some major limitations of doing only case-study specific research. The major advantage of this case-study approach, is the detailedness and in-depth focus of the research. I was able to study different aspects of rural development, on different levels of organisation, in the same region (supply chain level – household level – intra-household level). This contributed to a more comprehensive and integrated understanding of sustainable rural development. Also the fact that this case-study approach allowed me to go in the field (in Senegal), and truly understand the dynamics and livelihoods active in the region, contributed to a more robust data collection and validates the analysis and interpretation of the data.

The case-study approach, however, inhibits me in making robust claims about the findings in a broader context. The same research should be repeated for other case-studies before any external validity claim can be established. The main focus of this dissertation is the SRD region in Senegal which has some very specific characteristics. This region has known a significant increase in horticultural export in the last few decades. This contributed to the diversification of livelihoods in the region. In addition, Senegal is a lower-middle income country, which has known very little political and social instability in the last decades, a feature not often matched by its neighbouring countries. On the other hand, Senegal remains a rather mediocre player with regards to human development and female empowerment, especially in rural areas. The findings that result from this dissertation might be different in a low-income setting, with poor (public) infrastructure or higher political or social unrest.

The addition of a second case-study, the Mount Elgon region in Uganda, increases the comprehensiveness and validity of our results. However, I find that some of the findings (in chapter 4) are highly case-study specific. This highlights even more the importance of remaining cautious when making external validity claims.

3. Implications for rural development strategies

The results of this dissertation provide more insights into the micro-scale public interventions versus macro-scale market interventions approaches to rural development. First, I find that agricultural wage employment improves household welfare, both through direct and indirect income channels. Second, I find that modern supply chains are more resilient to adverse shocks compared to traditional supply chains, meaning that horticultural export companies can provide stable wage employment opportunities and thus stable income flows for rural households during systemic shocks. Increasing trade liberalisation and globalisation have often been criticised for not contributing to inequality reductions and welfare increases in low-income countries (Dorward et al., 2005; Goldberg & Pavcnik, 2007; L. A. Winters, McCulloch, & McKay, 2004). However, the results of chapters 2 and 3 argue in favour of macro-scale market interventions to enhance welfare increases amongst (poor) rural households and thus rural development, under the condition that they boost rural (unskilled) wage employment creation. Other scholars come to the same conclusion for both Asian and African countries. Kis-Katos & Sparrow (2015) shows that poverty reduces significantly in Indonesian regions with sectoral exposure to input tariff liberalization, and that labour market mechanisms are triggering this welfare effect. Warr (2014) reveals that poverty reduces after trade is liberalised in Thailand and Indonesia, as real wages increase for both skilled and unskilled labour. Asiedu & Gyimah-brempong (2008) use data from 33 African countries and show that trade liberalisation increases employment (indirectly through increased FDI investments), and thus has the potential to reduce poverty (if unskilled work is created). Maertens, Colen & Swinnen (2011) find that increased trade and FDI reduce poverty in Senegal, through increased wage employment on horticultural export companies.

On the other hand, micro-scale public interventions regarding family planning programs are indispensable if rural population growth in SSA is to be reduced drastically in the coming decades. Chapters 4 and 5 of my dissertation show that the focus of these programs might need to shift. Instead of focusing on contraception use, which is likely to be little effective in regions with high fertility preferences, a more

general focus on education and information might be more effective for triggering changes in fertility preferences.

An integrated approach to rural development must therefore, in my opinion, include both approaches. First, macro-scale market interventions are needed to incentivise overall economic growth and rural labour market expansion. These interventions need to target rural areas, the agricultural sector and unskilled labour to optimise the inclusion of the poor. Moreover, market interventions, and the resulting wage employment increase of women, can lead to beneficial social effects such as increased schooling of children (Maertens & Verhofstadt, 2013), increased empowerment of female workers (Krumbiegel, Maertens, & Wollni, 2020) and reductions in fertility (Van den Broeck & Maertens, 2015). Second, if rural population growth is to be reduced drastically in the coming decades in SSA (which is a highly necessary prerequisite for economic growth to contribute to rural development), well-targeted and well-defined micro-scale public interventions are needed in rural areas.

4. Chapter-specific policy implications

The main findings of this dissertation also entail some important chapter-specific policy implications. In chapter 2, I show that traditional food supply chains experience a stronger disruptive impact and a lower resilience to the Covid-19 pandemic. As traditional and transitional food supply chains are most prevalent in the poorest countries, and most important in their domestic food sectors (Feyaerts et al., 2020; Reardon et al., 2019), these results imply that developing countries will be affected more severely by the Covid-19 crisis. Especially the disruption of domestic food production and supply, rather than international trade effects, might reduce food availability in poor countries and cause additional food insecurity and hunger in the aftermath of the Covid-19 pandemic. Mitigating this food security impact requires public support to domestic food production – e.g., through the introduction of green passage lanes for food products during mobility restrictions – and attention to smallholder farmers in Covid-19 related financial aid programs in developing countries

(Laborde et al., 2021; United Nations, 2020). In addition, the observation of a Covid-19 induced shift from high-value FFV production to lower value staple and cash crops among smallholders might imply a reduced availability of more nutritious food, such as fruits and vegetables – as evidenced for Ethiopian consumers by Hirvonen, De Brauw and Abate (2020). Consequently, not only the accessibility of FFV is a concern (Harris, 2020), but also its availability may become a concern in the short to medium run (Torero, 2020b) – and likewise, not only food security but also nutrition security may become a concern (Jayawardena & Misra, 2020). Therefore, while the Senegalese government created a *Response and Solidarity Fund* "Force Covid-19" to aid households with food aid distributions and contributions to energy bills, it should also aid producers in traditional food supply chains if domestic production of varied and nutritious food is to be guaranteed.

In chapter 3, I find that job creation contributes importantly to upward income mobility, and poverty and food security reduction in rural areas. The development of a rural labour market does not only result in direct income gains from wages but can also increase labour productivity in smallholder farm (and nonfarm) enterprises. Moreover, I show that the agricultural sector, with mainly casual jobs in large-scale agro-industries, is particularly important as a source of job creation, in reducing rural poverty and food insecurity, and creating positive investment spillover effects on the smallholder sector. The focus of SSA countries' public spending must therefore be dual. First, policies should attract more (foreign) investments in rural areas such that labour market opportunities are expanded. Second, policies must make sure to create an investment-friendly climate either in the agricultural sector or in a non-agricultural sector with a focus on unskilled rural labour, if the investments are to significantly impact the poor and rural development is to be triggered. On the other hand I would like to stress the importance of comprehensive social protection and labour legislation to protect these workers. Governments must make sure to create an adequate legal framework and must control employers on the adherence to this legislation.

In chapter 4, I show the importance of considering the adequate decision-making unit when considering family planning and child-centred programs. While I find that

Senegalese women have different preferences from their partners, they do not have the agency to act on these preferences (86.2% of the couples experiments are dominated by the husband). As Senegalese women do not have proper autonomy over their own body, fertility and child-raising outcomes in rural Senegal will most likely follow men's preferences. Family planning and child-centred programs in Senegal must therefore – apart from triggering an increase in the decision-making power of women – incentivize men to participate in these programs. In Uganda, on the other hand, women seem to be much better able to decide and act on their own preferences, as the majority of the couples experiments (52%) was implemented using cooperative decision-making, and another 37.6% of the couples experiments was dominated by the woman. Here, programs focussing on women as the main beneficiary will likely be more efficient if the program addresses child education or health care, while couples should be addressed when the main goal is to trigger changes in child nutrition.

In chapter 5, I find that rural households prefer to have many children, but non-poor and monogamous respondents demonstrate a lower preference for many children than poor and polygamous respondents. I find that the quantity-quality trade-off is a two-sided story. On the one hand, for most of the quality attributes, we confirm the existence of a trade-off. On the other hand, quantity and quality are complementary when all children in the household can attain a lower secondary school diploma. These findings give rise to two important policy implications. First, the results imply that policies, aiming at increasing access to education free of charge or based on a general taxation system, can unintentionally result in increased household fertility, as parents do not have to make the Q-Q trade-off anymore. Social policies need therefore be created with caution and eye for secondary effects. Second, family planning programs are considered to be an important instrument for population reduction and control, and are often centred around the availability of and awareness on contraceptives. The results, however, show that fertility preferences in SSA continue to be biased towards large families but that important differences exist in fertility preferences related to poverty and polygamous status of the relation. A narrow focus on contraception in family planning programs might reduce the effectiveness of such programs in regions with high fertility preferences. A broader focus of family planning programs, is therefore

advised, such that also changes in fertility preferences are triggered, and more specific targeting of these programs towards the poor or polygamous households might strengthen their effectiveness.

5. Scope for further research

As the demographic transition in SSA is progressing very slowly, and many countries thus have a very young age structure (which is even more striking in rural areas), a very hot topic in rural development is the inclusion of and focus on rural youth (aged 15-24 years) – as evidenced by the 2019 Rural Development Report of IFAD titled "Creating Opportunities for Rural Youth" (IFAD, 2019). While this is not addressed as such in this dissertation, the importance of rural labour markets, and fertility and population growth for rural youth is major, and different avenues for further research can be distinguished. First, with respect to rural labour markets, the issues rural youth face is not necessarily a pressing unemployment rate, but more a high informality and casualness of employment (Fox, Senbet, & Simbanegavi, 2016). More research is needed to describe rural youth in function of their participation in the (dynamic and highly informal) rural labour market, and the impact of this employment on the (economic and mental) welfare of SSA youth.

Second, rural young women are the number one target group for family planning programs, as they did not yet completed their fertility. However, little is known about the fertility preferences of women in this specific age category. Also during the fertility experiment in this dissertation, women of all ages were included, and I did not take this age-effect into account. Further research on the fertility preferences of rural youth could provide insights into why the demographic transition in SSA is still lagging behind.

References

Abadian, S. (1996). Women's autonomy and its impact on fertility. *World Development*, *24*(12), 1793–1809. https://doi.org/10.1016/S0305-750X(96)00075-7

Abdellaoui, M., L'Haridon, O., & Paraschiv, C. (2013). Individual vs. couple behavior: An experimental investigation of risk preferences. *Theory and Decision*, *75*(2), 175–191. https://doi.org/10.1007/s11238-012-9322-7

Addai, I. (1999). Ethnicity and Contraceptive Use in Sub-Saharan Africa: The Case of Ghana. *Journal of Biosocial Science*, *31*(1), 105–120.

Adjognon, S. G., Liverpool-Tasie, L. S. O., de la Fuente, A., & Benfic, R. (2017). *Rural Non-Farm Employment and Household Welfare Evidence from Malawi* (No. 8096).

Adjognon, S. G., Liverpool-Tasie, L. S. O., & Reardon, T. (2017). Agricultural input credit in Sub-Saharan Africa: Telling myth from facts. *Food Policy*, *67*, 93–105.

Akoyi, K. T., & Maertens, M. (2018). Walk the Talk: Private Sustainability Standards in the Ugandan Coffee Sector. *Journal of Development Studies*, *54*(10), 1792–1818. https://doi.org/10.1080/00220388.2017.1327663

Alesina, A., Giuliano, P., & Nunn, N. (2013). On the Origins of Gender Roles: Women and the Plough. *The Quarterly Journal of Economics*, *128*(2), 469–530. https://doi.org/10.1093/qje/qjt005.Advance

Alexandratos, N. (2005). Countries with rapid population growth and resource constraints: Issues of food, agriculture, and development. *Population and Development Review*, *31*(2), 237–258. https://doi.org/10.1111/j.1728-4457.2005.00064.x

Ali, F. R. M., & Gurmu, S. (2018). The impact of female education on fertility: a natural experiment from Egypt. *Review of Economics of the Household*, *16*(3), 681–712. https://doi.org/10.1007/s11150-016-9357-6

Ali, Z., Green, R., Zougmoré, R. B., Mkuhlani, S., Palazzo, A., Prentice, A. M., … Scheelbeek, P. F. D. (2020). Long-term impact of West African food system responses to COVID-19. *Nature Food*, 1–3. https://doi.org/10.1038/s43016-020-00191-8

Alidou, S., & Verpoorten, M. (2019). Family size and schooling in sub-Saharan Africa: testing the quantity-quality trade-off. *Journal of Population Economics*.

Alvi, M., Gupta, S., Meinzen-Dick, R., & Ringler, C. (2020). Phone surveys to understand gendered impacts of covid-19: a cautionary note. Retrieved from EnGendering Data blog website: https://pim.cgiar.org/2020/07/14/phone-surveys-to-understand-gendered-impacts-of-covid-19-a-cautionary-note/

Amare, M., & Shiferaw, B. (2017). Nonfarm employment, agricultural intensification, and productivity change: empirical findings from Uganda. *Agricultural Economics*, *48*, 59–72.

Amin, R., Ahmed, A. U., Chowdhury, J., & Ahmed, M. (1994). Poor women's participation in income-generating projects and their fertility regulation in rural Bangladesh: Evidence from a recent survey. *World Development*, *22*(4), 555–565. https://doi.org/10.1016/0305-750X(94)90111-2

Angelucci, M., & Garlick, R. (2014). *Heterogeneity and Aggregation : Testing for Efficiency in Intra-Household Allocation*.

Angrist, J. D., Lavy, V., & Schlosser, A. (2010). Multiple Experiments for the Causal Link between the Quantity and Quality of Children. *Journal of Labor Economics*, *28*(4), 773–823.

Anríquez, G., & Daidone, S. (2010). Linkages between the farm and nonfarm sectors at the household level in rural Ghana: A consistent stochastic distance function approach. *Agricultural Economics*, *41*(1), 51–66.

ANSD. (2015). *Situation Economique et Sociale Regionale de Saint-Louis 2013*. Retrieved from http://www.ansd.sn/

Argys, L. M., & Averett, S. L. (2019). The effect of family size on education: New evidence from China's one-child policy. *Journal of Demographic Economics*, *85*(1), 21–42.

Armand, A., Attanasio, O., Carneiro, P., & Lechene, V. (2020). The Effect of Gender-Targeted Conditional Cash Transfers on Household Expenditures: Evidence from a Randomized Experiment. *The Economic Journal*, *130*(631), 1875–1897. https://doi.org/10.1093/ej/ueaa056

Arouna, A., Soullier, G., Mendez del Villar, P., & Demont, M. (2020). Policy options for mitigating impacts of COVID-19 on domestic rice value chains and food security in West Africa. *Global Food Security*, *26*(May), 100405. https://doi.org/10.1016/j.gfs.2020.100405

Asiedu, E., & Gyimah-brempong, K. (2008). The effect of the liberalization of investment policies on employment and investment of multinational corporations in Africa. *African Development Review*, *20*(1), 49–66. https://doi.org/10.1111/j.1467-8268.2008.00176.x

Attanasio, O. P., & Lechene, V. (2014). Efficient responses to targeted cash transfers. *Journal of Political Economy*, *122*(1), 178–222. https://doi.org/10.1086/674968

Ayenew, H. Y., Estruch, E., Sauer, J., Abate-Kassa, G., Schickramm, L., & Wobst, P. (2017). Decent rural employment and farm production efficiency: empirical evidence from Tanzania and Ethiopia. *Agricultural Economics*, *48*(5), 587–596.

Azarnert, L. V. (2010). Free education, fertility and human capital accumulation. *Journal of Population Economics*, *23*(2), 449–468. https://doi.org/10.1007/s00148-008-0205-8

Baert, M., Kervyn, M., Kagou, A. D., Guedjeo, C. S., Vranken, L., & Mertens, K. (2020). Land Use Policy Resettlement preferences from landslide prone areas in Cameroon : Willingness to move , reasons to stay. *Land Use Policy*, *95*(April 2019), 103975. https://doi.org/10.1016/j.landusepol.2019.04.036

Baland, J. M., Bonjean, I., Guirkinger, C., & Ziparo, R. (2016). The economic consequences of mutual help in extended families. *Journal of Development Economics*, *123*, 38–56.

Bankole, A. (1995). Desired fertility and fertility behaviour among the yoruba of Nigeria: A study of couple preferences and subsequent fertility. *Population Studies*, *49*(2), 317–328. https://doi.org/10.1080/0032472031000148536

Bankole, A., & Singh, S. (1998). Couples' Fertility and Contraceptive Decision-Making in Developing Countries: Hearing the Man's Voice. *International Family Planning Perspectives*, *24*(1), 15–24. https://doi.org/10.2307/2991915

Banks, J., Blundell, R., & Lewbel, A. (1997). Quadratic Engel Curves and Consumer Demand. *The Review of Economics and Statistics*, *79*(4), 527–539.

Barrett, C. B., Bachke, M. E., Bellemare, M. F., Michelson, H. C., Narayanan, S., & Walker, T. F. (2012). Smallholder participation in contract farming: Comparative evidence from five countries. *World Development*, *40*(4), 715–730.

Barrett, C. B., Reardon, T., & Webb, P. (2001). Nonfarm income diversification and household livelihood strategies in rural Africa: concepts, dynamics, and policy implications. *Food Policy*, *26*, 315–331.

Bateman, I. J., & Munro, A. (2009). Household Versus Individual Valuation: What's the Difference? *Environmental and Resource Economics*, *43*(1), 119–135.

Baulch, B., & Quisumbing, A. (2011). Testing and Adjusting for Attrition in Household Panel Data. In *CPRC toolkit note* (Vol. 1).

Bawa, A. B. (2013). From Imperialism to Diplomacy: A historical analysis of French and Senegal Cultural Relationship. *London Art as Cultural Diplomacy Conference*, 9. London.

Beblo, M., & Beninger, D. (2017). Do husbands and wives pool their incomes? A couple experiment. *Review of Economics of the Household*, *15*(3), 779–805. https://doi.org/10.1007/s11150-016-9342-0

Beck, M. J., & Rose, J. M. (2019). Stated preference modelling of intra-household decisions: Can you more easily approximate the preference space? *Transportation*, *46*(4), 1195–1213. https://doi.org/10.1007/s11116-017-9822-y

Becker, G. S. (1960). An Economic Analysis of Fertility. In National Bureau of Economic Research (Ed.), *Demographic and economic change in developed countries* (p. 536). Columbia University Press.

Becker, G. S. (1974). A Theory of Social Interactions. *Journal of Political Economy*, *82*(6).

Becker, G. S., & Lewis, H. G. (1973). On the interaction between quantity and quality of children. *Journal of Political Economy*, *81*(2), 279-S288.

Becker, G. S., & Tomes, N. (1976). Child Endowments and the Quantity and Quality of Children. *Journal of Political Economy*, *84*(4, Part 2), S143–S162.

Beegle, K., Carletto, C., & Himelein, K. (2012). Reliability of recall in agricultural data. *Journal of Development Economics*, *98*(1), 34–41. https://doi.org/10.1016/j.jdeveco.2011.09.005

Beegle, K., & Christiaensen, L. (2019). *Accelerating Poverty Reduction in Africa* (K. Beegle & L. Christiaensen, Eds.). https://doi.org/10.1596/978-1-4648-1232-3

Beegle, K., Christiaensen, L., Dabalen, A., & Gaddis, I. (2016). *Poverty in a Rising Africa*. Washington, DC: World Bank.

Beghin, J. C., Maertens, M., & Swinnen, J. (2015). Nontariff measures and standards in trade and global value chains. *Annual Review of Resource Economics*, *7*(1), 425–450. https://doi.org/10.1146/annurev-resource-100814-124917

Beharry-Borg, N., Hensher, D. A., & Scarpa, R. (2009). An analytical framework for joint vs separate decisions by couples in choice experiments: The case of coastal water quality in tobago. *Environmental and Resource Economics*, *43*(1), 95–117.

Bellemare, M. F. (2012). As You Sow, So Shall You Reap: The Welfare Impacts of Contract Farming. *World Development*, *40*(7), 1418–1434. https://doi.org/10.1016/j.worlddev.2011.12.008

Bernard, T., De Janvry, A., Mbaye, S., & Sadoulet, E. (2017). Expected Product Market Reforms and Technology Adoption by Senegalese Onion Producers. *American Journal of Agricultural Economics*, *99*(4), 1096–1115. https://doi.org/10.1093/ajae/aax033

Bezu, S., Barrett, C. B., & Holden, S. (2012). Does the Nonfarm Economy Offer Pathways for Upward Mobility? Evidence from a Panel Data Study in Ethiopia. *World Development*, *40*(8), 1634–1646.

Bhalotra, S., & Clarke, D. (2020). The Twin Instrument: Fertility and Human Capital Investment. *Journal of the European Economic Association*, *18*(6), 3090–3139. https://doi.org/10.1093/jeea/jvz058

Bhrolcháin, M. N., & Beaujouan, É. (2019). Do People Have Reproductive Goals? Constructive Preferences and the Discovery of Desired Family Size. In R. Schoen (Ed.), *Analytical Family Demography* (The Spring, pp. 27–56). https://doi.org/10.1007/978-3-319-93227-9_5

Black, S. E., Devereux, P. J., & Salvanes, K. G. (2005). The More the Merrier? The Effect of Family Size and Birth Order on Children's Education. *Quarterly Journal of Economics*, *120*(2), 669–700.

Blundell, R., & Walker, I. (1986). A Life-Cycle Consistent Empirical Model of Family Labour Supply Using Cross-Section Data. *The Review of Economic Studies*, *53*(4), 539–558. https://doi.org/10.2307/2297605

Bobonis, G. J. (2009). Is the allocation of resources within the household efficient? New evidence from a randomized experiment. *Journal of Political Economy*, *117*(3), 453–503. https://doi.org/10.1086/600076

Bongaarts, J. (1990). The Measurement of Wanted Fertility. *Population and Development Review*, *16*(3), 487–506.

Bongaarts, J. (2010). The causes of educational differences in fertility in Sub-Saharan Africa. *Vienna Yearbook of Population Research*, *8*(1), 31–50. https://doi.org/10.1553/populationyearbook2010s31

Bongaarts, J. (2011). Can family planning programs reduce high desired family size in Sub-Saharan Africa? *International Perspectives on Sexual and Reproductive Health*, *37*(4), 209–216.

Boyden, J. Y., Ersek, M., Deatrick, J. A., Widger, K., LaRagione, G., Lord, B., & Feudtner, C. (2021). What Do Parents Value Regarding Pediatric Palliative and Hospice Care in the Home Setting ? *Journal of Pain and Symptom Management*, *61*(1), 12–23. https://doi.org/10.1016/j.jpainsymman.2020.07.024

Braaten, R., & Martinsson, P. (2015). Experimental measures of household decision power. In *CREE Working Papers* (No. 02; Vol. 02). Retrieved from http://www.cree.uio.no/publications/2015_2/150130 Decision powerJMG.pdf

Brazell, J. D., Diener, C. G., Karniouchina, E., Moore, W. L., Séverin, V., & Uldry, P. F. (2006). The no-choice option and dual response choice designs. *Marketing Letters*, *17*(4), 255–268. https://doi.org/10.1007/s11002-006-7943-8

Browning, M. (2000). The saving behaviour of a two-person household. *Scandinavian Journal of Economics*, *102*(2), 235–251. https://doi.org/10.1111/1467-9442.00197

Browning, M., & Chiappori, P.-A. (1998). Efficient Intra-Household Allocations : A General Characterization and Empirical Tests. *Econometrica*, *66*(6), 1241–1278.

Browning, M., & Meghir, C. (1991). The Effects of Male and Female Labor Supply on Commodity Demands. *Econometrica*, *59*(4), 925–951.

Bryceson, D. F. (2002). Multiplex livelihoods in rural Africa: recasting the terms and conditions of gainful employment. *The Journal of Modern African Studies*, *40*(1), 1–28.

Caeyers, B., Chalmers, N., & De Weerdt, J. (2012). Improving consumption measurement and other survey data through CAPI: Evidence from a randomized experiment. *Journal of Development Economics*, *98*(1), 19–33. https://doi.org/10.1016/j.jdeveco.2011.12.001

Carletto, C., Jolliffe, D., & Banerjee, R. (2013). *The Emperor has no Data! Agricultural Statistics in Sub-Saharan Africa*.

Carlson, E. (2015). Ethnic Voting and Accountability in Africa: A Choice Experiment in Uganda. *World Politics*, *67*(2), 353–385. https://doi.org/10.1017/S0043887115000015

Carlsson, F., He, H., Martinsson, P., Qin, P., & Sutter, M. (2012). Household decision making in rural China: Using experiments to estimate the influences of spouses. *Journal of Economic Behavior and Organization*, *84*(2), 525–536. https://doi.org/10.1016/j.jebo.2012.08.010

Carson, R. T., Louviere, J. J., Anderson, D. A., Arabie, P., Bunch, D. S., Hensher, D. A., … Wiley, J. B. (1994). Experimental analysis of choice. *Marketing Letters*, *5*(4), 351–367. https://doi.org/10.1007/BF00999210

Chari, F., & Ngcamu, B. S. (2017). An assessment of the impact of disaster risks on dairy supply chain performance in Zimbabwe. *Cogent Engineering*, *4*(1). https://doi.org/10.1080/23311916.2017.1409389

Chen, Z., & Woolley, F. (2001). A Cournot-Nash model of family decision making. *Economic Journal*, *111*(474), 722–748. https://doi.org/10.1111/1468-0297.00657

Christiaensen, L. (2017). Agriculture in Africa – Telling myths from facts: A synthesis. *Food Policy*, *67*, 1–11.

Christiaensen, L., & Martin, W. (2018). Agriculture, structural transformation and poverty reduction: Eight new insights. *World Development*, *109*, 413–416.

Clark, S., & Brauner-Otto, S. (2015). Divorce in sub-Saharan Africa: Are Unions Becoming Less Stable? *Population and Development Review*, *41*(4), 583–605. https://doi.org/10.1111/j.1728-4457.2015.00086.x

Clark, S., & Hamplová, D. (2013). Single Motherhood and Child Mortality in Sub-Saharan Africa: A Life Course Perspective. *Demography*, *50*(5), 1521–1549. https://doi.org/10.1007/s13524-013-0220-6

Cleland, J., Machiyama, K., & Casterline, J. B. (2020). Fertility preferences and subsequent childbearing in Africa and Asia: A synthesis of evidence from longitudinal studies in 28 populations. *Population Studies*, *74*(1), 1–21. https://doi.org/10.1080/00324728.2019.1672880

Coates, J., Swindale, A., & Bilinsky, P. (2007). Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide. In *Food and Nutrition Technical Assistance*. Washington, D.C.

Colen, L., Maertens, M., & Swinnen, J. (2012). Private Standards, Trade and Poverty: GlobalGAP and Horticultural Employment in Senegal. *World Economy*, *35*(8), 1073–1088. https://doi.org/10.1111/j.1467-9701.2012.01463.x

Corfman, K. P., & Lehmann, D. R. (1987). Models of Cooperative Group Decision-Making and Relative Influence: An Experimental Investigation of Family Purchase Decisions. *Journal of Consumer Research*, *14*(1), 1. https://doi.org/10.1086/209088

Countryman, A. M., Paarlberg, P. L., & Lee, J. G. (2016). Dynamic effects of drought on the U.S. beef supply chain. *Agricultural and Resource Economics Review*, *45*(3), 459–484. https://doi.org/10.1017/age.2016.4

Creevey, L. (1996). Islam, women and the role of the state in Senegal. *Journal of Religion in Africa*, *26*(3), 268–307. https://doi.org/10.1163/157006696X00299

Dai, R., Feng, H., Hu, J., Jin, Q., Li, H., Wang, R., … Zhang, X. (2020). *The Impact of COVID-19 on Small and Medium-sized Enterprises: Evidence from Two-wave Phone Surveys in China* (No. 549). Washington, D.C.

David-Benz, H., & Seck, A. (2018). *Améliorer la qualité de l'oignon au Sénégal: Contractualisation et autres mesures transversales*. Retrieved from http://www.fao.org/3/i8488fr/I8488FR.pdf

Davis, B., Di Giuseppe, S., & Zezza, A. (2014). Income diversification patterns in rural Sub-Saharan Africa : reassessing the evidence. In *World Bank Working Paper Series* (No. 7108).

Davis, B., Di Giuseppe, S., & Zezza, A. (2017). Are African households (not) leaving agriculture? Patterns of households' income sources in rural Sub-Saharan Africa. *Food Policy*, *67*, 163–174.

Davis, B., Winters, P., Carletto, G., Covarrubias, K., Quiñones, E. J., Zezza, A., … Digiuseppe, S. (2010). A Cross-Country Comparison of Rural Income Generating Activities. *World Development*, *38*(1), 48–63.

Davis, K. F., Downs, S., & Gephart, J. A. (2021). Towards food supply chain resilience to environmental shocks. *Nature Food*, *2*(1), 54–65. https://doi.org/10.1038/s43016-020-00196-3

De Janvry, A., & Sadoulet, E. (2001). Income strategies among rural households in Mexico: The role of off-farm activities. *World Development*, *29*(3), 467–480. https://doi.org/10.1016/S0305-750X(00)00113-3

de la Croix, D., & Doepke, M. (2004). Public versus private education when differential fertility matters. *Journal of Development Economics*, *73*(2), 607–629. https://doi.org/10.1016/j.jdeveco.2003.05.005

De Palma, A., Picard, N., & Ziegelmeyer, A. (2011). Individual and couple decision behavior under risk: Evidence on the dynamics of power balance. *Theory and Decision*, *70*(1), 45–64. https://doi.org/10.1007/s11238-009-9179-6

De Schutter, O. (2011). How not to think of land-grabbing : three critiques of large-scale investments in farmland. *The Journal of Peasant Studies*, *38*(2), 249–279. https://doi.org/10.1080/03066150.2011.559008

Deaton, A., & Dreze, J. (2002). Poverty and Inequality in India: A Re-Examination. *Economic And Political Weekly*, *37*(36), 3729–3748.

Deininger, K., & Xia, F. (2016). Quantifying Spillover Effects from Large Land-based Investment: The Case of Mozambique. *World Development*, *87*, 227–241.

Delgado, C., Hopkins, J., & Kelly, V. (1998). *Agricultural Growth Linkages in Sub-Saharan Africa* (No. 107). Washington, D.C.

Deschênes, S., Dumas, C., & Lambert, S. (2020). Household resources and individual strategies. *World Development*, *135*. https://doi.org/10.1016/j.worlddev.2020.105075

Dethier, J. J., & Effenberger, A. (2012). Agriculture and development: A brief review of the literature. *Economic Systems*, *36*(2), 175–205. https://doi.org/10.1016/j.ecosys.2011.09.003

Djuikom, M. A., & van de Walle, D. (2018). Marital Shocks and Women's Welfare in Africa. In *Policy Research Working Paper* (No. 8306). https://doi.org/10.1596/1813-9450-8306

Dolan, C., & Humphrey, J. (2000). Governance and Trade in Fresh Vegetables : The Impact of UK Supermarkets on the African Horticulture Industry Governance and Trade in Fresh Vegetables : The Impact of UK Supermarkets on the. *Journal of Development Studies*, *37*(2), 147–176. https://doi.org/10.1080/713600072

Dorward, A., Kydd, J., & Poulton, C. (2005). Beyond Liberalisation: "Developmental Coordination" Policies for African Smallholder Agriculture. In *IDS Bulletin Vol 36 No 2*.

Dosman, D., & Adamowicz, W. (2006). Combining stated and revealed preference data to construct an empirical examination of intrahousehold bargaining. *Review of Economics of the Household*, *4*(1), 15–34.

Doss, C., Kovarik, C., Peterman, A., Quisumbing, A., & van den Bold, M. (2015). Gender inequalities in ownership and control of land in Africa: Myth and reality. *Agricultural Economics*, *46*(3), 403–434. https://doi.org/10.1111/agec.12171

Dou, Z., Stefanovski, D., Galligan, D., Lindem, M., Rozin, P., Chen, T., & Chao, A. M. (2020). *The COVID-19 Pandemic Impacting Household Food Dynamics: A Cross-National Comparison of China and the U.S.* https://doi.org/https://doi.org/10.31235/osf.io/64jwy

Drechsel, P., Gyiele, L., Kunze, D., & Cofie, O. (2001). Population density, soil nutrient depletion, and economic growth in sub-Saharan Africa. *Ecological Economics*, *38*(2), 251–258. https://doi.org/10.1016/S0921-8009(01)00167-7

Duflo, E. (2003). Grandmothers and granddaughters: Old-age pensions and intrahousehold allocation in South Africa. *World Bank Economic Review*, *17*(1), 1–25. https://doi.org/10.1093/wber/lhg013

Duflo, E., & Udry, C. (2004). *Intrahousehold Resource Allocation in Côte d'Ivoire: Social Norms, Separate Accounts and Consumption Choices* (No. 10498). Retrieved from http://www.nber.org/papers/w10498

Dumas, C., & Lefranc, A. (2019). “Sex in Marriage Is a Divine Gift”? Evidence on the Quantity-Quality Trade-off from the Manila Contraceptive Ban. *World Bank Economic Review*, *33*(1), 259–285.

Ellis, F. (2000). The Determinants of Rural Livelihood Diversification in Developing Countries. *Journal of Agricultural Economics*, *51*(2), 289–302.

Ezeh, A. C., Bongaarts, J., & Mberu, B. (2012). Global population trends and policy options. *The Lancet*, *380*(9837), 142–148.

Fabry, A., Van den Broeck, G., & Maertens, M. (2020). Decent work in global food value chains: Evidence from Senegal. *World Development*, (under review).

Falkowski, J. (2015). Resilience of farmer-processor relationships to adverse shocks: the case of dairy sector in Poland. *British Food Journal*, *117*(10), 2465–2483. https://doi.org/10.1108/BFJ-12-2014-0433

Feyaerts, H., Van den Broeck, G., & Maertens, M. (2020). Global and local food value chains in Africa: A review. *Agricultural Economics*, *51*(1), 143–157. https://doi.org/10.1111/agec.12546

Fiebig, D. G., Keane, M. P., Louviere, J., & Wasi, N. (2010). The generalized multinomial logit model: Accounting for scale and coefficient heterogeneity. *Marketing Science*, *29*(3), 393–421.

Fields, G. S. (2019). *Employment and Development: How Work Can Lead from and Into Poverty* (First edit; J. Pieters, Ed.). Oxford University Press.

Fink, G., Jack, K. B., & Masiye, F. (2014). *Seasonal credit constraints and agricultural labor supply: Evidence from Zambia* (No. 20218).

Fitzsimons, E., & Malde, B. (2014). Empirically probing the quantity-quality model. *Journal of Population Economics*, *27*(1), 33–68.

Fox, L., Senbet, L. W., & Simbanegavi, W. (2016). Youth employment in Sub-Saharan Africa: Challenges, constraints and opportunities. *Journal of African Economies*, *25*, i3–i15. https://doi.org/10.1093/jae/ejv027

FP2020. (2020). Family Planning 2020 Senegal. Retrieved from https://www.familyplanning2020.org/senegal

FP2020. (2021). Family Planning 2020 Uganda. Retrieved from https://www.familyplanning2020.org/uganda

Garenne, M. (2015). Traditional Wealth, Modern Goods, and Demographic Behavior in Rural Senegal. *World Development*, *72*, 267–276. https://doi.org/10.1016/j.worlddev.2015.03.013

Getahun, T. D., & Villanger, E. (2018). Labour-Intensive Jobs for Women and Development: Intra-household Welfare Effects and Its Transmission Channels. *Journal of Development Studies*, *54*(7), 1232–1252.

Gillespie, D., Ahmed, S., Tsuia, A., & Radloff, S. (2007). Unwanted fertility among the poor: An inequity? *Bulletin of the World Health Organization*, *85*(2). https://doi.org/10.2471/BLT.06.033829

Gipson, J. D., & Hindin, M. J. (2009). The effect of husbands' and wives' fertility preferences on the likelihood of a subsequent pregnancy, Bangladesh 1998-2003. *Population Studies*, *63*(2), 135–146. https://doi.org/10.1080/00324720902859372

Glauber, J., Laborde, D., Martin, W., & Vos, R. (2020). COVID-19: Trade restrictions are worst possible response to safeguard food security. In J. Swinnen & J. McDermott (Eds.), *COVID-19 & Global Food Security* (pp. 66–68). https://doi.org/https://doi.org/10.2499/p15738coll2.133762

Gohin, A., & Rault, A. (2013). Assessing the economic costs of a foot and mouth disease outbreak on Brittany: A dynamic computable general equilibrium analysis. *Food Policy*, *39*, 97–107. https://doi.org/https://doi.org/10.1016/j.foodpol.2013.01.003

Goldberg, P. K., & Pavcnik, N. (2007). Distributional effects of globalization in developing countries. *Journal of Economic Literature*, *45*(1), 39–82. https://doi.org/10.1257/jel.45.1.39

Gould, E. D., Moav, O., & Simhon, A. (2008). The mystery of monogamy. *American Economic Review*, *98*(1), 333–357. https://doi.org/10.1257/aer.98.1.333

Gouvernement Sénégalais. (2014). *Evaluation quantitative du DSRP-II - Dynamique de la pauvreté monétaire*.

Graves, A., Rosa, L., Nouhou, A. M., Maina, F., & Adoum, D. (2019). Avert catastrophe now in Africa's Sahel. *Nature*, *575*(7782), 282–286. https://doi.org/10.1038/d41586-019-03445-z

Guang, G., & Van Wey, L. K. (1999). Sibship Size and Intellectual Development: Is the Relationship Causal? *American Sociological Review*, *64*(2), 169–187.

Günther, I., & Harttgen, K. (2016). Desired Fertility and Number of Children Born Across Time and Space. *Demography*, *53*(1), 55–83.

Guo, R., Yi, J., & Zhang, J. (2017). Family size, birth order, and tests of the quantity–quality model. *Journal of Comparative Economics*, *45*(2), 219–224.

Gupta, N. D., & Dubey, A. (2006). Fertility and the household's economic status: A natural experiment using Indian micro data. *Journal of Development Studies*, *42*(1), 110–138. https://doi.org/10.1080/00220380500356779

Haggblade, S., Hazell, P., & Brown, J. (1989). Farm-Nonfarm Linkages in Rural Sub-Saharan Africa. *World Development*, *17*(8), 1173–1201.

Handa, S. (2000). The impact of education, income, and mortality on fertility in Jamaica. *World Development*, *28*(1), 173–186. https://doi.org/10.1016/S0305-750X(99)00114-X

Harris, J. (2020). Diets in a time of coronavirus: Don't let vegetables fall off the plate. Retrieved from IFPRI blog post website: https://www.ifpri.org/blog/diets-time-coronavirus-dont-let-vegetables-fall-plate

Hawkes, C. (2020). COVID-19 and the promise of food system innovation. Retrieved from IFPRI blog post website: https://www.ifpri.org/blog/covid-19-and-promise-food-system-innovation

Headey, D. D., & Jayne, T. S. (2014). Adaptation to land constraints: Is Africa different? *Food Policy*, *48*, 18–33. https://doi.org/10.1016/j.foodpol.2014.05.005

Hensher, D. A., & Greene, W. H. (2010). Non-attendance and dual processing of common-metric attributes in choice analysis: A latent class specification. *Empirical Economics*, *39*(2), 413–426.

Hensher, D. A., Rose, J., & Greene, W. H. (2005a). The implications on willingness to pay of respondents ignoring specific attributes. *Transportation*, *32*(3), 203–222.

Hensher, D. A., Rose, J. M., & Greene, W. H. (2005b). *Applied Choice Analysis - A Primer*. New York: Cambridge University Press.

Herrmann, R. (2017). Large-Scale Agricultural Investments and Smallholder Welfare: A Comparison of Wage Labor and Outgrower Channels in Tanzania. *World Development*, *90*, 294–310.

Herrmann, R., & Grote, U. (2015). Large-scale agro-industrial investments and rural poverty: Evidence from sugarcane in Malawi. *Journal of African Economies*, *24*(5), 645–676.

Himelein, K., Eckman, S., Lau, C., & McKenzie, D. (2020). Mobile Phone Surveys for Understanding COVID-19 Impacts: Part I Sampling and Mode. Retrieved from World Bank blogs website: https://blogs.worldbank.org/impactevaluations/mobile-phone-surveys-understanding-covid-19-impacts-part-i-sampling-and-mode

Hirvonen, K., De Brauw, A., & Abate, G. T. (2020). *Food Consumption and Food Security during the COVID-19 Pandemic in Addis Ababa* (No. 01964). Washington, D.C.

Hirvonen, K., Minten, B., Mohammed, B., & Tamru, S. (2021). Food prices and marketing margins during the COVID-19 pandemic: Evidence from vegetable value chains in Ethiopia. *Agricultural Economics*, 1–15. https://doi.org/10.1111/agec.12626

Hobbs, J. E. (2020). Food supply chains during the COVID-19 pandemic. *Canadian Journal of Agricultural Economics*, (April), 1–6. https://doi.org/10.1111/cjag.12237

Hoddinott, J. (1992). Rotten kids or manipulative parents: are children old age security in western Kenya? *Economic Development & Cultural Change*, *40*(3), 545–565. https://doi.org/10.1086/451960

Holden, S., Shiferaw, B., & Pender, J. (2004). Non-farm income, household welfare, and sustainable land management in a less-favoured area in the Ethiopian highlands. *Food Policy*, *29*, 369–392.

Hole, A. R., Kolstad, J. R., & Gyrd-Hansen, D. (2013). Inferred vs. stated attribute non-attendance in choice experiments: A study of doctors' prescription behaviour. *Journal of Economic Behavior and Organization*, *96*, 21–31.

Hossain, M., Malek, M. A., Hossain, M. A., Reza, M. H., & Ahmed, M. S. (2019). Agricultural Microcredit for Tenant Farmers: Evidence from a Field Experiment in Bangladesh. *American Journal of Agricultural Economics*, *101*(3), 692–709.

IFAD. (2019). *2019 Rural Development Report - Creating Opportunities for Rural Youth*.

ILOSTAT. (2019). Key Indicators of the Labour Market (KILM). Retrieved April 18, 2019, from https://www.ilo.org/ilostat

Imai, K. S., Gaiha, R., & Thapa, G. (2015). Does non-farm sector employment reduce rural poverty and vulnerability? Evidence from Vietnam and India. *Journal of Asian Economics*, *36*, 47–61.

IMF. (2020). *World Economic Outlook, April 2020: The Great Lockdown*. Retrieved from https://www.imf.org/en/Publications/WEO/Issues/2020/04/14/weo-april-2020

Inchauste, G. (2012). *Jobs and Transitions Out of Poverty: A Literature Review*.

IPAR. (2020). *La voix paysanne - Série spéciale Covid-10 & Agriculture*. Retrieved from https://www.ipar.sn/IMG/pdf/bulletin_-_la_voix_paysanne_-_1er_num-vf.pdf

ITC Trade Map. (2020). Trade Map - Trade statistics for international business development. Retrieved July 14, 2020, from https://www.trademap.org/Index.aspx

Ivanic, M., & Martin, W. (2018). Sectoral Productivity Growth and Poverty Reduction: National and Global Impacts. *World Development*, *109*, 429–439.

Iversen, V., Jackson, C., Kebede, B., Munro, A., & Verschoor, A. (2011). Do Spouses Realise Cooperative Gains? Experimental Evidence from Rural Uganda. *World Development*, *39*(4), 569–578. https://doi.org/10.1016/j.worlddev.2010.09.011

Jackson, C. (2013). Cooperative Conflicts and Gender Relations: Experimental Evidence from Southeast Uganda. *Feminist Economics*, *19*(4), 25–47. https://doi.org/10.1080/13545701.2013.827797

Jacobi, J., Mukhovi, S., Llanque, A., Augstburger, H., Käser, F., Pozo, C., … Ifejika Speranza, C. (2018). Operationalizing food system resilience: An indicator-based assessment in agroindustrial, smallholder farming, and agroecological contexts in Bolivia and Kenya. *Land Use Policy*, *79*(August), 433–446. https://doi.org/10.1016/j.landusepol.2018.08.044

Janssens, C., Havlík, P., Krisztin, T., Baker, J., Frank, S., Hasegawa, T., … Maertens, M. (2020). Global Hunger and Climate Change Adaptation through International Trade. *Nature Climate Change*, *10*(9), 829–835. https://doi.org/10.1038/s41558-020-0847-4

Jayawardena, R., & Misra, A. (2020). Balanced diet is a major casualty in COVID-19. *Diabetes and Metabolic Syndrome: Clinical Research and Reviews*, *14*(5), 1085–1086. https://doi.org/10.1016/j.dsx.2020.07.001

Jensen, R. (2012). Do labor market opportunities affect young women's work and family decisions? Experimental evidence from India. *Quarterly Journal of Economics*, *127*(2), 753–792. https://doi.org/10.1093/qje/qjs002

Joshi, S., & Schultz, T. P. (2013). Family Planning and Women's and Children's Health: Long-Term Consequences of an Outreach Program in Matlab, Bangladesh. *Demography*, *50*(1), 149–180.

Kabahinda, J. (2018). On-the-ground perspectives of women's land rights in Uganda. *Development in Practice*, *28*(6), 813–823. https://doi.org/10.1080/09614524.2018.1481933

Kang, C. (2011). Family Size and Educational Investments in Children: Evidence from Private Tutoring Expenditures in South Korea. *Oxford Bulletin of Economics and Statistics*, *73*(1), 59–78.

Kangogo, D., Dentoni, D., & Bijman, J. (2020). Determinants of farm resilience to climate change: The role of farmer entrepreneurship and value chain collaborations. *Sustainability*, *12*(3). https://doi.org/10.3390/su12030868

Kazeem, Y. (2020). African e-commerce is getting a much needed boost from coronavirus lockdowns. Retrieved from https://qz.com/africa/1855227/africas-e-commerce-boosted-by-coronavirus-lockdowns/

Kerr, R. B. (2005). Informal Labor and Social Relations in Northern Malawi: The Theoretical Challenges and Implications of Ganyu Labor for Food Security. *Rural Sociology*, *70*(2), 167–187.

Kessels, R., Goos, P., & Vandebroek, M. (2006). A comparison of criteria to design efficient choice experiments. *Journal of Marketing Research*, *43*(3), 409–419.

Kessels, R., Jones, B., Goos, P., & Vandebroek, M. (2008). Recommendations on the Use of Bayesian Optimal Designs for Choice Experiments. *Quality and Reliability Engineering International*, *24*, 229–248.

Kilic, T., Carletto, C., Miluka, J., & Savastano, S. (2009). Rural nonfarm income and its impact on agriculture: Evidence from Albania. *Agricultural Economics*, *40*(2), 139–160.

Kis-Katos, K., & Sparrow, R. (2015). Poverty, labor markets and trade liberalization in Indonesia. *Journal of Development Economics*, *117*, 94–106. https://doi.org/10.1016/j.jdeveco.2015.07.005

Knapen, A., Kitutu, M. G., Poesen, J., Breugelmans, W., Deckers, J., & Muwanga, A. (2006). Landslides in a densely populated county at the footslopes of Mount Elgon (Uganda): Characteristics and causal factors. *Geomorphology*, *73*(1–2), 149–165. https://doi.org/10.1016/j.geomorph.2005.07.004

Kodzi, I. A., Casterline, J. B., & Aglobitse, P. (2010). The time dynamics of individual fertility preferences among rural Ghanaian women. *Studies in Family Planning*, *41*(1), 45–54.

Kodzi, I. A., Johnson, D. R., & Casterline, J. B. (2010). Examining the predictive value of fertility preferences among Ghanaian women. *Demographic Research*, *22*(June 2010), 965–984.

Kollehlon, K. T. (2003). Ethnicity and fertility in Nigeria. *Social Biology*, *50*(3–4), 201–221. https://doi.org/10.1080/19485565.2003.9989072

Koopman, J. E. (2009). Globalization, gender, and poverty in the senegal river valley. *Feminist Economics*. https://doi.org/10.1080/13545700902920370

Krumbiegel, K., Maertens, M., & Wollni, M. (2020). Can employment empower women? Female workers in the pineapple sector in Ghana. *Journal of Rural Studies*, *80*(February), 76–90. https://doi.org/10.1016/j.jrurstud.2020.05.012

Kugler, A. D., & Kumar, S. (2017). Preference for Boys, Family Size, and Educational Attainment in India. *Demography*, *54*(3), 835–859. https://doi.org/10.1007/s13524-017-0575-1

Kwagala, B. (2013). Birthing choices among the Sabiny of Uganda. *Culture, Health and Sexuality*, Vol. 15, pp. S401–S414. https://doi.org/10.1080/13691058.2013.799232

Laborde, D., Martin, W., Swinnen, J., & Vos, R. (2020). COVID-19 risks to global food security. *Science*, *369*(6503), 500–502. https://doi.org/10.1126/science.abc4765

Laborde, D., Martin, W., & Vos, R. (2021). Impacts of COVID-19 on global poverty, food security, and diets: Insights from global model scenario analysis. *Agricultural Economics*, 1–16. https://doi.org/10.1111/agec.12624

Lal, N. (2020). Online grocery shopping is clicking with consumers amid pandemic. Retrieved from https://retail.economictimes.indiatimes.com/news/e-commerce/e-tailing/online-grocery-shopping-is-clicking-with-consumers-amid-pandemic/78692986

Lambert, S., & Rossi, P. (2016). Sons as widowhood insurance: Evidence from Senegal. *Journal of Development Economics*, *120*, 113–127. https://doi.org/10.1016/j.jdeveco.2016.01.004

Lancaster, G., Maitra, P., & Ray, R. (2006). Endogenous intra-household balance of power and its impact on expenditure patterns: Evidence from India. *Economica*, *73*(291), 435–460. https://doi.org/10.1111/j.1468-0335.2006.00502.x

Lancaster, K. J. (1966). A New Approach to Consumer Theory. *Journal of Political Economy*, *74*(2), 132–157.

Lanjouw, P., & Murgai, R. (2009). Poverty decline, agricultural wages, and nonfarm employment in rural India: 1983-2004. *Agricultural Economics*, *40*(2), 243–263.

Leat, P., & Revoredo-Giha, C. (2013). Risk and resilience in agri-food supply chains: The case of the ASDA PorkLink supply chain in Scotland. *Supply Chain Management*, *18*(2), 219–231. https://doi.org/10.1108/13598541311318845

Lee, J. (2008). Sibling size and investment in children's education: An asian instrument. *Journal of Population Economics*, *21*(4), 855–875.

Leesa-Nguansuk, S. (2020). Covid-19: Thailand eateries banking on delivery apps, social media to survive lockdown. Retrieved from https://www.thestar.com.my/tech/tech-news/2020/04/21/covid-19-thailand-eateries-banking-on-delivery-apps-social-media-to-survive-lockdown

Lele, U. (1976). Designing Rural Development Programs: Lessons from past Experience in Africa. *Economic Development and Cultural Change*, *24*(2), 287–308. https://doi.org/10.1086/450870

Leuthold, J. H. (1968). An Empirical Study of Formula Income Transfers and the Work Decision of the Poor. *The Journal of Human Resources*, *3*(3), 312. https://doi.org/10.2307/145103

Li, B., & Zhang, H. (2017). Does population control lead to better child quality? Evidence from China's one-child policy enforcement. *Journal of Comparative Economics*, *45*, 246–260.

Li, J., Dow, W. H., & Rosero-Bixby, L. (2017). Education Gains Attributable to Fertility Decline: Patterns by Gender, Period, and Country in Latin America and Asia. *Demography*, *54*(4), 1353–1373. https://doi.org/10.1007/s13524-017-0585-z

Liang, Y., & Gibson, J. (2018). Do siblings take your food away? Using China's one-child policy to test for child quantity-quality trade-offs. *China Economic Review*.

Libois, F., & Somville, V. (2018). Fertility, household size and poverty in Nepal. *World Development*, *103*, 311–322. https://doi.org/10.1016/j.worlddev.2017.11.005

Lim-Camacho, L., Plagányi, É. E., Crimp, S., Hodgkinson, J. H., Hobday, A. J., Howden, S. M., & Loechel, B. (2017). Complex resource supply chains display higher resilience to simulated climate shocks. *Global Environmental Change*, *46*, 126–138. https://doi.org/https://doi.org/10.1016/j.gloenvcha.2017.08.011

Lindhjem, H., & Navrud, S. (2009). Asking for Individual or Household Willingness to Pay for Environmental Goods? Implication for Aggregate Welfare Measures. *Environmental and Resource Economics*, *43*(1), 11–29. https://doi.org/10.1007/s10640-009-9261-0

Liu, H. (2014). The quality-quantity trade-off: Evidence from the relaxation of China's one-child policy. *Journal of Population Economics*, *27*(2), 565–602.

Loayza, N. V., & Raddatz, C. (2010). The composition of growth matters for poverty alleviation. *Journal of Development Economics*, *93*(1), 137–151.

Louviere, J. J., Hensher, D. A., & Swait, J. D. (2000). *Stated Choice Methods - Analysis and Applications*. Cambridge, MA: Cambridge University Press.

Lundberg, S., & Pollak, R. A. (1993). Separate Spheres Bargaining and the Marriage Market. *Journal of Political Economy*, *101*(6), 988–1010.

Lundberg, S., Pollak, R. A., & Wales, T. J. (1997). Do Husbands and Wives Pool Their Resources? Evidence from the United Kingdom Child Benefit. *The Journal of Human Resources*, *32*(3), 463–480.

Maertens, M. (2009). Horticulture exports, agro-industrialization, and farm-nonfarm linkages with the smallholder farm sector: Evidence from Senegal. *Agricultural Economics*, *40*(2), 219–229. https://doi.org/10.1111/j.1574-0862.2009.00371.x

Maertens, M., Colen, L., & Swinnen, J. F. M. (2011). Globalisation and poverty in Senegal: A worst case scenario? *European Review of Agricultural Economics*, *38*(1), 31–54. https://doi.org/10.1093/erae/jbq053

Maertens, M., Minten, B., & Swinnen, J. (2012). Modern Food Supply Chains and Development: Evidence from Horticulture Export Sectors in Sub-Saharan Africa. *Development Policy Review*, *30*(4), 473–497.

Maertens, M., & Swinnen, J. (2009). Trade, Standards, and Poverty: Evidence from Senegal. *World Development*, *37*(1), 161–178.

Maertens, M., & Verhofstadt, E. (2013). Horticultural exports, female wage employment and primary school enrolment: Theory and evidence from Senegal. *Food Policy*, *43*, 118–131.

Makwa, D. D. B. (2012). From "Entering" and "Hatching" to being "Clothed" into Manhood: Integration of Music and Dance in Imbalu Circumcision Rituals among the Bagisu (Eastern Uganda). In S. Nannyonga-Tamusuza & T. Solomon (Eds.), *Ethnomusicology in East Africa: Perspectives from Uganda and Beyond* (pp. 71–92). Kampala, Uganda: Fountain Publishers.

Malhotra, C., Farooqui, M. A., Kanesvaran, R., Bilger, M., & Finkelstein, E. (2015). Comparison of preferences for end-of-life care among patients with advanced cancer and their caregivers: A discrete choice experiment. *Palliative Medicine*, *29*(9), 842–850. https://doi.org/10.1177/0269216315578803

Mangham, L. J., Hanson, K., & McPake, B. (2009). How to do (or not to do)...Designing a discrete choice experiment for application in a low-income country. *Health Policy and Planning*, *24*(2), 151–158.

Manser, M., & Brown, M. (1980). Marriage and Household Decision-Making : A Bargaining Analysis. *International Economic Review*, *21*(1), 31–44.

Maralani, V. (2008). The Changing Relationship Between Family Size and Educational Attainment over the Course of Socioeconomic Development: Evidence from Indonesia. *Demography*, *45*(3), 693–717.

Marcucci, E., Stathopoulos, A., Rotaris, L., & Danielis, R. (2011). Comparing single and joint preferences: A choice experiment on residential location in three-member households. *Environment and Planning A*, *43*(5), 1209–1225. https://doi.org/10.1068/a43344

Mariel, P., Scarpa, R., & Vega-Bayo, A. (2018). Joint parental school choice: Exploring the influence of individual preferences of husbands and wives. *Regional Science and Urban Economics*, *68*(November 2017), 23–35. https://doi.org/10.1016/j.regsciurbeco.2017.10.017

Marteleto, L. J., & de Souza, L. R. (2012). The Changing Impact of Family Size on Adolescents' Schooling: Assessing the Exogenous Variation in Fertility Using Twins in Brazil. *Demography*, *49*(4), 1453–1477.

Marteleto, L. J., & de Souza, L. R. (2013). The Implications of Family Size for Adolescents' Education and Work in Brazil: Gender and Birth Order Differences. *Social Forces*, *92*(1), 275–302.

Masuda, K., & Yamauchi, C. (2020). How Does Female Education Reduce Adolescent Pregnancy and Improve Child Health?: Evidence from Uganda's Universal Primary Education for Fully Treated Cohorts. *Journal of Development Studies*, *56*(1), 63–86. https://doi.org/10.1080/00220388.2018.1546844

Mathenge, M. K., Smale, M., & Tschirley, D. (2015). Off-farm Employment and Input Intensification among Smallholder Maize Farmers in Kenya. *Journal of Agricultural Economics*, *66*(2), 519–536.

Matovu, J. K. B., Makumbi, F., Wanyenze, R. K., & Serwadda, D. (2017). Determinants of fertility desire among married or cohabiting individuals in Rakai, Uganda: A cross-sectional study. *Reproductive Health*, *14*(1), 1–11. https://doi.org/10.1186/s12978-016-0272-3

Matsumoto, T., Kijima, Y., & Yamano, T. (2006). The role of local nonfarm activities and migration in reducing poverty: Evidence from Ethiopia, Kenya, and Uganda. *Agricultural Economics*, *35*(supplement), 449–458.

McCarthy, A. S. (2019). Intimate partner violence and family planning decisions: Experimental evidence from rural Tanzania. *World Development*, *114*, 156–174. https://doi.org/10.1016/j.worlddev.2018.09.027

McCarthy, N., & Kilic, T. (2017). Stronger together: Intra-Household Cooperation and Household Welfare in Malawi. In *Policy Research Working paper* (No. 8043).

Mccullough, E. (2017). Labor productivity and employment gaps in Sub-Saharan Africa. *Food Policy*, *67*, 133–152.

McElroy, M. B., & Horney, M. J. (1981). Nash-Bargained Household Decisions : Toward a Generalization of the Theory of Demand. *International Economic Review*, *22*(2), 333–349.

Menapace, L., & Raffaelli, R. (2020). Unraveling hypothetical bias in discrete choice experiments. *Journal of Economic Behavior and Organization*, *176*, 416–430. https://doi.org/10.1016/j.jebo.2020.04.020

Miedema, S. S., Haardörfer, R., Girard, A. W., & Yount, K. M. (2018). Women's empowerment in East Africa: Development of a cross-country comparable measure. *World Development*, *110*, 453–464. https://doi.org/10.1016/j.worlddev.2018.05.031

Minten, B., Mohammed, B., & Tamru, S. (2020). Emerging Medium-Scale Tenant Farming, Gig Economies, and the COVID-19 Disruption: The Case of Commercial Vegetable Clusters in Ethiopia. *European Journal of Development Research*, *32*(5), 1402–1429. https://doi.org/10.1057/s41287-020-00315-7

Minten, B., Randrianarison, L., & Swinnen, J. (2009). Global Retail Chains and Poor Farmers: Evidence from Madagascar. *World Development*, *37*(11), 1728–1741. https://doi.org/10.1016/j.worlddev.2008.08.024

Mogstad, M., & Wiswall, M. (2016). Testing the quantity-quality model of fertility: Estimation using unrestricted family size models. *Quantitative Economics*, *7*(1), 157–192.

Mueller, E. (1984). The value and allocation of time in rural Botswana. *Journal of Development Economics*, *15*(1–3), 329–360.

Muhoza, D. N. (2019). The heterogeneous effects of socioeconomic and cultural factors on fertility preferences: evidence from Rwanda and Kenya. *Journal of Population Research*, *36*(4), 347–363.

Munro, A. (2014). *Hide and Seek : A Theory of Efficient Income Hiding within the Household* (No. 14-17 Hide). Tokyo.

Munro, A. (2018). Intra-Household Experiments: a Survey. *Journal of Economic Surveys*, *32*(1), 134–175. https://doi.org/10.1111/joes.12196

Nagler, P., & Naudé, W. (2017). Non-farm entrepreneurship in rural sub-Saharan Africa: New empirical evidence. *Food Policy*, *67*, 175–191.

Narayan, D., Pritchett, L., & Kapoor, S. (2009). *Success from the Bottom Up* (The World Bank, Ed.). Washington, D.C.: Palgrave Macmillan.

Narayanan, S. (2020). How India's agrifood supply chains fared during the COVID-19 lockdown, from farm to fork. Retrieved from IFPRI blog post website: https://www.ifpri.org/blog/how-indias-agrifood-supply-chains-fared-during-covid-19-lockdown-farm-fork

Nolte, K., & Ostermeier, M. (2017). Labour Market Effects of Large-Scale Agricultural Investment: Conceptual Considerations and Estimated Employment Effects. *World Development*, *98*, 430–446. https://doi.org/10.1016/j.worlddev.2017.05.012

Nyqvist, M. B., & Jayachandran, S. (2017). Mothers care more, but fathers decide: Educating parents about child health in Uganda. *American Economic Review*, *107*(5), 496–500. https://doi.org/10.1257/aer.p20171103

O'Sullivan, J. N. (2020). The social and environmental influences of population growth rate and demographic pressure deserve greater attention in ecological economics. *Ecological Economics*, *172*(June 2019), 106648. https://doi.org/10.1016/j.ecolecon.2020.106648

Orr, A., Mwale, B., & Saiti-Chitsonga, D. (2009). Exploring Seasonal Poverty Traps: The "Six-Week Window" in Southern Malawi. *The Journal of Development Studies*, *45*(2), 227–255.

Oseni, G., & Winters, P. (2009). Rural nonfarm activities and agricultural crop production in Nigeria. *Agricultural Economics*, *40*(2), 189–201.

Osili, U. O., & Long, B. T. (2008). Does female schooling reduce fertility? Evidence from Nigeria. *Journal of Development Economics*, *87*(1), 57–75. https://doi.org/10.1016/j.jdeveco.2007.10.003

Oya, C. (2013). Rural wage employment in Africa: methodological issues and emerging evidence. *Review of African Political Economy*, *40*(136), 251–273.

Palivos, T., & Scotese, C. A. (1996). Fertility, Growth and the Financing of Public Education and Health. *Journal of Population Economics*, *9*(4), 415–428.

Penn, J. M., Hu, W., & Cox, L. J. (2019). The effect of forced choice with constant choice experiment complexity. *Journal of Agricultural and Resource Economics*, *44*(2), 439–455.

Perez-Mendez, J. A., Roibas, D., & Wall, A. (2019). The influence of weather conditions on dairy production. *Agricultural Economics (United Kingdom)*, *50*(2), 165–175. https://doi.org/10.1111/agec.12474

Petursson, J. G., & Vedeld, P. (2015). The "nine lives" of protected areas. A historical-institutional analysis from the transboundary Mt Elgon, Uganda and Kenya. *Land Use Policy*, *42*, 251–263. https://doi.org/10.1016/j.landusepol.2014.08.005

Ponomarov, S. Y., & Holcomb, M. C. (2009). Understanding the concept of supply chain resilience. *The International Journal of Logistics Management*, *20*(1), 124–143. https://doi.org/10.1108/09574090910954873

Popov, D., McNally, T., & Munro, A. (2012). Taking it in Turn: An Experimental Test of Theories of the Household. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1125264

Pu, M., & Zhong, Y. (2020). Rising concerns over agricultural production as COVID-19 spreads: Lessons from China. *Global Food Security*, *26*(July), 100409. https://doi.org/10.1016/j.gfs.2020.100409

Qian, N. (2008). Missing Women and the Price of Tea in China: The Effect of Sex-Specific Earnings on Sex Imbalance. *The Quarterly Journal of Economics*, *123*(3), 1251–1285.

Qian, N. (2009). Quantity-Quality and the One Child Policy:The Only-Child Disadvantage in School Enrollment in Rural China. In *NBER Working Paper Series* (No. 14973).

Rasul, I. (2008). Household bargaining over fertility: Theory and evidence from Malaysia. *Journal of Development Economics*, *86*(2), 215–241. https://doi.org/10.1016/j.jdeveco.2007.02.005

Reardon, T., Barrett, C. B., Berdegué, J. A., & Swinnen, J. (2009). Agrifood Industry Transformation and Small Farmers in Developing Countries. *World Development*, *37*, 1717–1727.

Reardon, T., Bellemare, M. F., & Zilberman, D. (2020). How COVID-19 may disrupt food supply chains in developing countries. Retrieved from IFPRI blog post website: https://www.ifpri.org/blog/how-covid-19-may-disrupt-food-supply-chains-developing-countries

Reardon, T., Berdegue, J., & Escobar, G. (2001). Rural Nonfarm Employment and Incomes in Latin America: Overview and Policy Implications. *World Development*, *29*(3), 395–409.

Reardon, T., Echeverria, R., Berdegué, J., Minten, B., Liverpool-Tasie, S., Tschirley, D., & Zilberman, D. (2019). Rapid transformation of food systems in developing regions: Highlighting the role of agricultural research & innovations. *Agricultural Systems*, *172*(September 2017), 47–59. https://doi.org/10.1016/j.agsy.2018.01.022

Reardon, T., Mishra, A., Nuthalapati, C. S. R., Bellemare, M. F., & Zilberman, D. (2020). Covid-19's disruption of India's transformed food supply chains. *Economic and Political Weekly*, *55*(18), 18–22.

Reardon, T., & Swinnen, J. (2020). COVID-19 and resilience innovations in food supply chains. Retrieved from IFPRI blog post website: https://www.ifpri.org/blog/covid-19-and-resilience-innovations-food-supply-chains

Reardon, T., & Zilberman, D. (2018). Climate Smart Agriculture: Building Resilience to Climate Change. In L. Lipper, N. Mccarthy, D. Zilberman, S. Asfaw, & G. Branca (Eds.), *Climate Smart Agriculture - Building Resilience to Climate Change* (Vol. 52, p. 630). https://doi.org/10.1007/978-3-319-61194-5

Reuters. (2020). Senegal online food company sees sales double due to epidemic. Retrieved from https://www.reuters.com/article/us-health-coronavirus-senegal-e-commerce-idUSKBN22U0V3

Richardson, A. M. (2004). Women's Inheritance Rights in Africa: The Need to Intergrate Cultural Understanding and Legal Reform. *Human Rights Brief*, *11*(2), 19–22.

Rizzo, M., Kilama, B., & Wuyts, M. (2015). The Invisibility of Wage Employment in Statistics on the Informal Economy in Africa: Causes and Consequences. *Journal of Development Studies*, *51*(2), 149–161.

Robinson, J. (2012). Limited insurance within the household: Evidence from a field experiment in Kenya. *American Economic Journal: Applied Economics*, *4*(4), 140–164. https://doi.org/10.1257/app.4.4.140

Rosenzweig, M. R., & Wolpin, K. I. (1980). Testing the Quantity-Quality Fertility Model : The Use of Twins as a Natural Experiment. *Econometrica*, *48*(1), 227–240.

Rosenzweig, M. R., & Zhang, J. (2009). Do population control policies induce more human capital investment? Twins, birth weight and China's "one-child" policy. *Review of Economic Studies*, *76*(3), 1149–1174.

RPCA. (2020). *Summary of Conclusions RPCA Restricted Meeting*. Retrieved from http://www.food-security.net/wp-content/uploads/2020/04/RPCA2020_summary-of-conclusions_EN.pdf

Ruben, R., & van den Berg, M. (2001). Nonfarm Employment and Poverty Alleviation of Rural Farm Households in Honduras. *World Development*, *29*(3), 549–560.

Rungie, C., Scarpa, R., & Thiene, M. (2014). The influence of individuals in forming collective household preferences for water quality. *Journal of Environmental Economics and Management*, *68*(1), 161–174.

Salazar-Espinoza, C., Jones, S., & Tarp, F. (2015). Weather shocks and cropland decisions in rural Mozambique. *Food Policy*, *53*, 9–21. https://doi.org/10.1016/j.foodpol.2015.03.003

Schady, N., & Rosero, J. (2008). Are cash transfers made to women spent like other sources of income? *Economics Letters*, *101*(3), 246–248. https://doi.org/10.1016/j.econlet.2008.08.015

Scharf, M. M., & Rahut, D. B. (2014). Nonfarm employment and rural welfare: Evidence from the Himalayas. *American Journal of Agricultural Economics*, *96*(4), 1183–1197.

Schoumaker, B. (2004). Poverty and Fertility in Sub-Saharan Africa. *Population Association of America Meeting*. Boston.

Sculpher, M., Bryan, S., Fry, P., De Winter, P., Payne, H., & Emberton, M. (2004). Patients' preferences for the management of non-metastatic prostate cancer: Discrete choice experiment. *British Medical Journal*, *328*(7436), 382–384. https://doi.org/10.1136/bmj.37972.497234.44

Sheffi, Y., & Rice Jr., J. B. (2005). A Supply Chain View of the Resilient Enterprise. *MIT Sloan Management Review*, *47*(1).

Shenk, M. K., Towner, M. C., Kress, H. C., & Alam, N. (2013). A model comparison approach shows stronger support for economic models of fertility decline. *Proceedings of the National Academy of Sciences of the United States of America*, *110*(20), 8045–8050. https://doi.org/10.1073/pnas.1217029110

Shi, A. (2003). The impact of population pressure on global carbon dioxide emissions, 1975-1996: Evidence from pooled cross-country data. *Ecological Economics*, *44*(1), 29–42. https://doi.org/10.1016/S0921-8009(02)00223-9

Sidibe, A. M., Kadetz, P. I., & Hesketh, T. (2020). Factors Impacting Family Planning Use in Mali and Senegal. *International Journal of Environmental Research and Public Health*, *17*(12), 1–15. https://doi.org/10.3390/ijerph17124399

Smale, M., Kusunose, Y., Mathenge, M. K., & Alia, D. (2016). Destination or distraction? Querying the linkage between off-farm work and food crop investments in Kenya. *Journal of African Economies*, *25*(3), 388–417.

Smith, K., Lawrence, G., MacMahon, A., Muller, J., & Brady, M. (2016). The resilience of long and short food chains: a case study of flooding in Queensland, Australia. *Agriculture and Human Values*, *33*(1), 45–60. https://doi.org/10.1007/s10460-015-9603-1

Snopkowski, K., Towner, M. C., Shenk, M. K., & Colleran, H. (2016). Pathways from education to fertility decline: A multi-site comparative study. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *371*(1692). https://doi.org/10.1098/rstb.2015.0156

Stampini, M., & Davis, B. (2009). Does nonagricultural labor relax farmers' credit constraints? Evidence from longitudinal data for Vietnam. *Agricultural Economics*, *40*(2), 177–188.

Steelman, L. C., Powell, B., Werum, R., & Carter, S. (2002). Reconsidering the Effects of Sibling Configuration: Recent Advances and Challenges. *Annual Review of Sociology*, *28*(1), 243–269.

Stone, J., & Rahimifard, S. (2018). Resilience in agri-food supply chains: a critical analysis of the literature and synthesis of a novel framework. *Supply Chain Management*, *23*(3), 207–238. https://doi.org/10.1108/SCM-06-2017-0201

Sunder, N. (2019). Marriage Age, Social Status, and Intergenerational Effects in Uganda. *Demography*, *56*(6), 2123–2146. https://doi.org/10.1007/s13524-019-00829-8

Swinnen, J. (2007). *Global Supply Chains, Standards and the Poor* (J. Swinnen, Ed.). CABI Publishing.

Swinnen, J., & Maertens, M. (2007). Globalization, privatization, and vertical coordination in food value chains in developing and transition countries. *Agricultural Economics*, *37*(S1), 89–102. https://doi.org/10.1111/j.1574-0862.2007.00237.x

Takahashi, K., & Otsuka, K. (2009). The increasing importance of nonfarm income and the changing use of labor and capital in rice farming: The case of Central Luzon, 1979-2003. *Agricultural Economics*, *40*(2), 231–242.

Takyi, B. K., & Addai, I. (2002). Effects of ethnicity on the onset of parenthood in a developing country: Some evidence from the early 1990s. *Journal of Comparative Family Studies*, *33*(1). https://doi.org/10.3138/jcfs.33.1.57

Tandon, S. (2020). Pandemic helped kirana stores embrace technology: EY survey. Retrieved from https://www.livemint.com/industry/retail/pandemic-helped-kirana-stores-embrace-technology-ey-survey-11593997552843.html

Tertilt, M. (2005). Polygyny, Fertility, and Savings. *Journal of Political Economy*, *113*(6), 1341–1371.

Thiombiano, B. G., LeGrand, T. K., & Kobiané, J.-F. (2013). Effects of Parental Union Dissolution on Child Mortality and Child Schooling in Burkina Faso. *Demographic Research*, *29*(DECEMBER), 797–816. https://doi.org/10.4054/demres.2013.29.29

Tiruneh, F. N., Chuang, K. Y., Ntenda, P. A. M., & Chuang, Y. C. (2016). Factors associated with contraceptive use and intention to use contraceptives among married women in Ethiopia. *Women and Health*, *56*(1), 1–22. https://doi.org/10.1080/03630242.2015.1074640

Torero, M. (2020a). A battle plan for ensuring global food supplies during the COVID-19 crisis. Retrieved from FAO website: http://www.fao.org/news/story/en/item/1268059/icode/

Torero, M. (2020b). Without food, there can be no exit from the pandemic. *Nature*, *580*(7805), 588–589. https://doi.org/10.1038/d41586-020-01181-3

Track20 Project. (2020a). Projected Trends in mCPR Senegal. Retrieved from http://www.track20.org/Senegal

Track20 Project. (2020b). Projected Trends in mCPR Uganda. Retrieved from http://www.track20.org/Uganda

Train, K. E. (2003). *Discrete Choice Methods with Simulation* (First). Cambridge, MA: Cambridge University Press.

Trinitapoli, J., & Yeatman, S. (2018). The Flexibility of Fertility Preferences in a Context of Uncertainty. *Population and Development Review*, *44*(1), 87–116. https://doi.org/10.1111/padr.12114

Tsuge, T., Kishimoto, A., & Takeuchi, K. (2005). A choice experiment approach to the valuation of mortality. *Journal of Risk and Uncertainty*, *31*(1), 73–95. https://doi.org/10.1007/s11166-005-2931-6

Uganda Bureau of Statistics. (2017). *The National Population and Housing Census 2014 - Area Specific Profiles Series*.

UNCTAD. (2020). Senegal's e-commerce sector helps country cope with COVID-19. Retrieved from https://unctad.org/news/senegals-e-commerce-sector-helps-country-cope-covid-19

UNDP. (2019). Gender Inequality Index (GII). Retrieved May 21, 2021, from http://hdr.undp.org/en/content/gender-inequality-index-gii

UNFPA. (2021). State of World Population 2021. *UNFPA Division for Communications*.

UNICEF. (2021). Child marriage. Retrieved May 18, 2021, from https://data.unicef.org/topic/child-protection/child-marriage/

United Nations. (2019). World Population Prospects 2019: Highlights. In *World Population Prospects 2019*. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12283219

United Nations. (2020). *Policy Brief: The Impact of COVID-19 on Food Security and Nutrition*. Retrieved from http://www.ceigram.upm.es/wp-content/uploads/2020/03/HLPE.-Impact-of-COVID-19-on-FSN-2020-03-24.pdf

Van den Broeck, G., & Kilic, T. (2019). Dynamics of off-farm employment in Sub-Saharan Africa: A gender perspective. *World Development*, *119*, 81–99.

Van den Broeck, G., & Maertens, M. (2015). Female employment reduces fertility in rural Senegal. *PLoS ONE*, *10*(3), 1–15.

Van den Broeck, G., & Maertens, M. (2017). Moving Up or Moving Out? Insights into Rural Development and Poverty Reduction in Senegal. *World Development*, *99*, 95 – 109.

Van den Broeck, G., Swinnen, J., & Maertens, M. (2017). Global value chains, large-scale farming, and poverty: Long-term effects in Senegal. *Food Policy*, *66*, 97–107. https://doi.org/10.1016/j.foodpol.2016.12.003

Van den Broeck, G., Van Hoyweghen, K., & Maertens, M. (2016). Employment Conditions in the Senegalese Horticultural Export Industry: A Worker Perspective. *Development Policy Review*, *34*(2), 301–319.

Van den Broeck, G., Van Hoyweghen, K., & Maertens, M. (2018). Horticultural exports and food security in Senegal. *Global Food Security*, *17*, 162–171.

Van Hoyweghen, K., Van den Broeck, G., & Maertens, M. (2020). Employment Dynamics and Linkages in the Rural Economy: Insights from Senegal. *Journal of Agricultural Economics*, *71*(3), 904–928. https://doi.org/10.1111/1477-9552.12387

Van Rooyen, C., Stewart, R., & De Wet, T. (2012). The Impact of Microfinance in Sub-Saharan Africa: A Systematic Review of the Evidence. *World Development*, *40*(11), 2249–2262.

Vanermen, I., Kessels, R., Verheyen, K., Muys, B., & Vranken, L. (2021). The effect of information transfer related to soil biodiversity on Flemish citizens' preferences for forest management. *Science of the Total Environment*, *776*, 145791. https://doi.org/10.1016/j.scitotenv.2021.145791

Veldwijk, J., Lambooij, M. S., De Bekker-Grob, E. W., Smit, H. A., & De Wit, G. A. (2014). The effect of including an opt-out option in discrete choice experiments. *PLoS ONE*, *9*(11). https://doi.org/10.1371/journal.pone.0111805

Vermeulen, F. (2002). Collective Household Models: Principles and Main Results. *Journal of Economic Surveys*, *16*(4), 533–564. https://doi.org/10.1111/1467-6419.00177

Vlaeminck, P., Maertens, M., Isabirye, M., Vanderhoydonks, F., Poesen, J., Deckers, S., & Vranken, L. (2016). Coping with landslide risk through preventive resettlement. Designing optimal strategies through choice experiments for the Mount Elgon region, Uganda. *Land Use Policy*, *51*, 301–311. https://doi.org/10.1016/j.landusepol.2015.11.023

Vos, R., Martin, W., & Laborde, D. (2020). How much will global poverty increase because of COVID-19? Retrieved from IFPRI blog post website: https://www.ifpri.org/blog/how-much-will-global-poverty-increase-because-covid-19

Vroegindewey, R., & Hodbod, J. (2018). Resilience of agricultural value chains in developing country contexts: A framework and assessment approach. *Sustainability*, *10*(4). https://doi.org/10.3390/su10040916

Wadhwa, D. (2018). The number of extremely poor people continues to rise in Sub-Saharan Africa. Retrieved from https://blogs.worldbank.org/opendata/number-extremely-poor-people-continues-rise-sub-saharan-africa

Wang, Q., & Sun, X. (2016). The Role of Socio-political and Economic Factors in Fertility Decline: A Cross-country Analysis. *World Development*, *87*(71401085), 360–370. https://doi.org/10.1016/j.worlddev.2016.07.004

Wanyonyi, M. G. (2018). *The economic transformation of the Bagisu of Eastern Uganda 1904-1962*. Retrieved from http://10.1.1.45:8080/xmlui/handle/123456789/230

Warr, P. (2014). Agricultural liberalization, poverty and inequality: Indonesia and Thailand. *Journal of Asian Economics*, *35*(2014), 92–106. https://doi.org/10.1016/j.asieco.2014.10.003

Wendt, A., Gibbs, C. M., Peters, S., & Hogue, C. J. (2012). Impact of increasing inter-pregnancy interval on maternal and infant health. *Paediatric and Perinatal Epidemiology*, *26*(SUPPL. 1), 239–258.

Westoff, C. F. (2010). Desired Number of Children 2000-2008. In *Dhs Comparative Reports*.

Whiteside, M. (2000). *Ganyu labour in Malawi and its implications for livelihood security interventions – An analysis of recent literature and implications for poverty alleviation* (No. Network Paper No. 99). London.

Wiig, H., Bråten, R. H., & Orge Fuentes, D. (2012). Land ownership and women's empowerment – combining survey and experiments in Peruvian rural households. In *Background Paper for World Development Report*.

Williams, M. J., & Chen, S. (2014). When "mom's the boss": Control over domestic decision making reduces women's interest in workplace power. *Group Processes & Intergroup Relations*, *17*(4), 436–452. https://doi.org/10.1177/1368430213497065

Winters, L. A., McCulloch, N., & McKay, A. (2004). Trade liberalization and poverty: The evidence so far. *Journal of Economic Literature*, *42*(1), 72–115. https://doi.org/10.1257/002205104773558056

Winters, P., Essam, T., Zezza, A., Davis, B., & Carletto, C. (2010). Patterns of Rural Development: A Cross-Country Comparison using Microeconomic Data. *Journal of Agricultural Economics*, *61*(3), 628–651.

World Bank. (2005). *Niger Providing All Nigeriens with Food , Education and Health Care: A Demographic Perspective*.

World Bank. (2012). *World Development Report 2013: Jobs*. Washington, DC: World Bank.

World Bank. (2020a). DataBank Global Financial Inclusion. Retrieved October 23, 2020, from https://databank.worldbank.org/source/global-financial-inclusion

World Bank. (2020b). World Development Indicators Databank. Retrieved from https://databank.worldbank.org/source/world-development-indicators

World Bank. (2021a). Fertility rate, total (births per woman). Retrieved June 8, 2021, from https://data.worldbank.org/indicator/SP.DYN.TFRT.IN?most_recent_value_desc=true

World Bank. (2021b). Wage and salaried workers, female (% of female employment) (modeled ILO estimate). Retrieved June 14, 2021, from https://data.worldbank.org/indicator/SL.EMP.WORK.FE.ZS

Yeatman, S., Sennott, C., & Culpepper, S. (2013). Young Women's Dynamic Family Size Preferences in the Context of Transitioning Fertility. *Demography*, *50*(5), 1715–1737. https://doi.org/10.1007/s13524-013-0214-4

Yeatman, S., Trinitapoli, J., & Garver, S. (2020). The Enduring Case for Fertility Desires. *Demography*. https://doi.org/10.1007/s13524-020-00921-4

Yount, K. M., Cheong, Y. F., Maxwell, L., Heckert, J., Martinez, E. M., & Seymour, G. (2019). Measurement properties of the project-level Women's Empowerment in Agriculture Index. *World Development*, *124*, 104639. https://doi.org/10.1016/j.worlddev.2019.104639

Yount, K. M., VanderEnde, K. E., Dodell, S., & Cheong, Y. F. (2016). Measurement of Women's Agency in Egypt: A National Validation Study. *Social Indicators Research*, *128*(3), 1171–1192. https://doi.org/10.1007/s11205-015-1074-7

Zhong, H. (2017). The Effect of Sibling Size on Children's Health and Education: Is there a Quantity-Quality Trade-off? *Journal of Development Studies*, *53*(8), 1194–1206.