EAST AFRICA

Economic Impact Assessment of World Food Program Expenditures in East Africa

Final Report on Aggregate Impacts

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GTAP Global Trade Analysis Project
UCDAVIS
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WFP World Food Programme

Table of Contents

Acknowledgements 3

Abbreviations 3

1. Background 4

2. Methodology 5

3. GTAP and the GTAP Database 7

a. 3.1 Data Challenges 8

b. 3.2 Modelling Impacts of WFP Expenditures on Food 8

c. 3.3 Modelling WFP Expenditures on Non-food Goods and Services 9

4. Mapping WFP Expenditures to GTAP Sectors 11

5. Applied General Equilibrium Modelling of WFP's East Africa Footprint 12

d. 5.1 Studies Using the GTAP Modelling Platform 13

6. Impacts of WFP Spending in East Africa 16

a. Production Multipliers 17

b. Real Income or GDP Multipliers 20

c. Employment Impacts of WFP Spending 20

d. Sensitivity of Impacts to Labor and Capital Availability 20

e. Impacts on Prices and Other Indicators 27

8. Conclusions 28

Appendix A: EXCEL Template to Record Information on Food Vendors to WFP's RBN 29

Appendix B. Excel Template to Record Information on Non-food Expenditures by WFP's RBN 30

Appendix C. WFP Food Expenditure Processing 31

References 34

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Abbreviations

AGE	Applied General Equilibrium
CGE	Computable General Equilibrium
GTAP	Global Trade Analysis Project
LEWIE	Local Economy Wide Impact Evaluation
MT	Metric Tons
RBN	Regional Bureau Nairobi (WFP)
SAM	Social Accounting Matrix
WFP	World Food Programme
XEC	Rest of East Africa Region (GTAP database)

1. Background

The World Food Programme's (WFP) total portfolio in Regional Bureau Nairobi (RBN) countries is more than USD 745 million annually. In 2019, the RBN region moved 1.1 million MT of food throughout the region. It disbursed USD 270 million in cash to 5.4 million beneficiaries in the countries covered by RBN. It procured and supplied more than 500,000 MT of food from local, regional, and global sources. These numbers increased further with the inclusion of Sudan in the RBN beginning in December 2020. This spending is vital to the humanitarian operations of the WFP. It also has economic impacts on RBN economies, potentially creating large income and production impacts in the region.

This project uses state-of-the-art economic modelling tools to estimate the broader economic impacts of WFP's food and other expenditures in the region, that is, beyond the impacts on food security and nutrition.[5] These economic impacts include direct impacts as well as the indirect spillover effects WFP operations generate. For example:

- Food assistance programs that give cash to poor households directly increase beneficiaries' incomes. As beneficiaries spend this cash, markets transmit benefits to the businesses that sell goods and services to the program beneficiaries. These businesses, in turn, pay wages to workers and profits to business owners, who in turn spend their income. Businesses may purchase goods and services from other businesses, as well.

- Programs that procure food from local farmers directly contribute to farm household incomes. As those farms and households spend this new income on inputs, including wage labor for farm operations, or on goods and services to meet the needs of farm households, markets transmit program impacts to others in the economy.

- All in-kind food, whether procured in the region or imported, needs to be moved across the region to final destination, using a combination of road, rail, ferry and barge transport. Both transportation and storage largely are outsourced to the private sector, creating jobs and income in these activities.

As the impacts of WFP operations work their way through the economy, they spread to other households, businesses, and localities within the country or in other countries of the region in the form of income and production spillovers, or secondary impacts. A dollar spent on cash transfers to poor households could raise income by more than the dollar transferred. WFP's purchase and transportation of food, as well as it's other operations expenses, raise the demand for goods and services from some sectors (e.g., those with which the WFP transacts). The effect on other sectors is less clear. Some may benefit, for example, if they supply inputs to the directly affected sectors. Others could lose, if they compete with the directly affected sectors for scarce labor and other inputs. If WFP spending in one country (say, Kenya) includes goods imported from other countries (e.g., Rwanda), economic impacts shift to the exporting country. However, the exporting

[5] We do not consider the impacts of cash disbursements to households, which would add to the multiplier effects of WFP operations.

country could, in turn, demand more imports if its income increases. Kenya's imports to help supply RBN operations could raise incomes in neighbouring Rwanda, which in turn could increase its imports from Kenya. Failing to take spillovers across sectors and countries into consideration can result in a misrepresentation and possibly under-estimates of program impacts. There could also be negative impacts of higher demand created by WFP programs, in the form of higher prices, including food price inflation, if supply response in the region is not responsive, or elastic.

This project assesses the total annual economic impacts, within countries and the RBN region as a whole, of the WFP's procurement and supply chain with respect to the following operations:

- Global/regional/local procurement (500,000+ MT) of food items (cereals, pulses, lentils, nutrition products). Current procurement is mainly from Uganda, Kenya, and Rwanda within the RBN and Tanzania and South Africa outside the region.

- Transportation of imported food and local and regional purchases (LRP) to country operations by air, road and sea (and differential impacts of each), with consideration of different supply chain corridors through Somalia, Sudan, Kenya and Djibouti.

For each of these operations, the study estimates both costs and benefits, including spillover effects within RBN countries as well as across borders, via trade. It offers insights into the differential impacts of WFP operations within and among RBN countries, among economic sectors, and on households.

This report presents findings for each RBN country from simultaneous simulations of the impacts of WFP spending throughout the East Africa region. The rest of the report provides a detailed description of the approach, activities, and findings from a general-equilibrium analysis of impacts of WFP spending in the RBN countries. It is important to note that the results presented here are from modelling WFP spending in each country as well as in the East Africa region as a whole. Because of this, they capture trade and other linkages that may create important feedback effects in the region. General equilibrium models of individual countries would not capture these linkages.

2. Methodology

Local economy-wide impact evaluation (LEWIE) models have been used to estimate direct and spillover effects of specific WFP programmes in RBN countries, including impacts of cash versus in-kind assistance to refugees in Rwanda (Taylor et al. 2016) and Uganda (Zhu et al. 2016) and impacts of home-grown school feeding programs in Kenya (Gupta et al. 2019). LEWIE is an ideal methodology to estimate local impacts (Taylor and Filipski 2014). However, the nature and scope of this study calls for a more aggregate or "macro" approach.

Computable general equilibrium (CGE) models have been used to simulate impacts of policies and other interventions on the economies of countries and, in some cases, groups of countries, including the spillovers they create. In most cases, CGEs are aggregated multisectoral models of national economies, calibrated using national social accounting matrices (SAMs; Stone 1986; Burfisher 2011), although there are instances of CGE models of regions within countries – even villages (Taylor and Adelman 1996). Production activities and households within CGEs may be highly aggregated or disaggregated into many different sectors and /or household groups. An advantage of CGE models is their ability to capture aggregate spillovers across production sectors as well as households. They shift the focus of impact analysis from micro actors to whole economies, which is appropriate when the study's goal is to document aggregate (national or international-scale) impacts. Many country-level CGE models have been created for this purpose. Two examples include:

- Arndt, Pauw and Thurlow (2016) used a CGE model to evaluate the impacts of Malawi's Farm Input Subsidy Program (FISP), including the production and income spillovers it creates. This study found that the benefit-cost ratios for this program were 60% higher when spillovers were taken into account.

- Dorosh and Haggblade (2003) used CGE and SAM multiplier models to measure economic linkages from public investments in eight African countries. They found that indirect spillover effects were nearly as large as direct effects, and the impacts of agricultural investments favoured the poor more than investments in other sectors.

The goals of this study include estimating both national and regional (RBN) impacts of WFP operations on production, income (GDP), incomes of poor and nonpoor households, and employment. This calls for an expanded methodology that "nests" CGE models of each of the countries in the region within a larger regional CGE model. Taylor et al. (2003) used such an approach to estimate the impacts of eco-tourism on income in each of the three main Galápagos Islands as well as on the archipelago as a whole. They constructed a CGE model for each island, then integrated these into a CGE model for the entire archipelago. They found that trade and the movement of tourists transmitted impacts from one island to another, in much the same way as trade among countries might spread impacts of WFP operations through the RBN region.

Srinivasan, Whalley and Wooton (1993) used multi-country CGE models to examine impacts of regional trade agreements on agricultural performance. Linked country CGE models also have been used to simulate impacts of climate change across world regions. One of these models, by Hertel et al. (2010), shows how global food trade transmits impacts of climate change among countries, via changes in global food prices. They find that non-agricultural household groups in Africa and Asia are particularly hard hit.

Aggregate CGEs are less useful for understanding heterogeneous impacts within countries, particularly when high transaction costs result in impacts that are heterogeneous across space. This is an advantage of LEWIE models, which were designed to fill the lacuna between aggregate CGE and micro-household models. Nevertheless, when the goal of a study is to document aggregate country and regional impacts, including spillovers across production sectors, household groups, and countries, a nested aggregate CGE model is the tool of choice.

For this study, we build a multi-country model to assess WFP's economic footprint in East Africa, grounded in the Global Trade Analysis Project (GTAP) framework (Hertel 1997). A platform built on top of GTAP, the Environmental Impact and Sustainability Applied General Equilibrium (ENVISAGE) model, Version 10.2 (van der Mensbrugghe 2021), is particularly suited to this task. Although originally developed with an environmental focus, it has all of the advantages of the original GTAP model (Hertel and Tsigas 1997; Corong et al. 2017) as well as the flexibility to explicitly include the WFP as an agent that sources food and other goods and services. Originally developed at The World Bank and currently housed at GTAP, ENVISAGE, like GTAP, is a multi-regional applied general equilibrium (AGE) model. It is similar to other computable general equilibrium models that combine AGE models of individual countries into larger, regional models. It is global, but it is also flexible enough to model impacts in individual countries and regions, including East Africa. A primary objective of ENVISAGE is to provide a focus on the economics of climate change in developing countries. The main reason behind using ENVISAGE for this project is that it has the advantage over the standard GTAP model of enabling sourcing by individual agents. We intend to include WFP as an agent that sources food

and other goods and services from RBN countries, and the rest of the world. ENVISAGE, like GTAP, makes use of GTAP's extensive country database, which is described below.

3. GTAP and the GTAP Database

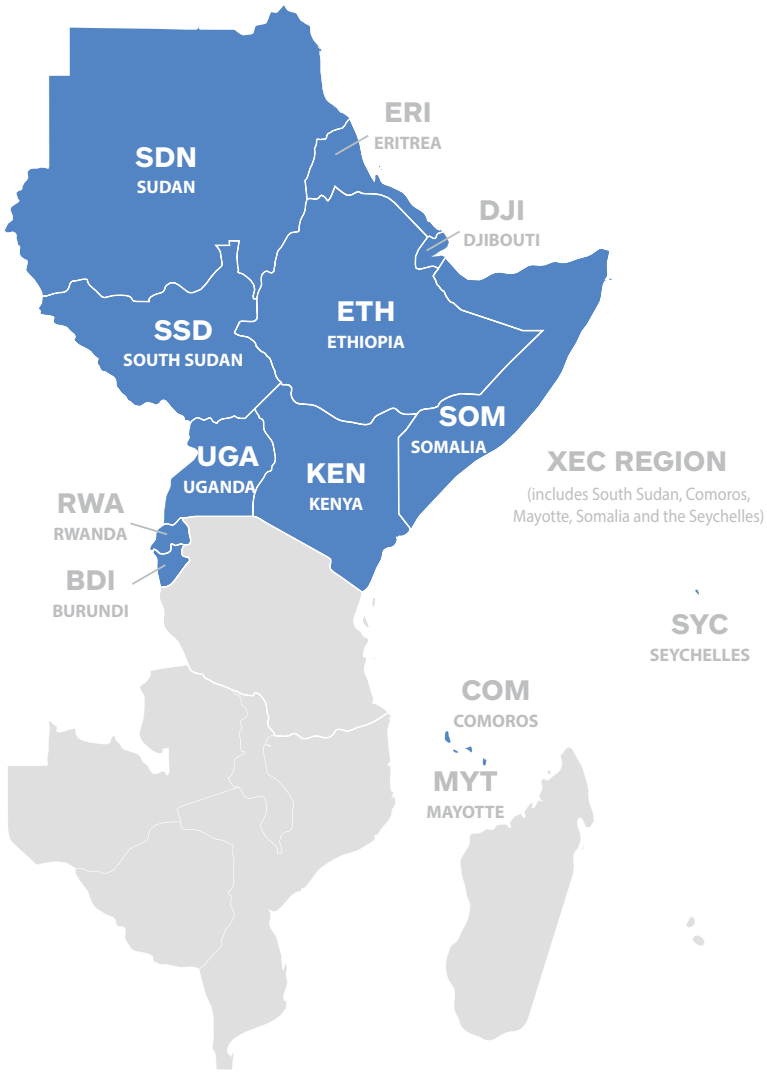
The GTAP model was founded in the 1990s together with the GTAP Data Base, the first widely available source of data on global economic activity for the development of computable general equilibrium (CGE) models. The GTAP Data Base provides the data input to build CGE models for specific GTAP regions and groups of regions. Hertel (2013) explains:

> *Construction of the database begins with the assembly of input-output tables (or condensed social accounting matrices) for a large number of economies (93 at the time of this writing – covering about 97% of global GDP). Where these are not available, the structure of the national economy is inferred from a similar economy.*

GTAP's 2017 revised database includes most of the major East African countries in the RBN (Table 1). In most cases, GTAP regions correspond to individual countries, including Ethiopia, Kenya, Rwanda, Uganda, Burundi, Djibouti, Eritrea, and Sudan. This makes it possible to use the GTAP platform to simulate the impacts of WFP spending in the region on the economies of those countries. The remaining NB countries are combined into the "Rest of Eastern Africa" (XEC) region, which includes South Sudan Somalia. Unfortunately, the XEC region also includes a small number of non-NB countries, including Comoros, Mayotte, and Seychelles. This creates a challenge for the project, which will be addressed below.

Table 1. East African Countries in the GTAP Database

GTAP Region	Country Code
Ethiopia	ETH
Kenya	KEN
Rwanda	RWA
Uganda	UGA
Burundi	BDI
Djibouti	DJI
Eritrea	ERI
Sudan	SDN
Rest of Eastern Africa	XEC
Comoros	COM
Mayotte	MYT
South Sudan	SSD
Somalia	SOM
Seychelles	SYC



Source: Aguiar et al. (2019)

a. 3.1 Data Challenges

The scarcity of economic information on Somalia and South Sudan, two major countries of WFP RBN operations, is one of the two major data challenges for this project. (The other is decomposing household impacts between poor and non-poor households, discussed later on in this report.) In the GTAP Data Base, Somalia and South Sudan are included as part of the XEC region. There are two options to deal with this. In the worst case, the study could be pared back to not consider the WFP economic footprint in South Sudan and Somalia. This would understate the WFP's economic footprint in the region. We propose to use what is known about the WFP operations corridors together with the XEC model to capture this footprint as much as possible. This depends critically on (a) WFP's ability to provide us with food and non-food expenditure data by RBN country, including Somalia and South Sudan, and (b) our team's success at using these expenditures as inputs into the XEC model to capture impacts within the XEC region as well as in the rest of East Africa. A strength of GTAP is the ability to capture trade spillovers across countries. We are in the process of disaggregating XEC region impacts among Somalia, South Sudan, and the rest of XEC, most likely in proportion to WFP RBN spending in the three. This report presents estimated impacts of WFP spending on the XEC region but not on Somalia and South Sudan individually.

b. 3.2 Modelling Impacts of WFP Expenditures on Food

Figure 1 illustrates the strategy to evaluate the economic footprint of WFP's expenditures on food in the RBN region. The initial impact in each country and the region is via WFP's direct expenditures on foods and other goods and services procured from the food vendors with which the RBN contracts. Panel A of Figure 1 lists the categories of food expenditures, taken from the RBN Food Procurement Report for 2020. All of these food expenditures represent payments to food vendors (wholesalers). The vendors, in turn, use part of these funds to purchase different food items inside and outside the RBN region. The breakdown of payments to vendors into vendor demand for food (by item) and the part that vendors retain to cover their costs (wages, transport, etc.) and as profits is illustrated in Panel B of the Figure.

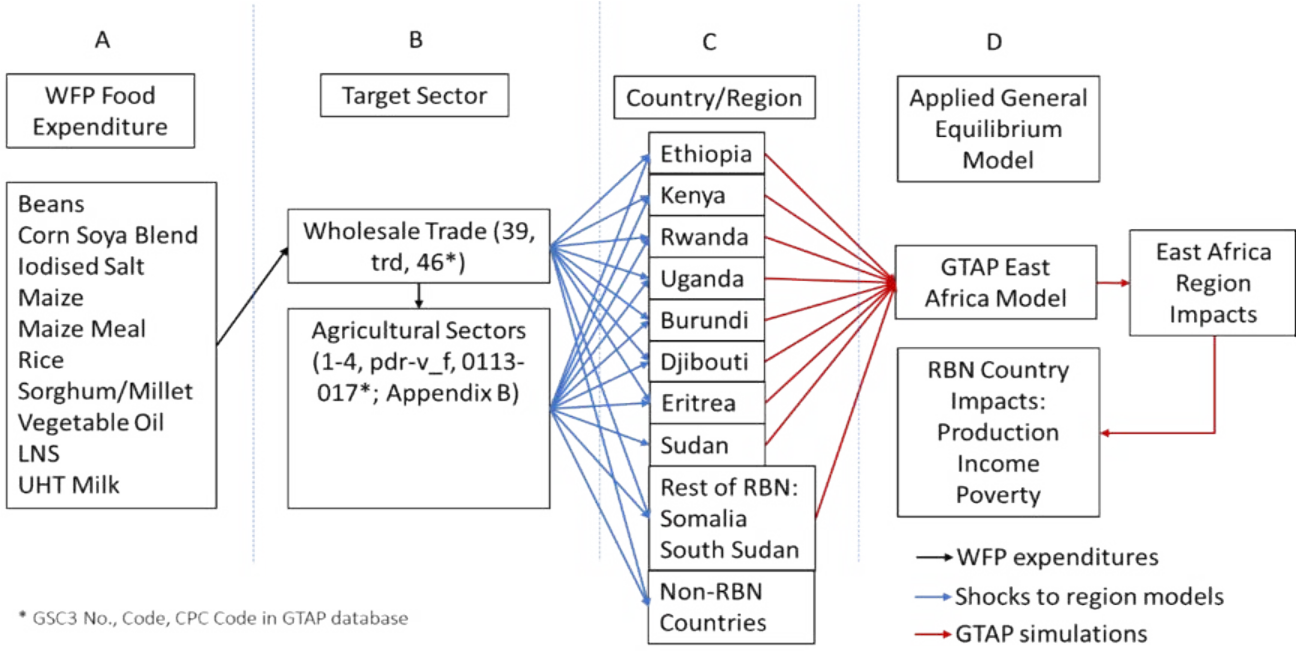


Figure 1. Modelling Impacts of WFP RBN Food Expenditures

We do not require a detailed breakdown of vendor costs in order to carry out this project, because payments by the wholesale trade to other production sectors, wages, etc., are part of the GTAP's input-output data for each country/region. However, because our focus is on measuring economic impacts of food purchases in particular, we need to know how much of RBN's payments go to vendors in each country and, in turn, how much money these vendors channel into the demand for food items from each agricultural activity and country in the GTAP database.

Table 2 provides a breakdown of the agricultural and food processing sectors in the GTAP database (Aguiar et al. 2019). For the study we need to know: (a) how much RBN paid to food vendors (wholesalers) in each RBN country; (b) how much of the food (in value) that these vendors sold to RBN was produced in each RBN country; and (c) how much of the food (in value) came from the rest of the world outside the RBN region. The RBN Food Procurement Report for 2020 provides only part of these data—total expenditures by food item. This would be the sum of purchases of the food items from all vendors. The WFP RBN office provided data on the purchase of each food item from each vendor in order to tally this sum. The Food Procurement Report also reports total RBN food purchases from the 20 largest vendors, but not from all vendors, and not the country in which each vendor is located.

Table 2. Agricultural and Food Processing Sectors Corresponding to WFP Expenditures in the GTAP Database

GSC3 No.	Code	CPC Code	Description
1	pdr	0113	Rice
2	wht	0111	Wheat
3	gro	0112	Maize (corn)
		0114	Sorghum
		0115	Barley
		0116	Rye
		0117	Oats
		0118	Millets
		0119	Other cereals
4	v_f	012	Vegetables
		013	Fruit and nuts
		015	Edible roots and tubers with high starch or inulin content
		017	Pulses (dried leguminous vegetables)

Source: Aguiar et al. (2019)

To complete the mapping of food expenditures to RBN countries requires a further breakdown of each food expenditure by RBN country, as well as Tanzania, from which the food was purchased and where it was ultimately consumed. It is evident from the RBN Food Procurement Report for 2020 that the WFP purchases this food from vendors based in different countries, and the vendors, in turn, procure the food they sell to WFP from agricultural producers in each country or outside the RBN region. To map WFP payments to food vendors onto food vendor payments to agricultural sectors in each RBN country and outside the RBN region, the RBN office provided our team with information from invoices and contact food vendors to fill out the data collection instrument (DCI) provided as an Excel document imaged in Appendix A of this report. With these detailed data, we are able to map WFP payments to specific countries and production sectors as required for this modelling.

c. 3.3 Modelling WFP Expenditures on Non-food Goods and Services

Besides purchasing food, RBN operations have expenditures on goods and services ranging from non-food services contracted through logistics to "office stationery to kitchen equipment for schools to materials and services for the construction of warehouses, roads and bridges" (WFP Supply Chain Annual Report 2015). These expenditures increase the demand for goods and services inside and outside the RBN region. Whereas food procurement creates income for food vendors and farmers, other spending spreads economic benefits across a wide range of production activities, benefiting businesses as well as input suppliers and workers.

Figure 2 illustrates the strategy to evaluate the economic footprint of WFP's non-food expenditures in the RBN region and in Tanzania. Non-food expenditures are modelled through direct mapping from WFP expenditures to the affected sectors in each country. Panel A of Figure 2 lists the categories of non-food expenditures, taken from the WFP Supply Chain Annual Report 2015. These non-food expenditures affect the corresponding sectors (listed in Table 3) in each of the countries/regions in the model.

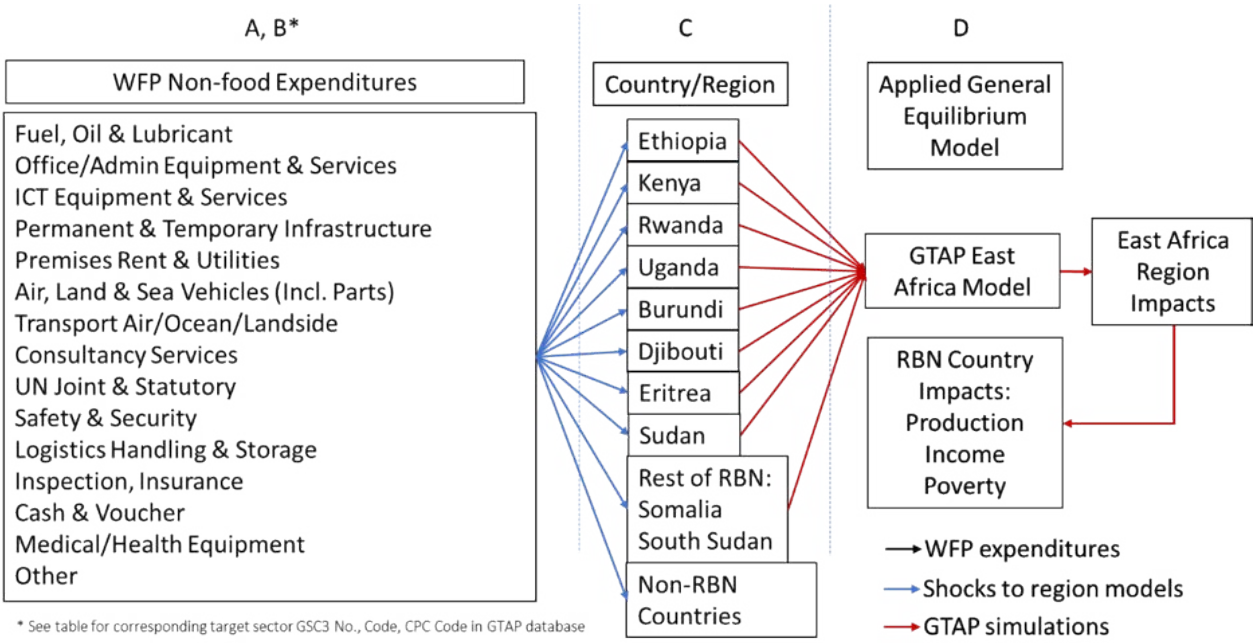


Figure 2. Modelling impacts of WFP RBN non-food expenditures

Table 3 lists the types of nonfood expenditures the WFP makes in RBN and other countries, as well as the GTAP production sectors to which they correspond.

Table 3. WFP Non-food Expenditure Categories and Corresponding GTAP Sectors

WFP Non-food Item	Corresponding GTAP Sector
Fuel, Oil & Lubricant	Manufacture of chemicals and chemical products (33,chm,20)
Office/Admin Equipment & Services	Manufacture of computer, electronic and optical products (40,ele,26)
ICT Equipment & Services	Computer programming, consultancy and related activities (56,cmn,62)
Permanent & Temporary Infrastructure	Specialized construction activities (49,cns,43)
Premises Rent & Utilities	Real estate activities (59,rsa,68)
Air, Land & Sea Vehicles (Incl. Parts)	Wholesale and retail trade and repair of motor vehicles and motorcycles (50,trd,45)
Transport Air/Ocean/Landside	Land transport and transport via pipelines (52,otp,49), Water transport (53,wtp,50) and Air transport (54,atp,51)
Consultancy Services	Professional, scientific and technical activities and Administrative and support service activities (60,obs,M,N)
UN Joint & Statutory	Other services (government), Public administration and defense; extra-territorial organization and bodies (62, osg, O, U)
Safety & Security	Other service activities (61,ros,R,S,T)
Logistics Handling & Storage	Warehousing and support activities for transportation (55,whs,52)
Inspection, Insurance	Insurance, reinsurance and pension funding, except compulsory social security; 58, ins, 65
Cash & Voucher	Human health and social work activities
Medical/Health Equipment	Manufacture of computer, electronic and optical products (40,ele,26)
Other	Other business activities (60,obs,M,N)

Source: Aguiar et al. (2019)

Mapping the WFP's RBN non-food expenditures onto accounts in country input-output tables requires knowing how much money the RBN spent on each of these non-food goods and services in each of the RBN countries and in Tanzania (Panels A and C in Figure 2). The WFP Supply Chain Annual Report 2015 presents WFP's total global expenditures on each of the non-food items in the first column of Table 3. The RBN office provided a disaggregation of each expenditure by RBN country supplying these items to the WFP (as well as Tanzania).

Appendix B presents an image of the Excel template we created for the WFP RBN office to record this information about non-food expenditures. Appendix C shows how WFP food expenditures were processed.

4. Mapping WFP Expenditures to GTAP Sectors

Table 4 and Table 5 maps WFP expenditures to GTAP sectors in each of the RBN countries, and the rest of the world. They also show the breakdown in spending between domestic and imports. The WFP program is estimated to have spent a total of $745 million in the region in 2020. Of this total, 605 million was spent within the RBN region while importing $140 million to the region. Most of WFP's spending in the region was on crops and other food (44.3% of the total), transport (26.6%), and trade, including warehousing (10.4%; see Figure 3).

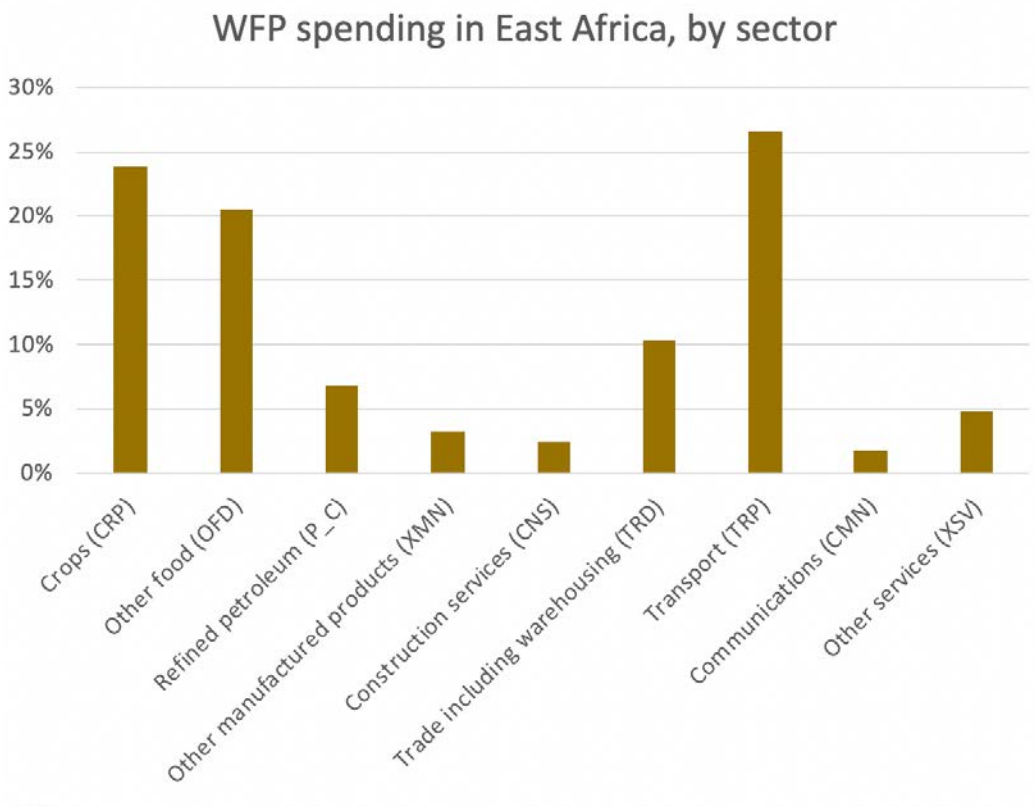


Figure 3. WFP spending in East Africa is mostly on food, transport, and trade including warehousing.

Country spending varied with, for example, the WFP spending $63 million in Kenya. Of this, 75% was on purchases of domestic goods and services and the remainder imports. Of the $16 million spent on imports, some 59% was sourced in Rwanda—mainly crops. The main domestic purchases included: 34% on crops and other food (CRP and OFD); 29% on transport (TRP); 16% on trade, including warehousing services (TRD); 12% spent on other services (XSV); 5% on other manufacturing (XMN); 2% on construction services (CNS); and 1% on communications (CMN).

Similarly, one can see from these tables that the WFP program spent around $69 million in Ethiopia, $9.6 million in Rwanda, $19 million in Burundi, $46 million in Djibouti, $6.5 million in Eritrea, $125 million in Sudan, $73 million in Uganda, and $355 million in the rest of the region. Roughly 87% of WFP spending in Ethiopia and 58% in Rwanda was on purchases of domestic goods, including food and services, with the remainder

imported from within and outside East Africa. Approximately 65% and 52% of the $9 million and $4 million imports for Ethiopia and Rwanda, respectively, came from East Africa. This import spending represents a relatively small level of expenditures compared with the countries' total economies—only 0.01% of Ethiopia's $82 billion GDP and 0.04% of Rwanda's $9.1 billion GDP in the reference year.

Table 4. Value of WFP Expenditures in RBN countries (GTAP Sectors and Domestic vs Imports)

Sector	KEN	ETH	RWA	BDI	DJI	ERI	SDN	UGA	XEC	RBN Total
	Value (millions, US$)	Value (millions, US$)	Value (millions, US$)	Value (millions, US$)	Value (millions, US$)	Value (millions, US$)	Value (millions, US$)	Value (millions, US$)	Value (millions, US$)	Value (millions, US$)
Crops (CRP)	12.72	4.44	2.96	12.18	4.44	4.44	4.44	44.72	87.06	177.40
Other food (OFD)	8.79	2.59	2.19	2.48	2.05	2.05	2.05	9.31	121.17	152.67
Refined petroleum (P_C)	0.35	14.76	0.11	0.17	0.18	0.00	18.02	0.72	16.08	50.38
Other manufactured products (XMN)	3.21	3.09	0.67	0.81	1.25	0.00	7.01	3.65	3.98	23.68
Construction services (CNS)	1.04	1.92	0.05	0.06	0.45	0.00	0.76	0.43	12.79	17.50
Trade including warehousing (TRD)	9.80	11.75	0.55	1.07	17.15	0.00	18.97	2.95	15.27	77.51
Transport (TRP)	18.19	23.13	2.12	0.28	19.03	0.00	66.76	9.04	59.33	197.87
Communications (CMN)	1.29	1.58	0.30	0.25	0.56	0.00	3.07	0.87	4.90	12.82
Other services (XSV)	7.85	5.50	0.60	0.86	1.26	0.01	3.62	1.13	14.61	35.43
Total	63.24	68.77	9.55	18.15	46.36	6.49	124.70	72.82	335.18	745.27
Value by										
Domestic	47.36	59.68	5.52	4.50	38.04	0.01	111.49	43.86	119.03	605.28
Imported	15.88	9.09	4.03	13.66	8.32	6.49	13.20	28.96	216.16	139.99
Total	63.24	68.77	9.55	18.15	46.36	6.49	124.70	72.82	335.18	745.27

Table 5. WFP Expenditures in RBN countries (GTAP Sectors and Domestic vs Imports, Percent of Total)

Sector	KEN	ETH	RWA	BDI	DJI	ERI	SDN	UGA	XEC	RBN
	Percent of Total	Percent of Total	Percent of Total	Percent of Total	Percent of Total	Percent of Total	Percent of Total	Percent of Total	Percent of Total	Percent of Total
Crops (CRP)	20.1%	6.5%	31.0%	67.1%	9.6%	68.4%	3.6%	61.4%	26.0%	23.8%
Other food (OFD)	13.9%	3.8%	23.0%	13.7%	4.4%	31.6%	1.6%	12.8%	36.1%	20.5%
Refined petroleum (P_C)	0.6%	21.5%	1.1%	0.9%	0.4%	0.0%	14.4%	1.0%	4.8%	6.8%
Other manufactured products (XMN)	5.1%	4.5%	7.1%	4.5%	2.7%	0.0%	5.6%	5.0%	1.2%	3.2%
Construction services (CNS)	1.7%	2.8%	0.5%	0.4%	1.0%	0.0%	0.6%	0.6%	3.8%	2.3%
Trade including warehousing (TRD)	15.5%	17.1%	5.7%	5.9%	37.0%	0.0%	15.2%	4.0%	4.6%	10.4%
Transport (TRP)	28.8%	33.6%	22.2%	1.5%	41.0%	0.0%	53.5%	12.4%	17.7%	26.6%
Communications (CMN)	2.0%	2.3%	3.1%	1.4%	1.2%	0.0%	2.5%	1.2%	1.5%	1.7%
Other services (XSV)	12.4%	8.0%	6.3%	4.7%	2.7%	0.1%	2.9%	1.6%	4.4%	4.8%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100.0%
Percent of Total by										
Domestic	75%	87%	58%	25%	82%	0%	89%	60%	36%	81%
Imported	25%	13%	42%	75%	18%	100%	11%	40%	64%	19%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: World Food Program, Regional Bureau of Nairobi.

5. Applied General Equilibrium Modelling of WFP's East Africa Footprint

Once we know the WFP RBN's expenditures on food and non-food goods and services supplied and demanded by a RBN country, this information is fed into a model to estimate economy-wide impacts in the country as well as on the region as a whole, as depicted in Panel D of Figures 1 and 2. We use the Envisage model, which is structurally related to Purdue University's GTAP platform but, we believe, better suited for the project for reasons discussed below.

The GTAP platform offers several advantages for this project:

1. It makes it possible to estimate the WFP's economic footprint on individual countries as well as the East Africa region.

2. It is a general equilibrium model, so it can be used to capture both direct and indirect impacts of WFP spending within each country as well as in the region as a whole.

3. While doing (1) and (2), it places the East Africa region within the context of the rest of the rest of the global economy, capturing trade flows between the two.

4. The GTAP model's database and programming cover a large number of countries and economic activities, including those from which WFP RBN operations demand goods and services. The latest version, GTAP 10, includes 141 countries/regions and 65 production sectors.

The Envisage model, also developed at Purdue's Center for Global Trade Analysis, has the same structural features of GTAP but additional options valuable for this project. They include:

1. The MRIO module, which allows for agent-specific sourcing of goods. The WFP RBN can be set up as an agent in this model.

2. Labor market segmentation (agricultural versus non-agricultural)

3. Potential for a more complete modelling of current accounts (remittances and transfers)

4. A major challenge in this project is to obtain the data needed to construct country and regional AGE models. Envisage uses GTAP's extensive country data base including the detailed input-output data required for AGE modelling of countries and regions, on the production as well as household side. Without this, we would have to obtain the data to build each country model and combine these into an East Africa region model, which would be quite expensive and time-consuming. Despite this, there remain some challenges due to the presence of data-poor countries in the region, particularly South Sudan and Somalia, which are combined in the "Rest of East Africa" region in the GTAP database. We consider some strategies to deal with this later in this report.

The Envisage model was used together with WFP expenditure data to perform a comparative static analysis of the impacts of WFP spending within each RBN country, the rest of East Africa, and the RBN region as a whole, while capturing region-wide impacts and general-equilibrium feedback effects through trade.

The theory behind the GTAP model is similar to that of other multi-regional AGE models. The GTAP equation system covers accounting relationships that ensure all receipts and expenditures of agents in the economy (country and region) are balanced, as well as sets of equations describing behavioral responses of producers, households, and other agents. These behavioral responses are based on microeconomic theory of producers and consumers, which assumes that all agents are optimizing: firms maximize profits, and consumers maximize utility or welfare from consuming goods and services. The GTAP model uses a common set of equations for all countries, with functional forms that are quite flexible compared with other AGE models. Rather than extending the length of this report by summarizing the GTAP model in an appendix, a detailed description of the basic GTAP model is available here. GTAP is a regional analogue to the micro Local Economy-wide Impact Evaluation (LEWIE) approach, which nests heterogeneous household groups (instead of regions) within an AGE local (instead of regional) economic model.

d. 5.1 Studies Using the GTAP Modelling Platform

Perhaps the best way to get to know GTAP and its appropriateness for this study is to briefly review existing work based on the GTAP platform. A very large volume of AGE studies has been carried out using GTAP. Most are policy papers published by international development and other institutions, and several have appeared in peer-refereed journals. Overwhelmingly, these studies use GTAP to simulate impacts of trade and policy reforms. This study is unique in using GTAP—or any other AGE platform, to our knowledge—to assess the impacts of the operations of a major international development agency.

ENVISAGE has been used by the World Bank since 2007. The GTAP platform has been used for a large number of AGE studies. Here is a selection of past GTAP studies that gives a flavour of what can be accomplished using this type of model:

Dennis, A., 2006. *The impact of regional trade agreements and trade facilitation in the Middle East and North Africa region*. The World Bank.

This study uses the GTAP model and database to seek explanations for disappointing trade performance in the Middle East and North Africa regions. Simulations reveal that there would be large welfare gains from integrating these regions with the European Union (EU)—much greater than the welfare gains from improved intra-regional integration.

Mold, Andrew; Mukwaya, Rodgers (2015) : The effects of the Tripartite Free Trade Area: Towards a new Economic geography in Southern, Eastern and Northern Africa? CREDIT Research Paper, No. 15/04, The University of Nottingham, Centre for Research in Economic Development and International Trade (CREDIT), Nottingham; https://www.econstor.eu/bitstream/10419/126452/1/835515214.pdf

In this study, the GTAP model is used to assess the impact of the proposed COMESA-SADC-EAC Tripartite Free Trade Area (TFTA) on 26 African countries. It finds that the TFTA would increase trade within the region by 29%, with particularly large benefits for light and heavy manufacturing and processed food sectors.

Yang, G., Huang, X., Huang, J. and Chen, H., 2020. Assessment of the effects of infrastructure investment under the belt and road initiative. *China Economic Review*, 60, p.101418.

In contrast to the previous two studies, which focus on trade policy, this paper uses the GTAP model to evaluate the impact on Asian nations of a major infrastructure project: the Belt and Road Initiative. Simulations show that most countries and regions gain from higher economic growth and international trade as a result of this initiative, though some do not.

Stone, S., Strutt, A. and Hertel, T.W., 2010. Assessing socioeconomic impacts of transport infrastructure projects in the Greater Mekong Subregion.

In a similar vein, Stone et al. study the links between infrastructure investment and poverty reduction in the Greater Mekong Subregion (GMS, comprised of Cambodia, Lao People's Democratic Republic (Lao PDR), Myanmar, Thailand, Viet Nam, and Yunnan Province and Guangxi Zhuang Autonomous Region of the People's Republic of China (PRC)), using a multi-region GTAP general equilibrium model. For the poverty analysis, they supplement the GTAP modelling with household survey data. The findings suggest strong gains to GMS countries as a result of infrastructure development and trade facilitation. National poverty declines throughout the region. However, the impacts are not the same for all segments of the population. Skilled wages rise by more than unskilled wages in the region, and this tends to benefit urban households more than rural ones.

Thomas W. Hertel, Marshall B. Burke, and David B. Lobell, "The Poverty Implications of Climate-Induced Crop Yield Changes by 2030," *Global Environmental Change* 20, no. 4 (2010): 577–85.

This study embodies a novel use of the GTAP model to study the effects of climate change on poor households in fifteen different developing countries. Climate change alters crop yields. This can affect poor households directly, if they grow crops, as well as indirectly, by changing food prices. Poor urban households, which are not involved in crop production, may suffer if food consumption prices rise. Climate predictions are used as inputs into the GTAP global model. One climate change and food production scenario finds that prices for major staple crops rise by 10–60% by 2030. This increases poverty rates by 20–50% in parts of Africa and Asia. In other parts of Asia and in Latin America, some households specializing in agriculture actually gain as a result of climate change.

Mold, A., 2018. The consequences of Brexit for Africa: the case of the east African community. *Journal of African Trade*, *5*(1-2), pp.1-17.

Brexit has potentially important impacts on African economies through trade. This study uses the GTAP model to simulate possible impacts of Brexit on Africa. It finds that direct impacts, through investment, trade and migrant remittances, are likely to be relatively small. However, African countries may benefit from the creation of new export opportunities. The benefits of trade are mainly in resource-intensive sectors. In the longer run, Brexit is likely to have equally important indirect impacts, through its influence on Economic Partnership Agreements (EPAs) with the European Union and a possible reduction in UK development cooperation. The findings suggest that regional integration, through the African Continental Free Trade Area, could take on a more important role post-Brexit.

These studies illustrate the diversity of development and trade questions that have been addressed using the GTAP platform. To our knowledge, this project is the first to use GTAP to assess the impacts of spending by

a major development agency on income and production in beneficiary countries, including indirect spillover and trade effects.

To date, impacts of WFP spending on specific programs have been evaluated in individual countries or regions using local economy-wide impact evaluation (LEWIE) methods. Examples include impacts of cash versus in-kind assistance to refugees in Rwanda (Taylor et al. 2016) and Uganda (Taylor, Zhu, Gupta et al. 2016) and impacts of home-grown school feeding programs in Kenya (Taylor, Zhu, Gupta et al. 2019). Whereas LEWIE models are constructed from microdata gathered through surveys of local households and businesses, that approach is not feasible for a project whose focus is on entire national and regional economies. The alternative of using national accounts and trade data from each RBN country to construct a series of national AGE models and link them together within an RBN regional model would be costly and time consuming. The great advantage of the GTAP platform is that it provides the basic national and regional models as well as database that can serve as the starting point for this project. Detailed data on WFP spending by category and country can be fed into the GTAP East Africa model to estimate impacts on individual RBN countries, and the region as a whole.

The impacts of WFP spending in this report are assessed under two sets of assumptions (commonly referred to as "closure rules") about labor and capital markets, summarized in Table 6. In the first case (FEFK), aggregate labor and capital supply are assumed to be fixed, and wages and capital returns adjust to equate their respective demand and supply. This is the most restrictive set of closure assumptions. Without the availability of labor and capital to fuel economic expansion, WFP spending competes with other spending in the economy to purchase goods and services. The second closure condition (FWFR) assumes that real wages and rents are fixed, and the level of employment as well as investment adjust to accommodate production to satisfy changes in demand due to WFP expenditures. This is the most flexible assumption, under which both aggregate employment and capital adjust in response to WFP expenditures. It is typical of an economy with long-term structural unemployment and reasonable access to capital if needed to expand production.[6]

Given persistently high unemployment rates, it is likely that the current state of East African economies is characterized by at least some excess capacity. If so, WFP spending is likely to create real economic benefits in addition to its primary objective of distributing food and cash assistance. Throughout this report, we report findings under FWFR assumptions. Nevertheless, it is important to keep in mind the sensitivity of findings to the structure of the economy in question, reflected in market closure assumptions in general equilibrium models. In that spirit, we include a section towards the end of this report that compares findings under the two sets of closure conditions.

Table 6: Definition of Scenarios

Country	Fixed employment and fixed capital (FEFK)	Fixed wages and fixed rent (FWFR)
KEN	WFP spends $63 million	
ETH	WFP spends $69 million	
RWA	WFP spends $10 million	
UGA	WFP spends $63 million	
BDI	WFP spends $18 million	
DJI	WFP spends $46 million	
ERI	WFP spends $6 million	
SDN	WFP spends $125 million	
XEC	WFP spends $335 million	

[6] All economy-wide modeling requires establishing closure rules, which determine whether prices (or, in the case of labor, wages) or total supply are fixed in the economy. Where abundant labor is available, the demand for labor can increase without putting significant upward pressure on wages. New investments to fund capital expansion or excess capacity in the economy enables production to increase without being significantly inhibited by capital constraints.

6. Impacts of WFP Spending in East Africa

The model was used to derive country and regional economy-wide impacts of WFP spending. We begin by presenting the multiplier effects of each dollar of WFP spending on real (inflation-adjusted) GDP and the value of total production, as well as impacts on employment. Multiplier effects are calculated by dividing total impacts by the amount of WFP spending in each country. They are useful in providing easy-to-interpret estimates of the aggregate impacts of WFP spending in the region. We then unpack these aggregate impacts by considering effects on specific production activities, prices, and selected other outcomes in each country.

The results presented here are intended to be a basis for thinking about how WFP expenditures can affect income, production, and employment, but also how the effects depend in important ways on what economies look like, in particular the availability of labor and capital to support increased production. The same expenditures can produce strikingly different outcomes in different economic settings. It is important to keep this in mind while assessing the regional impacts of WFP activities, whether they are local, national, or regional.

We used the model to simulate the impacts of total WFP RBN spending in each country. We allocated these expenditures to their corresponding production sectors as shown in Table 4. The immediate impact of this spending is to stimulate demand for goods and services supplied by the directly affected sectors. As these sectors increase their output to meet WFP demand, they purchase inputs from other sectors, and they generate income in the form of payments to labor (wages) and capital (profits). The income flows into households, which in turn spend it, creating additional rounds of impacts on production and income. In the FWFR scenario, with labor and capital available, the economy expands as a result of this WFP spending.

In contrast, in the FEFK scenario, the directly affected sectors compete with other production sectors for scarce labor and capital. This competition among sectors could result in decreased output in some sectors not directly favoured by WFP spending. If capital is fixed and labor is in limited supply, increased production in some sectors may drive up rental rates and wages in all sectors. This can transmit negative impacts from sectors that are favoured by WFP spending to sectors that are not.

The reality is likely to fall somewhere in between these extremes, but it probably favours the FEFK case; this is our preferred scenario. Unemployment rates generally are high in East African countries. For example, the unemployment rate in Kenya averaged 9.93 percent from 1991 until 2020, suggesting that labor is available to support increases in production.[7] The availability of capital is less clear; however, traditionally at least some countries, including Kenya and Ethiopia, have been able to attract foreign capital to support economic growth.

It is important to note that there is no reason to expect WFP spending multipliers to be greater than one—that is, for $1 of WFP spending to increase total real income by more than $1. When the WFP purchases goods and services, much of the impact goes to purchase intermediate inputs required to expand production. Only part of the impact takes the form of higher value-added (payments to labor and capital), which contribute to countries' real gross domestic product (GDP). Some WFP purchases and intermediate inputs are imported from other countries and thus cannot directly affect a country's GDP. This is in contrast with the multiplier effects of cash transfers to households. A dollar transferred to households immediately raises total income by the $1 transferred, and spillover effects, if positive, can add to the income effect, resulting in multipliers that commonly exceed 1.0.

It is also important to recognize that WFP spending, though impressive, is small compared with the size of whole country economies in East Africa, especially once imports are taken into account (see Table 7). For example, in 2020 the WFP program is estimated to have spent around $69 million in Ethiopia, which had a total GDP of $81.76 billion.[8] Thus, total WFP spending in Ethiopia was equivalent to only about 0.08% of total income or GDP. Rwanda has a much smaller economy than Ethiopia, with a total GDP of $9.1 billion. WFP spending in Rwanda is equivalent to 0.1% of the country's GDP—only slightly larger than in Ethiopia. WFP spending represents the largest share of GDP in Djibouti (1.7%). Because WFP spending is small compared with the size of national economies, so are the total impacts of this spending. Nevertheless, as we shall

[7] For unemployment estimates see Trading Economics; https://tradingeconomics.com/kenya/unemployment-rate

[8] The reference year for GDP was according to the GTAP model database, in the case of Ethiopia this was for 2017.

see, impacts relative to GDP spending often are large, because of spillovers. In theory, spillover effects can be positive or negative, depending on whether an economy has sufficient labor and capital to expand its production to meet the new demand created by WFP spending in the region. In practice, as we shall see under what we believe to be the more likely, optimistic scenario, a dollar of WFP spending in East African countries usually creates several dollars of income and production growth, and WFP spending also can have a disproportionately large impact on employment.

Table 7: WFP Spending as a Percentage of GDP

Country/Region	WFP Spending (millions)	GDP (billions)	WFP Spending as % of GDP
Kenya	63.24	78.76	0.08%
Ethiopia	68.77	81.76	0.08%
Rwanda	9.55	9.14	0.10%
Uganda	72.82	26.00	0.28%
Burundi	18.15	3.17	0.57%
Djibouti	46.36	2.77	1.68%
Eritrea	6.49	5.81	0.11%
Sudan	124.70	41.28	0.30%
XEC Region*	335.18	10.30	3.25%

*The XEC Region includes Somalia, South Sudan, Comoros, Mayotte, and Seychelles

These calculations are based on total WFP spending in each country; however, much of this spending is not on goods and services in the country, but rather, imports. Roughly 80% of WFP spending in Ethiopia and 46% in Rwanda was on purchases of domestic goods, including food, and services, with the remainder imported from within and outside East Africa. Imports do affect other countries in the region, though. For example, approximately 64% and 54% of the $9 million and $4 million in imports for Ethiopia and Rwanda, respectively, came from East Africa. These imports transmit some of the impacts of WFP spending to other countries in the region.

By integrating country models into the regional model, we are able to pick up region-wide impacts through trade, including exports from other countries as well as the feedback effects they produce as they cycle through the region. These region-wide trade impacts can add to the multiplier effects of WFP spending in RBN countries. They also have impacts outside the RBN region, which are not a focus of this study.

a. Production Multipliers

Under the FWFR assumptions, in most countries total production expands more than the amount of WFP spending, resulting in multipliers greater than 1.0; see Figure 4. The largest production multipliers are in Kenya and Uganda. The production multiplier is 6.47 in Kenya and 6.02 in Uganda. It exceeds 2.0 in Ethiopia, Sudan, Rwanda, Burundi, Burundi, and it is positive but small in Djibouti (0.84) and the rest of the East Africa region, which includes South Sudan and Somalia (0.33). It is negative in Eritrea (-3.87). Negative production multipliers indicate that most of the demand created by WFP spending comes from imports, and this together with competition among production sectors results in a negative overall production impact. The positive production multipliers in all other countries and in the region as a whole tell us that WFP spending results in a net gain in production, benefiting local producers. Detailed impacts across production sectors appear at the end of this report. They show that, under an optimistic scenario, positive impacts are spread across nearly all production sectors in most cases, with transportation-related sectors among the largest beneficiaries.

Production Increase* per $1 of WFP Spending

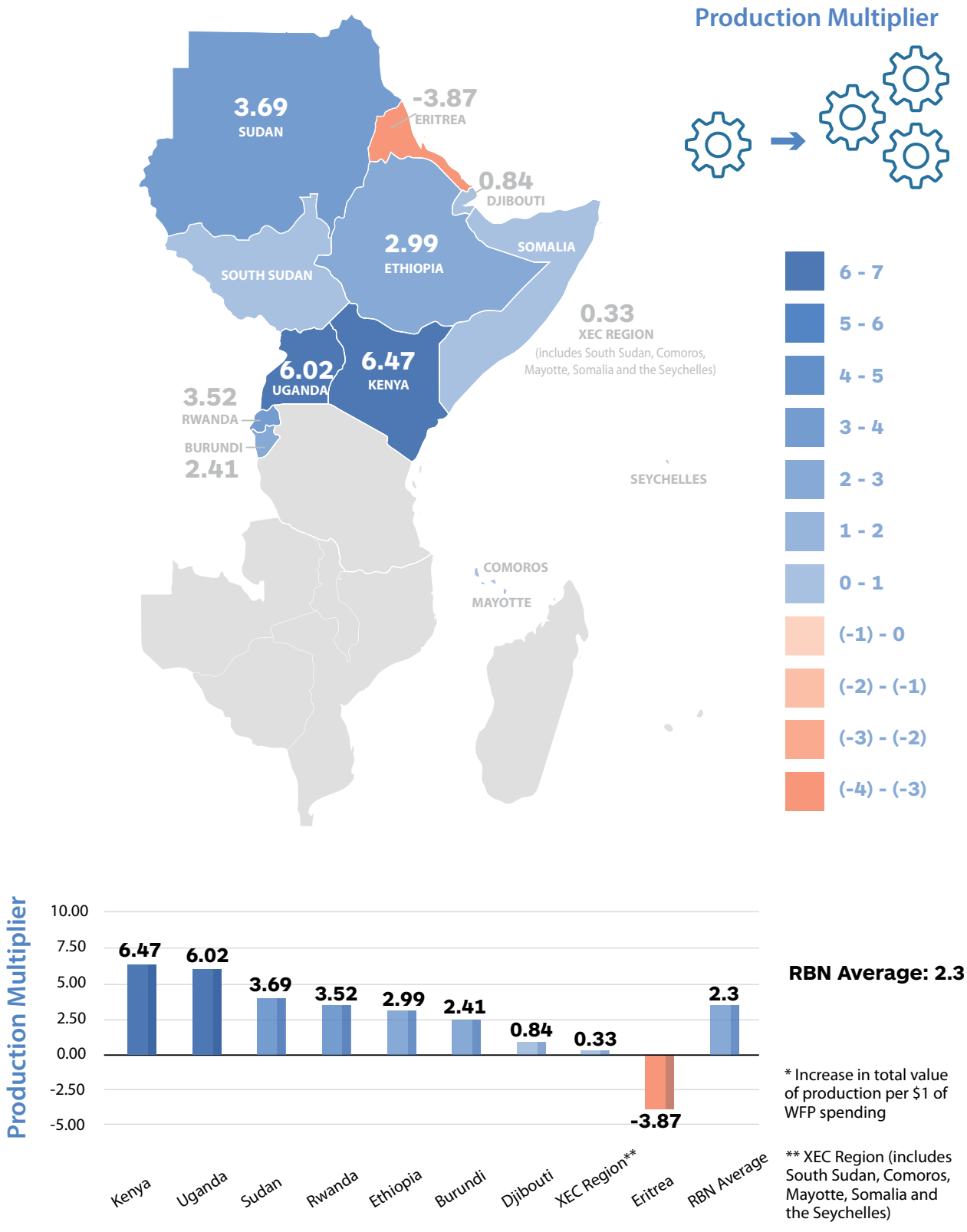


Figure 4. The production multiplier effects of WFP spending vary across countries.

Real (Inflation-adjusted) GDP Impact per $1 of WFP Spending

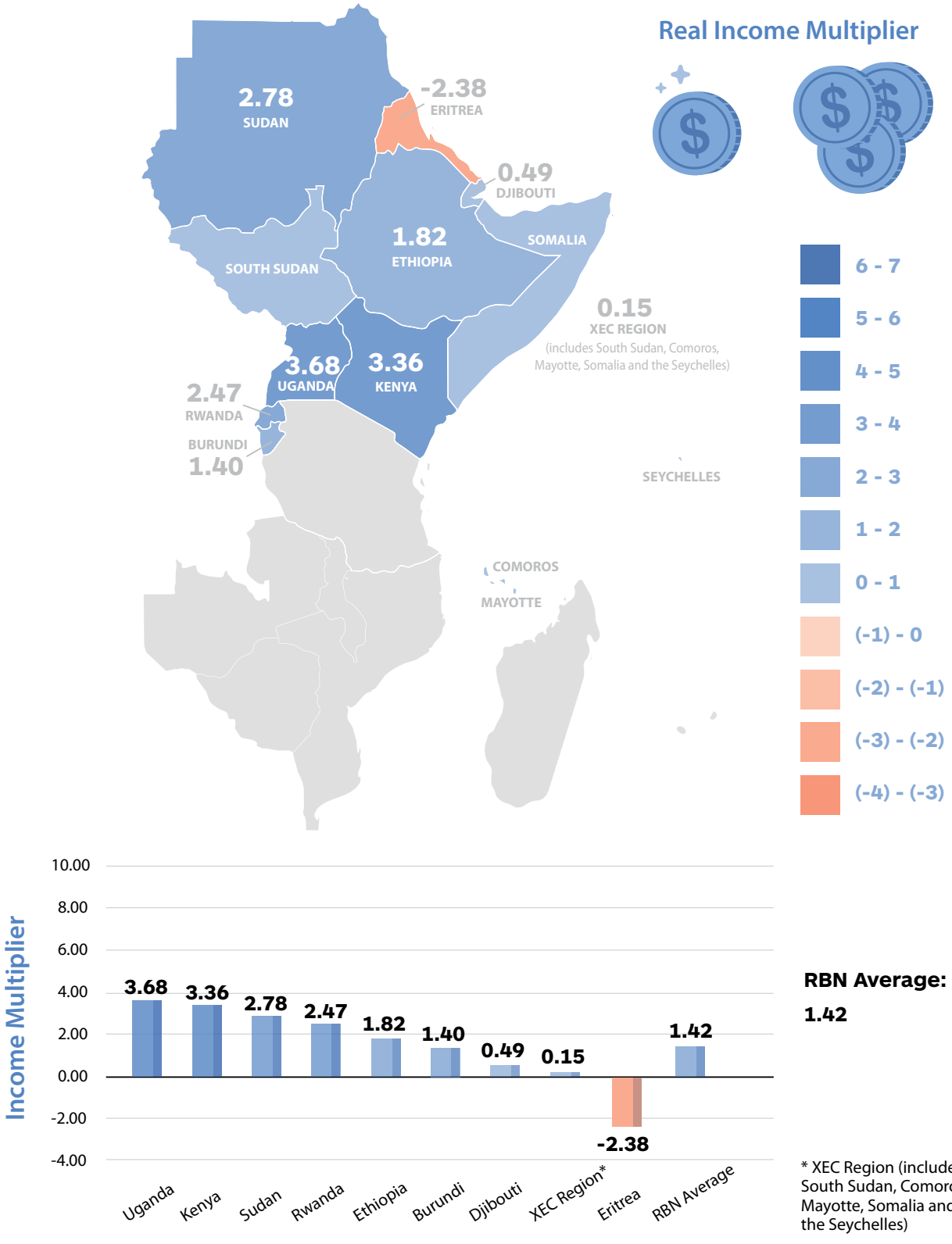


Figure 5. The multiplier effects on real GDP tend to be large where production multipliers are large.

b. Real Income or GDP Multipliers

As production expands, income flows into households, stimulating consumption demand and additional rounds of production increases in the economy. Rising demand also can put upward pressure on the prices of goods and services. Price inflation raises consumption costs and creates the possibility that, even if cash income expands, real or inflation-adjusted income could fall.

Figure 5 shows the total real, or inflation-adjusted, increases in national income per dollar of WFP spending in each country. For the most part, real-income multipliers follow a pattern similar to production multipliers. An additional dollar of WFP spending raises total real income by $3.68 in Uganda and $3.36 in Kenya. The WFP income multiplier is 2.78 in Sudan, 2.47 in Rwanda, 1.82 in Ethiopia, and 1.4 in Burundi. It is small but positive in Djibouti (0.49) and in the rest of East Africa (0.15). The real income multiplier, like the production multiplier, is negative in Eritria (-2.38). The positive real income multipliers in all other countries and in the region as a whole tell us that WFP spending results in a net income gain, benefiting local households.

c. Employment Impacts of WFP Spending

Higher production creates jobs. Figure 6 shows the total employment effects of WFP spending in East Africa. These are calculated as the increase in total wage income divided by the average wage, then converted into year-round equivalent jobs.

The largest employment impact of WFP spending is in Uganda: 151,936 unskilled-worker jobs and 9,342 skilled-worker jobs. Impacts on unskilled employment are considerably larger than on skilled employment. The reason is that WFP spending impacts sectors that are likely to hire unskilled labor. Farming, transportation, trade, rely on farm labor, truckers, warehousing employees, and expand their hiring because of the direct and indirect impacts of WFP spending. The largest employment impact of WFP spending is in Uganda: 151,936 unskilled-worker jobs and 9,342 skilled-worker jobs. In the other countries, for unskilled employment, the positive impacts range from 1,642 in Djibouti to 73,145 in Ethiopia. Skilled employment expands by 167 in Djibouti to 4,219 in Kenya. Employment contracts slightly in Eritrea, where production and real income also fall: unskilled employment falls by 3,599, and skilled employment by 296. In the rest of East Africa, employment increases by 13,987 for unskilled workers and 550 for skilled workers. The positive employment effects in in the region tell us that WFP spending results in a net gain for workers.

It is clear from Figures 4-6 that the overall net effects of WFP spending in the RBN region are positive and large. Nevertheless, individual countries experience the impacts at different scales. In general, it appears that the most stable and productive countries benefit more, whereas the less stable countries and those relying heavily on imports benefit less or do not benefit.

d. Sensitivity of Impacts to Labor and Capital Availability

The preferred scenario, FWFR, corresponds to an economy in which labor and capital are available to support production in response to higher demand. We believe this scenario best reflects the current situation in most East African countries, which have fairly high unemployment rates and reasonable access to foreign capital. Often, FWFR is assumed to represent economies in the medium-to-long run, over which it may be easier for countries to increase their labor forces and investment. It also may depict shorter-term situations if unemployed labor and capital can be brought on line easily.

The results under FWFR presented up to this point are optimistic compared to a scenario in which labor and capital are not available. In an economy at full or near full employment, it may not be possible for the workforce to expand, though rising labor force participation could still offer some flexibility. If the supply of workers is unresponsive, production will be constrained, and higher demand—stimulated by WFP spending or other sources—will tend to increase wages instead of employment. If capital is also at or near full utilization and new investments are not forthcoming, this will intensify the constraints on economic expansion. In these constrained situations, it is not surprising to find that WFP spending has little or no effect on income and employment growth, and by pushing up prices, it could even provoke a decrease in real or inflation-adjusted incomes.

WFP Impact on Employment

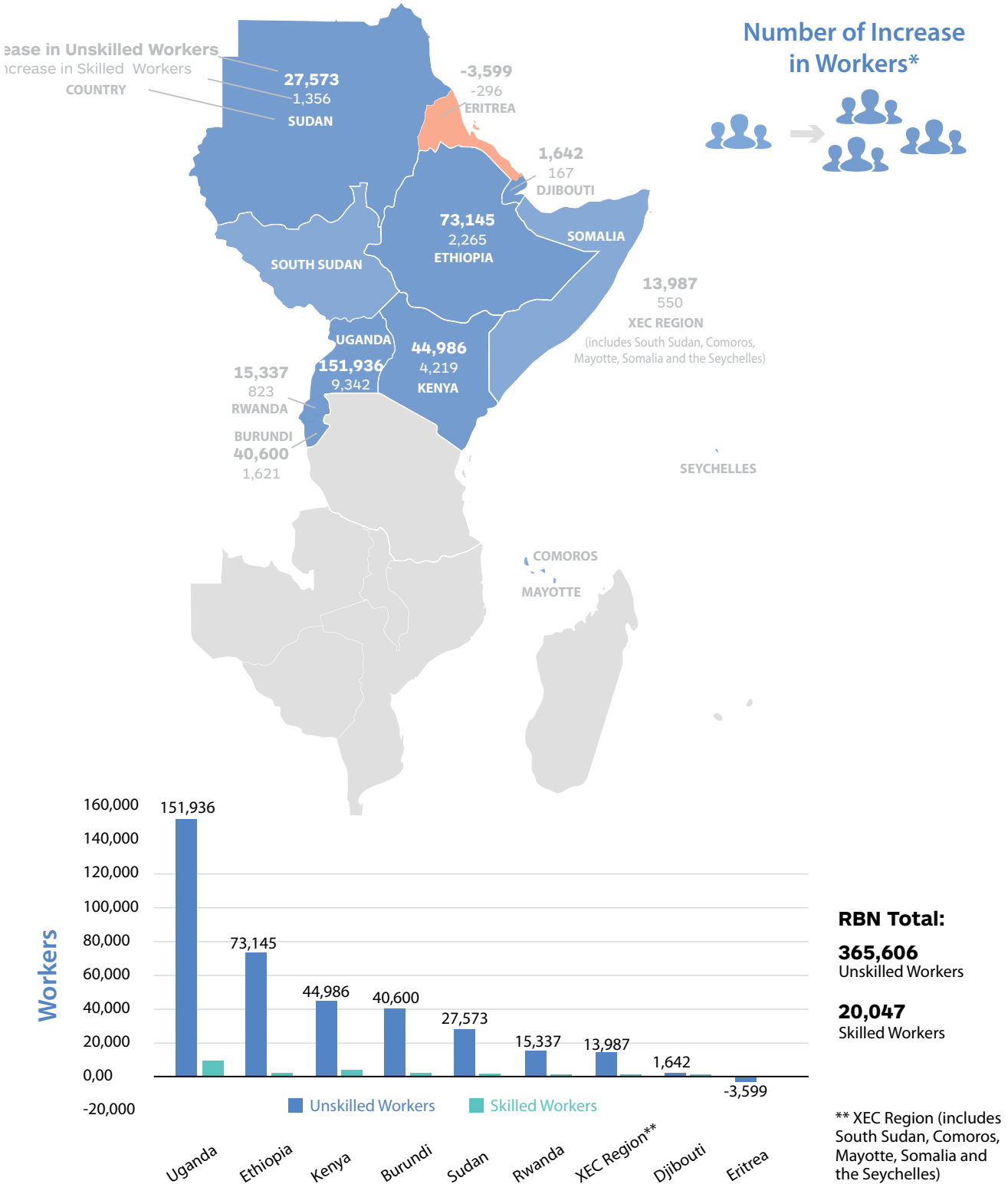


Figure 6. Total employment effects of WFP spending by country (year-round equivalent jobs)

Figures 7-8 compare the aggregate production and GDP findings in Figures 4-5 with those under the most restrictive, FEFK, scenario. The orange bars correspond to the FWFR scenario, and the blue bars correspond to the FEFK scenario.

If both labor and capital are available, WFP spending creates positive and in many cases large production, real income, and employment multipliers. Across the entire East Africa (RBN) region, each dollar of WFP spending increases the total value of domestic production by $3.52 and total real income, or GDP, by $2.34. The impacts vary across RBN countries. In Kenya, each dollar of WFP spending increases the total value of domestic production by $6.47 and total real income, or GDP, by $3.36. Production and real-income multipliers are positive for all countries and the rest of East Africa region, with the exception of Eritrea, where there is evidence that WFP spending competes with local production and mostly stimulates imports.

In contrast with the FWFR case, when both labor and capital are fixed, the positive impacts of WFP spending become small or negative. In Kenya, for example, under the FEFK assumptions, a $1 increase in WFP expenditures results in an increase in total production value of $6.47. In the fixed-labor and capital case, the total production impact is small and negative, 0.14. The WFP spending creates 44,986 non-skilled jobs and 4,219 skilled jobs in the unconstrained case. If the labor supply and capital are fixed, there is (by definition) no increase in employment or investment. A similar pattern of large impacts under FWFR and small or negative impacts under FEFK is evident for the other countries in the region.

The employment impacts shown in Figure 6 completely disappear under the FEFK case, because (by assumption) the labor force does not change.

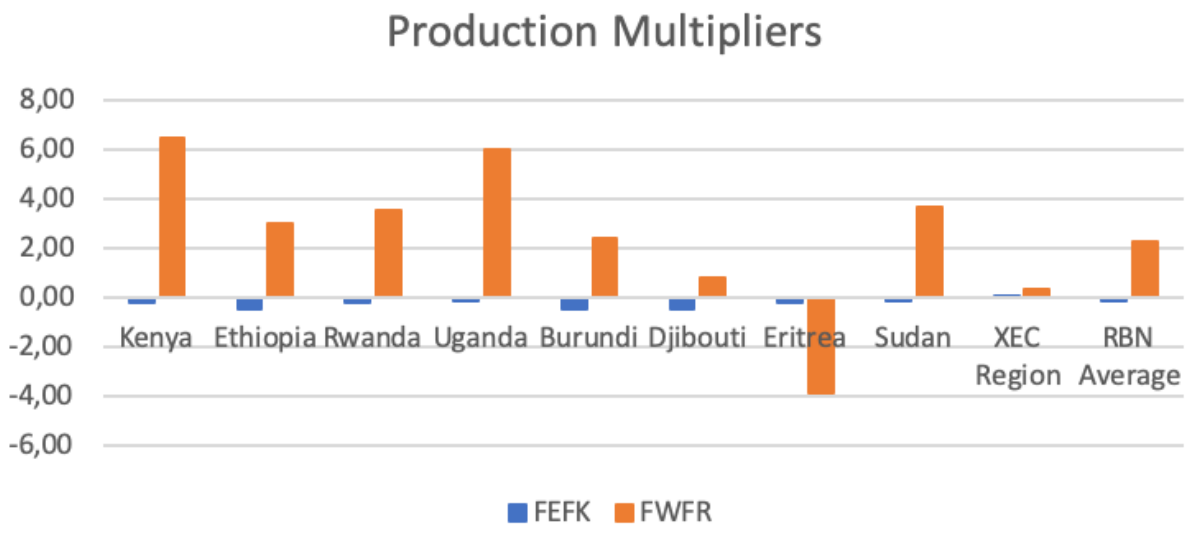


Figure 7. Impacts of WFP spending on total production value are large and positive where labor and capital are available but small and often negative where they are not

A more detailed look at impacts across production activities provides some additional insights into why the closure assumptions matter. Table 8 provides definitions for the detailed sectors, and Figures 9(a)-(i) show sector impacts by country under both the FWFR and FEFK scenarios. If labor and capital are in excess supply (orange bars), all (or nearly all) sectors expand as a result of WFP demand for goods and services from some sectors. The positive spillovers to non-WFP favoured sectors reflect higher demands for intermediate inputs as well as for consumer goods purchased by households as incomes rise in the economy. The blue bars tell a different story. Output from the WFP-favoured sectors rises, while (in most cases) other sectors, which compete for scarce labor, contract. The impact on total production is positive and large in the first case but negative in the second.

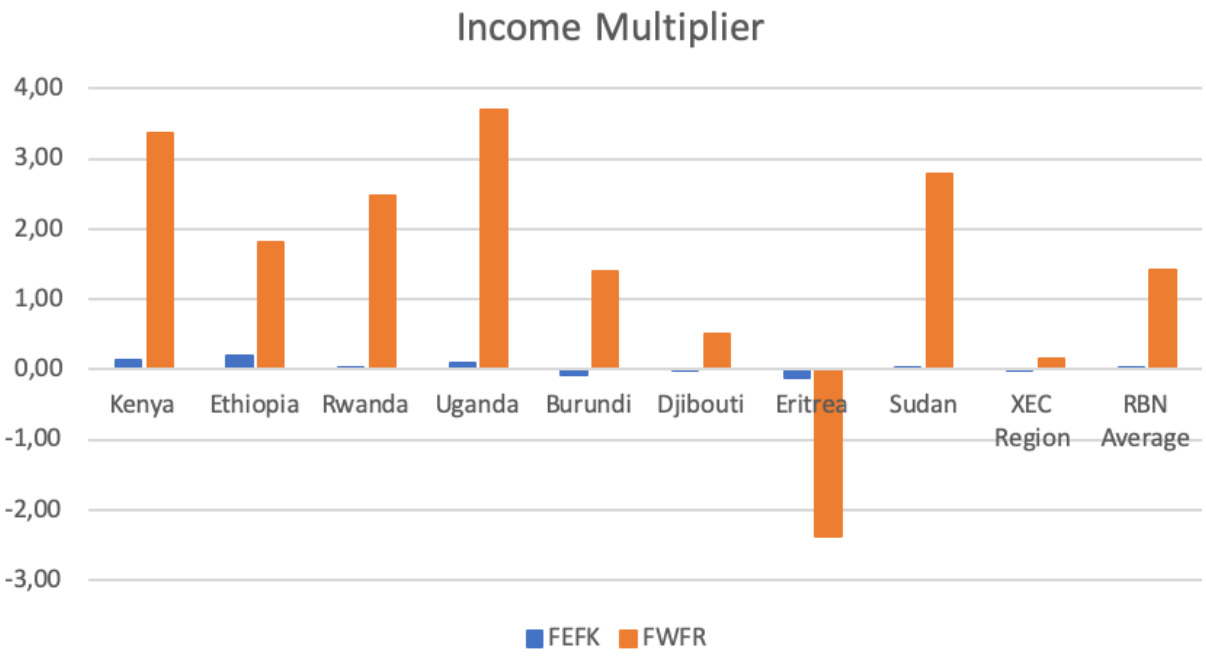
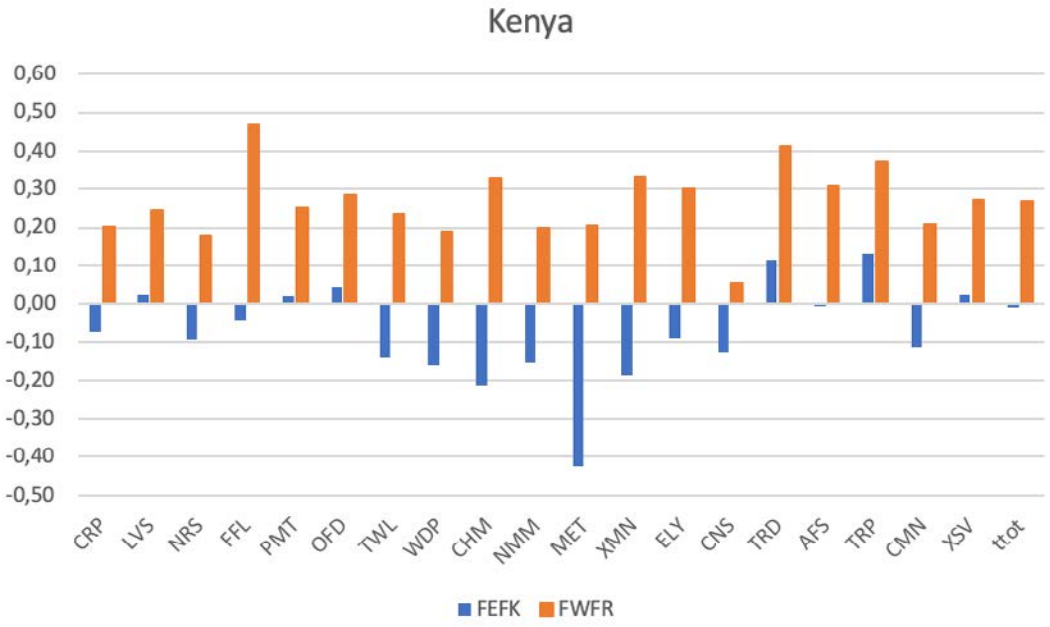


Figure 8. Impacts on real income are almost always large and positive in the optimistic case but small and sometimes negative in the pessimistic case.

Table 8. Detailed Sector Definitions

CRP	ETH
LVS	KEN
NRS	RWA
FFL	UGA
PMT	BDI
OFD	DJI
TWL	ERI
WDP	SDN
CHM	XEC
NMM	COM
MET	MYT
XMN	SSD
ELY	SOM
CNS	SYC
TRD	Trade incl. warehousing
AFS	Accommodation
TRP	Transport
CMN	Communications
XSV	Other services
ttot	Total output


Kenya
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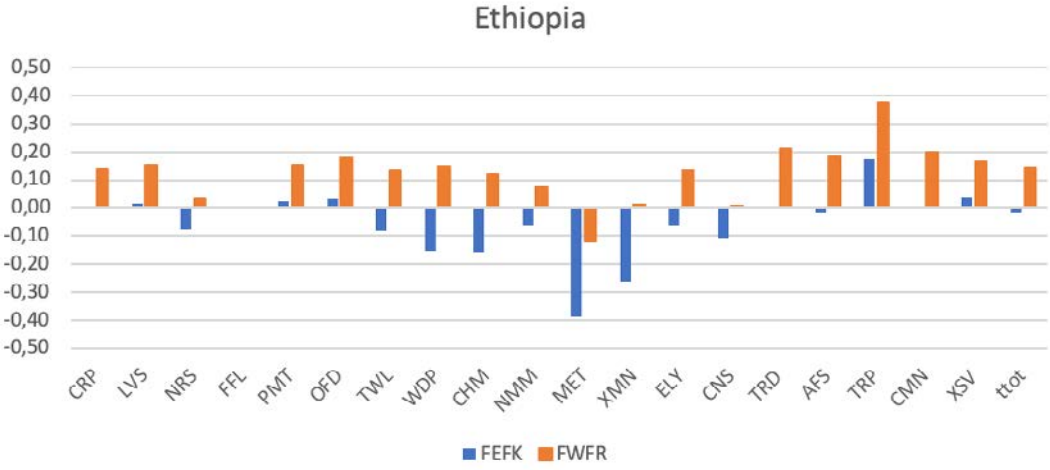
CRP LVS NRS FFL PMT OFD TWL WDP CHM NMM MET XMN ELY CNS TRD AFS TRP CMN XSV ttot
FEFK FWFR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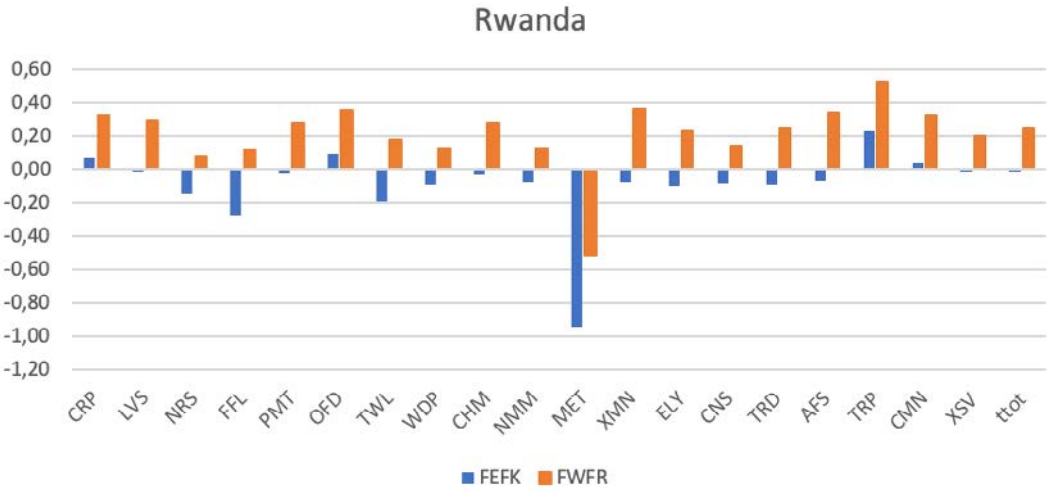
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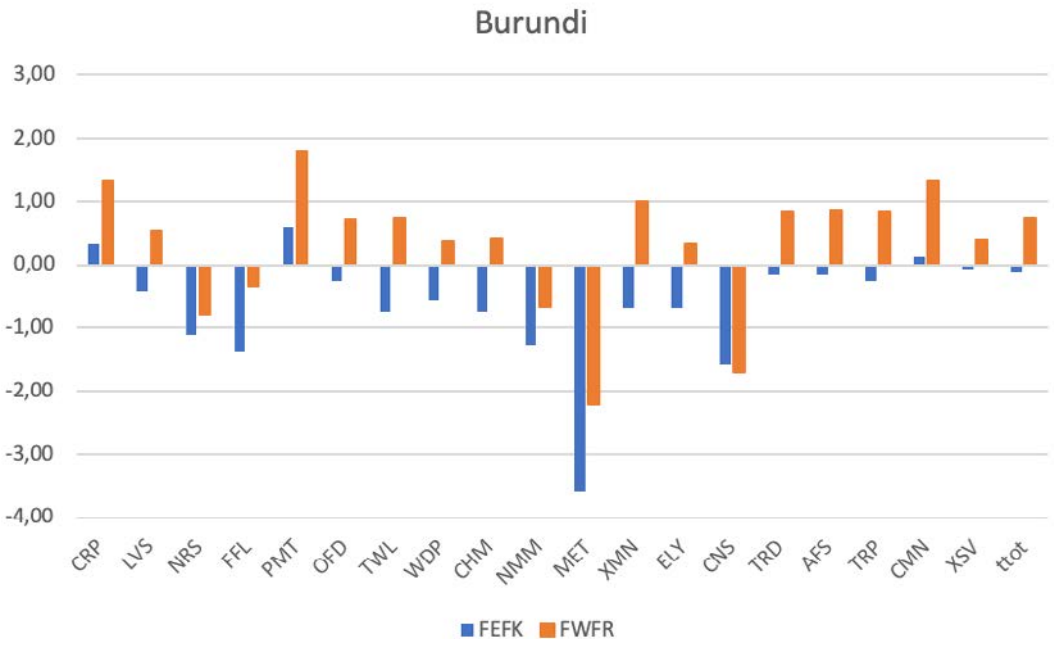
Burundi
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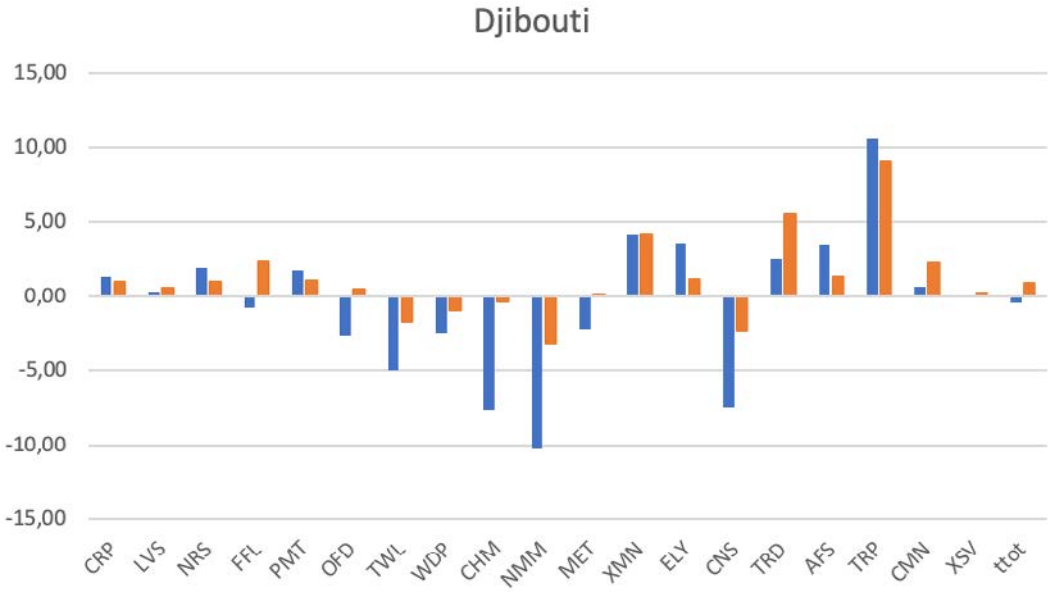
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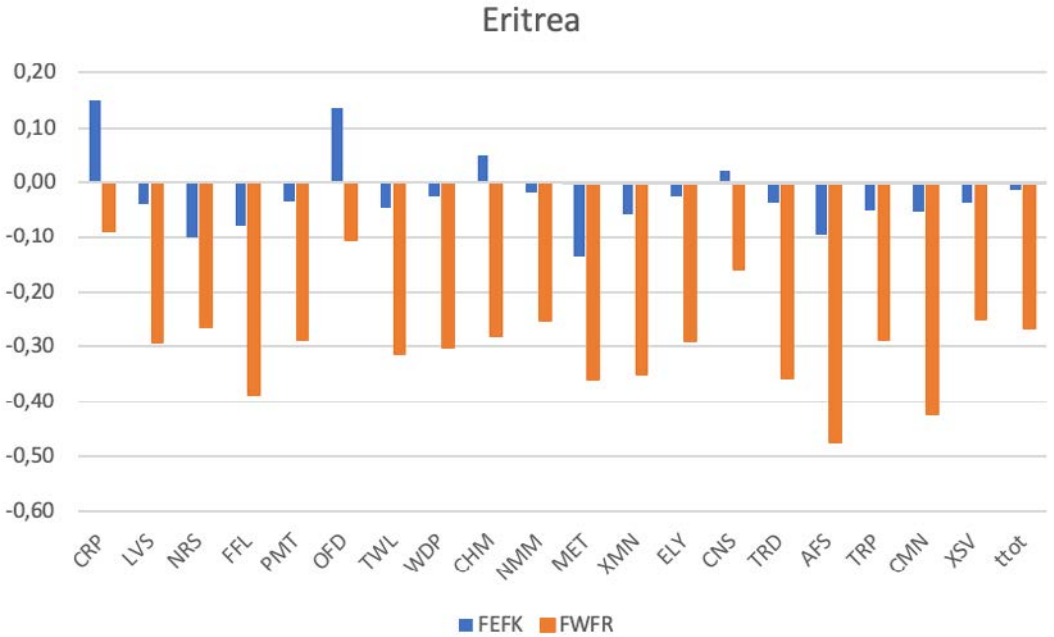
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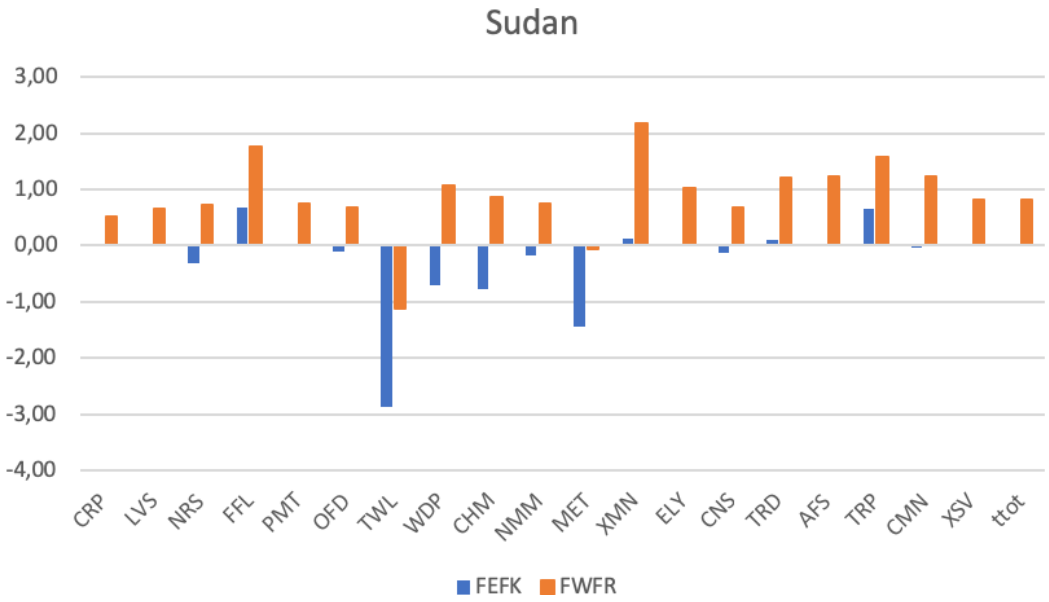

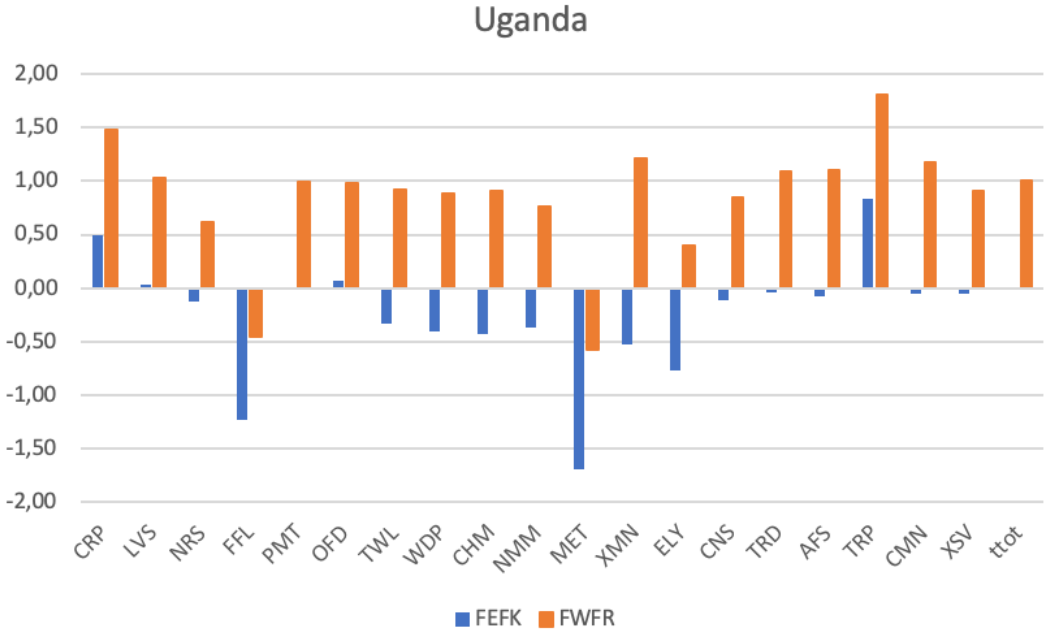

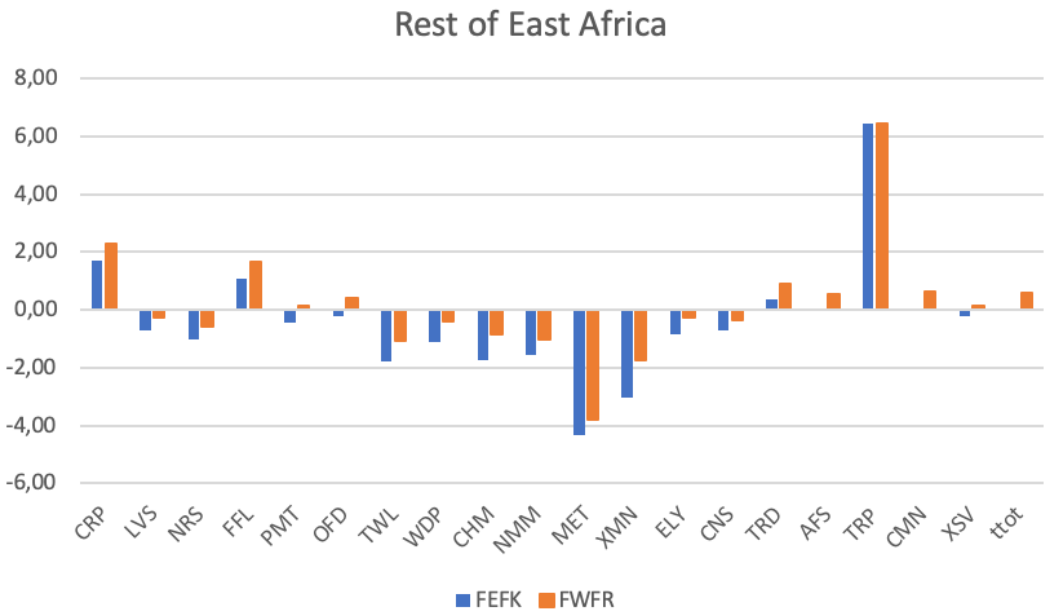

Figures 9(a-i). WFP spending stimulates production in both directly and indirectly affected sectors in the unconstrained-labor and capital case, but impacts are mixed in the constrained case.

e. Impacts on Prices and Other Indicators

WFP spending affects GDP, production and employment through its direct and indirect impacts on prices and wages for unskilled and skilled workers. Figures 10-12, respectively, compare these price and wage impacts under the FWFR and FEFK closure conditions. Under FWFR, wages do not change, and inflationary impacts of WFP spending are muted. Because of this, more of the impacts of WFP spending are in the form of real income and production gains. The blue bars in the figures reflect a limited availability of labor and capital to support production expansion. Under the restrictive FEFK scenario, inflationary impacts are much larger, and more of the effect of WFP spending is inflationary instead of expansionary.

It is clear from these figures that price and wage inflation depend critically on whether or not labor and capital are in excess supply. For example, in the unconstrained case (FWFR), the $18 million in WFP spending in Burundi has a minimal effect on the CPI. Nominal wages do not change much, due to the assumption that workers are readily available at prevailing wages, given unemployment and/or an elastic labor-force participation response. In contrast, if the labor and capital are not available to fuel expansion in production output, the Burundi CPI rises by 0.77%, and nominal wages for unskilled labor increase by 0.91%. A similar pattern of inflationary impacts under FEFK is evident in most of the other countries. Higher prices and wages explain the negative production effects in Figures 4 and 9(a)-(j) and the small or negative real income and employment effects shown in Figures 5 and 6.

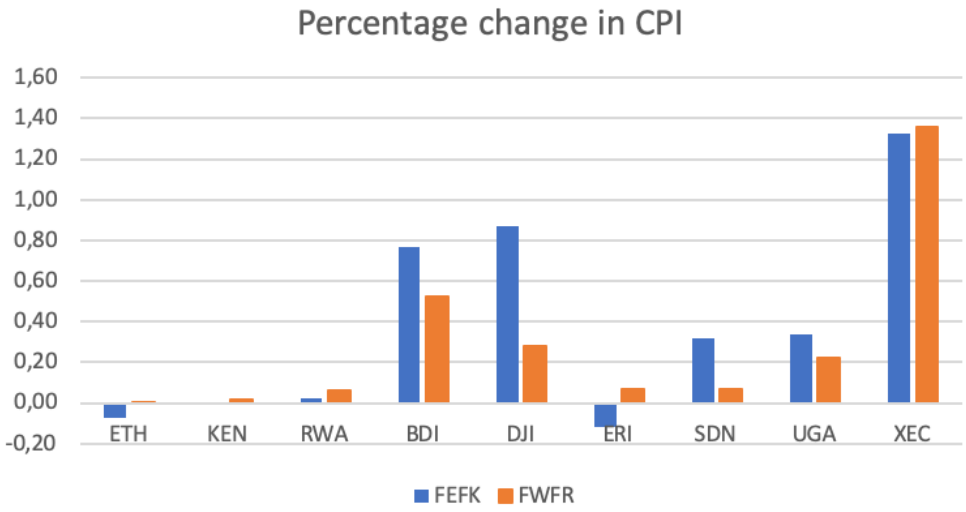

Figure 10. Impacts of WFP spending on the consumer price index (CPI) under the pessimistic (blue) and optimistic (orange) scenarios.

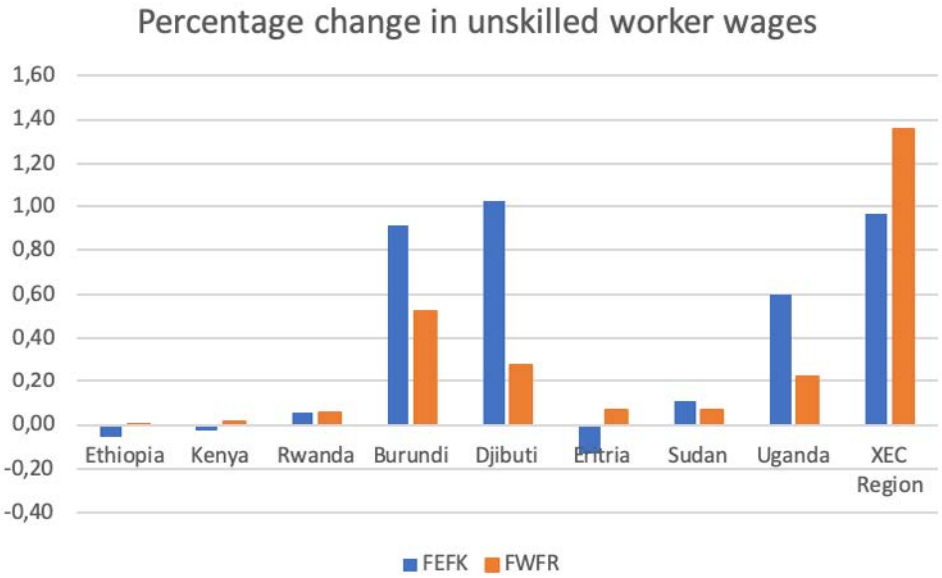

Figure 11. Impacts of WFP spending on wages for unskilled workers under the pessimistic (blue) and optimistic (orange) scenarios.

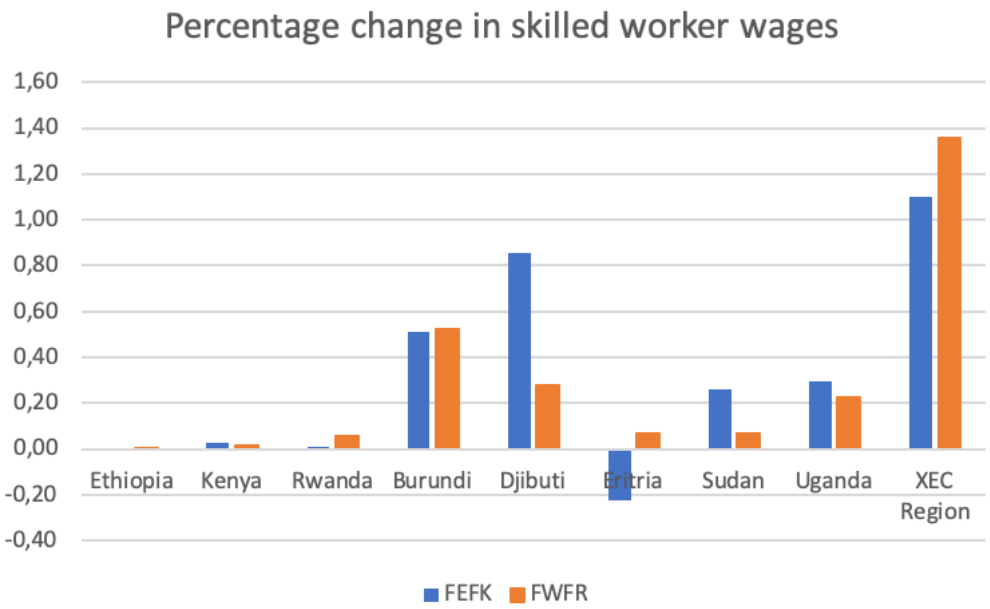

Figure 12. Impacts of WFP spending on wages for skilled workers under the pessimistic (blue) and optimistic (orange) scenarios.

8. Conclusions

Taken together these findings suggest that, provided labor and capital are available, WFP spending can have a large impact on production and GDP in most cases. WFP expenditures are small compared with the size of whole country economies in East Africa. Nevertheless, each dollar spent by the RBN, according to our simulations, increases real income (GDP) by as much as $3.68 and total production by as much as $6.47. WFP spending creates 365,606 jobs for unskilled workers and 20,047 jobs for skilled workers across East Africa. Employment, like production and GDP impacts, vary considerably across countries.

Impacts of WFP spending depend critically on the structure of the economy, however. For example, our preliminary simulations show small negative impacts on production if labor and capital are not available. In an economy without excess capacity and unemployed workers, WFP spending on goods and services from some production sectors can crowd out production in other sectors, rather than contributing to real income and production growth in the economy. Highly import-dependent countries get fewer benefits from WFP spending, as trade shifts impacts to exporting countries.

Appendix A.

EXCEL Template to Record Information on Food Vendors to WFP's RBN

Order/id	Vendor	Country	Food Item	RBN Purchase from Vendor	Value of this Item Vendor Purchased for this Order in...									Total for all items
					Ethiopia	Kenya	Rwanda	Uganda	Burundi	Djibouti	Eritrea	So. Sudan	Somalia	
1	AFRICA IM	Rwanda	Beans		?	?	?							22776226
			Corn Soya Blend											
			Iodised Salt											
			Maize											
			Maize Meal											
			Rice											
			Sorghum/ Millet											
			Vegetable Oil											
			LNS											
			UHT Milk											
2	APONYE U	Uganda	Beans											9601675
			Corn Soya Blend											
			Iodised Salt											
			Maize											
			Maize Meal											
			Rice											
			Sorghum/ Millet											
			Vegetable Oil											
			LNS											
			UHT Milk											
4	CEREALS A	?	Beans											9338480
			Corn Soya Blend											
			Iodised Salt											
			Maize											
			Maize Meal											
			Rice											
			Sorghum/ Millet											
			Vegetable Oil											
			LNS											
			UHT Milk											

Appendix B.

Excel Template to Record Information on Non-food Expenditures by WFP's RBN

Non-food Item	Corresponding GTAP Sector	Supplying Country									
		Ethiopia	Kenya	Rwanda	Uganda	Burundi	Djibouti	Eritrea	So. Sudan	Somalia	Non-RBN
Fuel, Oil & Lubricant	Manufacture of chemicals and chemical products										
Office/Admin Equipment & Services	Manufacture of computer, electronic and optical products (40,ele,26)										
ICT Equipment & Services	Computer programming, consultancy and related activities (56,cmn,62)										
Permanent & Temporary Infrastructure	Specialized construction activities (49,cns,43)										
Premises Rent & Utilities	Real estate activities (59,rsa,68)										
Air, Land & Sea Vehicles (Incl. Parts)	Wholesale and retail trade and repair of motor vehicles and motorcycles (50,trd,45)										
Transport Air/Ocean/Landside	Land transport and transport via pipelines (52,otp,49), Water transport (53,wtp,50) and Air transport (54,atp,51)										
Consultancy Services	Professional, scientific and technical activities and Administrative and support service activities (60,obs,M,N)										
UN Joint & Statutory	?										
Safety & Security	Other service activities (61,ros,R,S,T)										
Logistics Handling & Storage	Warehousing and support activities for transportation (55,whs,52)										
Inspection, Insurance	Insurance, reinsurance and pension funding, except compulsory social security; 58, ins, 65										
Cash & Voucher	?										
Medical/Health Equipment	Manufacture of computer, electronic and optical products (40,ele,26)										
Other	?										

Appendix C.

WFP Food Expenditure Processing

We further processed the food expenditure data to allocate $130 million in food expenditures that WFP bought from various East African countries, but for which the final country of destination is not specified—i.e., food sent to WFP zones (GCMF-FPF East Africa zone and GCMF-FPF Global zone or GCMF-small holder farmers). Table C1 shows that roughly 70% of these expenditures were sourced from Kenya, Tanzania and Uganda. On the commodity side, Maize, LNS and Corn Soya blend respectively accounted for 53%, 35% and 25% share of food expenditures going into WFP zones.

Table C1: WFP expenditure allocated to zones ($million, by source country)

	Source						
Commodity	**KEN**	**ETH**	**RWA**	**TZA**	**UGA**	**SSD**	**Total**
Beans	-	-	-	6.9	3.7	-	**10.6**
Corn Soya blend	2.4	-	22.8	-	-	-	**25.1**
LNS	26.3	5.7	-	-	27.2	-	**32.0**
Maize	0.0	5.9	-	19.9	-	-	**53.0**
Sorghum millet	0.2	-	-	5.8	0.4	1.5	**7.9**
Vegetable oil	1.1	-	-	-	-	-	**1.1**
Total	**30.0**	**11.6**	**22.8**	**32.6**	**31.4**	**1.5**	**129.8**

To allocate these zone-destined expenditures, we first calculated the commodity-specific expenditure share ($EAFDshr_{c,d}$) of each East African destination country in the full WFP food expenditure data (where: *c* - commodity; *s* – East African *source* country; *d* – East African *destination* country).

$$EAFDshr_{c,d} = \sum_{s} \frac{EAFD_{c,s,d}}{\sum_{s';d} EAFD_{c,s';d'}} \quad (1)$$

Where:

$EAFDshr_{c,d}$: Food commodity-specific share for each East African destination country

$EAFDshr_{c,s,d}$: WFP food expenditure from East African source and destination country

The calculated shares, presented in Table C2, shows that a majority of beans purchased by WFP are sent to Tanzania (49%) and Burundi (40%). Kenya accounted for roughly 80% of Corn Soya blend, while much of LNS, Sorghum, Maize, milk and vegetable oil are destined for Rwanda (80%), South Sudan (93%), Tanzania (94%), Burundi (93%) and Somalia (96%).

Table C2: Commodity-Specific Expenditure share for each East African destination country

	KEN	ETH	RWA	TZA	UGA	BDI	SOM	SSD	Total
Beans	8.5	-	1.5	48.9	-	40.0	1.0	-	**100.0**
Corn Soya blend	79.9	-	-	4.7	-	-	15.3	-	**100.0**
LNS	-	-	80.1	-	19.9	-	-	-	**100.0**
Maize	0.2	-	0.8	94.3	-	-	-	0.05	**100.0**
Sorghum millet	0.4	1.6	-	-	4.7	-	0.3	0.93	**100.0**
Vegetable oil	4.4	-	-	-	-	-	95.6	-	**100.0**

We then allocated all food expenditures in WFP zones ($EAFDinZone_{c,s,d}$) by using the calculated commodity-specific expenditure share ($EAFDshr_{c,d}$) for each East African destination country and a zone factor ($ZoneFac_c$)—the latter ranges between 0 and 1 thereby determining the amount of food expenditures to be reallocated from the zone.

$$EAFDZone_{c,s,d} = EAFDshr_{c,d} * (ZoneFac_c * EAFDinZone_{c,s}) \quad (2)$$

$$EAFDinZone_{c,s} = EAFDnZone_{c,s} * (1-ZoneFac_c) \quad (3)$$

Finally, the reallocated food expenditure from the zone are added to initial WFP food expenditure for each East African source and destination pair.

$$EAFood_{c,s,d} = EAFood_{c,s,d} + EAFDZone_{c,s,d} \quad (4)$$

Tables C3 to C7 shows the impact on WFP expenditure for each East African country after allocating all zone-destined food expenditures, depending on the assumed reallocation factor. WFP expenditures increase significantly in Tanzania, Uganda and Kenya (between 82 and 128%) followed by modest increases in Ethiopia and Rwanda (between 7% and 23%). WFP expenditures for Rest of East Africa fall by between 18 and 25% due to our default assumption that any zone-destined expenditures are allocated to this composite region.

Table C3: WFP expenditure in Kenya ($million)

Zone food (% reallocated)				
	Default (No allocation)	**75%**	**50%**	**25%**
Crops	9.5	30.1	29.6	29.0
Food	5.8	14.3	14.3	14.3
Others	18.6	18.6	18.6	18.6
Total	**33.9**	**63.0**	**62.4**	**61.8**

Table C4: WFP expenditure in Ethiopia ($million)

Zone food (% reallocated)				
	Default (No allocation)	**75%**	**50%**	**25%**
Crops	0.0	4.4	2.9	1.5
Food	0.9	5.2	3.7	2.3
Others	37.4	37.4	37.4	37.4
Total	**38.3**	**46.9**	**44.1**	**41.2**

Table C5: WFP expenditure in Rwanda ($million)

Zone food (% reallocated)				
	Default (No allocation)	**75%**	**50%**	**25%**
Crops	1.2	1.4	1.4	1.4
Food	0.1	0.1	0.1	0.1
Others	2.3	2.3	2.3	2.3
Total	**3.6**	**3.9**	**3.9**	**3.9**

Table C6: WFP expenditure in Uganda ($million)

Zone food (% reallocated)				
	Default (No allocation)	**75%**	**50%**	**25%**
Crops	4.3	27.5	19.7	12.0
Food	5.3	5.7	5.6	5.5
Others	9.3	9.3	9.3	9.3
Total	**18.9**	**42.5**	**34.6**	**26.8**

Table C6: WFP expenditure in Tanzania ($million)

Zone food (% reallocated)				
	Default (No allocation)	**75%**	**50%**	**25%**
Crops	15.5	38.8	38.8	38.8
Food	1.1	5.5	4.0	2.6
Others	5.0	5.0	5.0	5.0
Total	**21.6**	**49.2**	**47.8**	**46.4**

Table C7: WFP expenditure in Rest of East Africa ($million)

Zone food (% reallocated)				
	Default (No allocation)	**75%**	**50%**	**25%**
Crops	116.5	44.8	54.6	64.3
Food	130.4	112.8	115.8	118.8
Others	108.3	108.3	108.3	108.3
Total	**355.2**	**265.9**	**278.6**	**291.4**

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