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General equilibrium models of different food procurement modalities

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Contents

Figures

Tables

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Acronyms

SFVs	school feeding vouchers
CBT	cash-based transfer
CFAF	Communauté financière d'Afrique (African Financial Community) franc
CI	confidence interval
CMNESF	cash-based component of the Ministry of Education SFP
FAO	Food and Agriculture Organization of the United Nations
HGSF	home-grown school feeding
KES	Kenyan shilling
LEWIE	local economy-wide impact evaluation
SF	school feeding
SFP	school feeding programme
TFP	total factor productivity
WFP	World Food Programme

Introduction

The Government of Senegal's current school feeding programme (SFP) provides support to schools in the form of food, cash or vouchers. The primary goal of the programme is to improve children's nutrition and health, school attendance and capacity to learn. However, the programme also potentially creates benefits for the local economies in areas around participating schools and for the rest of Senegal by stimulating local production activities and raising household incomes. Understanding these economic benefits is an essential part of any cost-benefit analysis of the SFP, critical not only for evaluating the SFP's full impact, but also for designing measures that increase the benefits the programme can create for local populations.

This project uses local economy-wide impact evaluation (LEWIE) to perform a simulation analysis of different food procurement modalities employed by Senegal's current SFP. The LEWIE methodology was designed to capture both the direct and the indirect impacts of a wide range of government programmes and policies in local economies. It has been used for a variety of purposes, including estimating the impacts of the United Nations World Food Programme (WFP) food assistance for refugees on host country households and businesses surrounding refugee camps (Taylor *et al.*, 2016), the impacts of poverty programmes in several African countries (Taylor, Thome and Filipski, 2016) and in a fishing community in the Philippines (Gilliland, Sanchirico and Taylor, 2019), and the impacts of technological change on a cotton-producing region in the United Republic of Tanzania (Gupta *et al.*, 2018). A similar methodology was used recently in a WFP project to examine the local-economy impacts of Kenya's home-grown school meals programme (Taylor *et al.*, 2019).

This final report provides a summary of the main characteristics of the SFP in Senegal and the different food procurement modalities; a brief description of the econometric model used in the context of SFPs, which can be seen as a combination of social protection interventions (school feeding) and agricultural interventions (food procurement); and a set of simulations that calculate the income and production multipliers of the programme under the various food procurement modalities.

The Senegal school feeding programme and the main goals of the local economy-wide impact evaluation

In the last decade, governments have invested increasingly in linking SFPs to the local food supply, supporting farmers and small-scale value chain actors by reducing the uncertainties and transaction costs that hamper access to local demand (markets), and providing school meal menus with diverse food groups in accordance with nutritional requirements and dietary recommendations.

Linking schools' demand for safe, diverse and nutritious food with local production entails prioritizing supply from smallholder farmers at the local and national levels. This approach has the potential to increase the benefits of school feeding initiatives through improved food security and nutrition for the direct beneficiaries who receive and consume the food and indirect benefits for food producers and other actors in the food value chain.

The Government of Senegal SFP operates through the following three modalities.

1. Distribution of food to schools through an in-kind home-grown school feeding (HGSF) programme: The government's school feeding intervention was initially launched by the School Canteens Division, established in 2009. The implementation model was based primarily on mobilizing resources from central government to the regional academic inspectorates and inspectorates for education and training, which were responsible for procuring and distributing food to high schools and elementary schools, respectively. The funding from the government is solely for the purchase of food for schools, but the regulations are not clear about from whom the food should be purchased. Owing to the national law on decentralizing public administration, the implementation model of the SFP has also been decentralized, and includes an active and central role for local communities. While resources are transferred directly to schools from central and regional governments, local school management committees are responsible for managing those resources, coordinating, and deciding menus and procurement plans once schools receive the money (Swensson, 2019).

2. Provision of cash-based food assistance from the Ministry of Education through a cash-based school feeding (CMNES) programme: To enhance the school performance and nutrition outcomes of school feeding, the Ministry of Education also provided cash-based transfers (CBTs) in the form of value vouchers in conjunction with the World Food Programme (WFP). This programme was launched in November 2014, and scaled up to all the schools assisted by WFP in nine regions of Senegal. The CBT food vouchers are delivered through the School Canteens Division and inspectorates for education and training. Schools can redeem their vouchers at retailers for the purchase food from eligible food products approved by school management committees, while retailers receive refunds for the vouchers from a financial institution in partnership with WFP (Bichard *et al.*, 2018).

3. Provision of vouchers from WFP for the purchase of food from local businesses through the school feeding vouchers' (SFVs) programme. In the early stages of the programme, WFP initiatives were based primarily on imported food. In 2012/13, owing mainly to implementation of the Purchase from Africans for Africa programme, which seeks to promote local food purchasing in Africa, WFP changed its implementation model and started to use local food products. WFP initiatives in Senegal now cover 820 schools and benefit approximately 160 000 students in vulnerable areas (Swensson, 2019).

In all three of these modalities, schools can provide meals using foods produced within or outside the local economy. By sourcing food items locally, the programme can stimulate local production and income growth, while the sourcing of food outside the local economy shifts the benefits to other parts of the country.

The impacts on local economies are likely to vary across the three modalities: under modality 1, local impacts depend critically on where the government sources food for the programme; under modality 2, the impacts depend on where beneficiary schools spend their cash; and under modality 3, schools source food from local shops, keeping some benefits within the local economy, although the impacts depend critically on where local businesses source the food that they sell to schools.

The effects of local sourcing, in turn, depend on the local food supply response. If farmers expand production to meet new food demand (i.e., the food supply response is elastic), the programme can create large real income multipliers, as incomes rise for farmers and their input suppliers (including hired workers), and households spend their income on locally supplied goods and services, creating additional rounds of impacts. If the local food response is inelastic, however, higher demand for food could put upward pressure on food prices. In short, the SFP's impacts on local economies are likely to be complex and to vary across modalities.

It is widely acknowledged that SFPs contribute effectively to school attendance, and the nutrition and food security of schoolchildren (Kristjansson *et al.*, 2007; Jomaa, McDonnell and Probart, 2011; Drake *et al.*, 2017; Wang and Fawzi, 2020). However, despite the expansion of SFPs, studies of the programmes' impact on local food security and nutrition, household incomes and the overall local economy remain limited. Verguet *et al.* (2020) is one of the only studies that examines this kind of impact by adopting an economic evaluation methodology to estimate the costs and benefits of SFPs in four sectors: health and nutrition, education, social protection and the local agricultural economy. New research is therefore needed to fill evidence gaps with regard to these impacts.

Under its Strategic Objectives 4 (enabling inclusive and efficient agrifood systems) and 3 (reducing rural poverty), FAO has focused on building evidence and understanding among policymakers with regard to the broad range of impacts that social protection can have on productive and economic activities in the communities where it is implemented. FAO has sought to demonstrate with rigorous evidence that social protection can be an effective measure for combating hunger, reducing poverty and fostering rural development. So far, FAO has undertaken a full impact evaluation of HSGF programmes in Zambia (Prifti, Daidone and Grinspun, 2021) and has a similar project ongoing in Ethiopia.

The goals of the current project are twofold: first to determine how the SFP in its current form affects local economies and trade with other parts of Senegal, including food production and linked activities (transport, storage, grain cleaning and sorting, demand for pesticides), non-food production activities, and household incomes; and the second is to document the differential impacts of the three modalities used to provide food for school meals. At the time of this study, the HGSF pilot programme was under way but was not yet being implemented at scale, and was severely disrupted by the COVID-19 pandemic. As a result, this study uses information from the initial beneficiaries of the pilot programme and the local economies in which they participate to build the Senegal HSGF local economy-wide impact evaluation (LEWIE) model and run simulations of the programme's likely impacts.

The findings suggest that SFPs in Senegal have significant positive impacts on production and incomes within a 10-km radius of beneficiary schools. These impacts grow as SFPs increase their sourcing from local traders and food producers.

Potential impacts of the school feeding programme on local economies

When the SFP provides locally produced food to beneficiary schools or when schools spend their cash or vouchers on local food purchases, the demand for food from local producers and/or traders increases. The local food supply response determines whether there is a real impact on local food production, food trade with outside markets and/or price inflation. If local farmers respond by increasing their production to meet the new food demand, or traders bring in food from other regions, local food prices may be relatively unaffected by the programme, but there could be a potentially large impact on local production and/or trade. If the local food supply (from local producers or traders) is unresponsive or inelastic, food prices may increase as the demand for food of schools and households rises.

If local food production and trade increase, the incomes of traders and food producers could rise, and the incomes of workers and others who supply food producers and traders with inputs also could increase. Increases in local income translate into increases in demand for food and non-food goods and services. As the demand for these goods and services rises, businesses may expand, and new businesses may open up. This could result in lower prices and increased supply of both food and non-food items for local businesses and consumers. In this way, non-farm businesses and households benefit from the programme, creating additional rounds of income and demand increases. The sum of these impacts, divided by the programme's costs and adjusted for price inflation, is the local real income multiplier of each dollar spent on the SFP.

If traders source food and non-food goods and services from other parts of Senegal or abroad, the programme's impacts shift away from the local economy. When food is sourced from other regions, local households and businesses lose the chance to benefit from the programme. Similarly, if local businesses and households spend their income on goods and services supplied from other regions, potential income multipliers shift out of the local economy. The leakage of income out of the local economy represents a loss to local households and businesses but a gain for households and businesses in other regions.

EVALUATING THE SFP'S FULL IMPACT ON PRODUCTION AND INCOMES

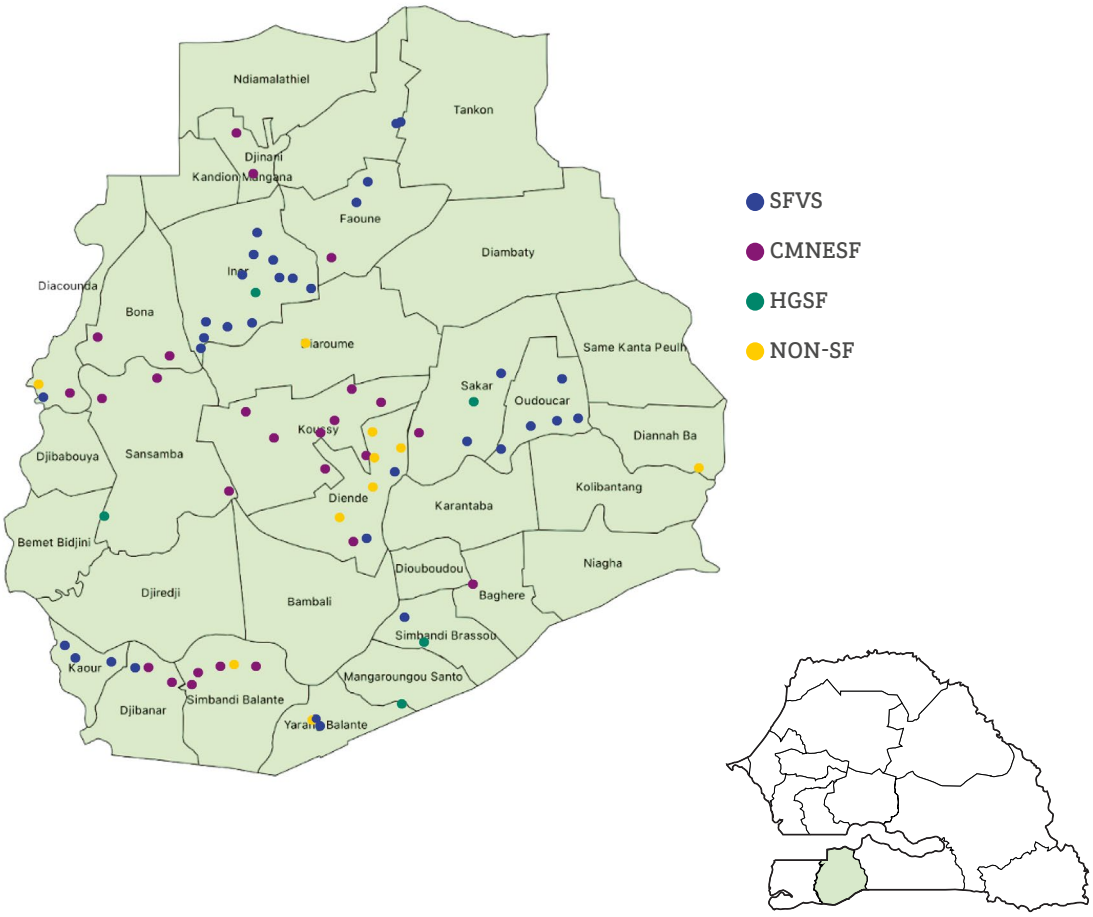
Quantifying the impacts of Senegal's SFP on local economies requires a modelling approach that captures the indirect effects on production, incomes and prices. This study employs the LEWIE methodology to analyse the economic impacts of Senegal's SFP and compare these impacts across the various programme designs. The LEWIE methodology was designed to quantify the full impact of government interventions and other outside influences on local, regional and national economies, including the indirect impacts on businesses and households. It has been used to evaluate local economy impacts of HGSF programmes in Kenya and to answer a variety of other questions, including the economic impacts of refugees and WFP refugee assistance around three refugee camps in Rwanda, the impacts of poverty programmes in African and Asian countries, and the local economy-wide impacts of tourism (for examples of LEWIE studies see **https://idragroup.org**).

LEWIE is a simulation method that integrates micromodels of individual actors (schools, traders, farmers, other producers and households) into a short-run static general equilibrium model of the local, regional or national economy.[1] Microdata gathered through surveys are used to calibrate the models. The present study utilizes data collected in a survey conducted in Senegal in 2019–2020 under the "Policy support for government-led home grown school food initiatives" project. This database includes a surveys of households, schools and non-agricultural businesses in Sedhiou region, including Sedhiou, Bounkiling and Goudomp departments. Figure 1 shows the region and the locations of the schools surveyed by type of SFP implemented. In total, 83 school interviews, 2 246 household interviews and 891 enterprise survey interviews were conducted. During data processing and cleaning, duplicate interviews were dropped from the dataset and interviews outside a 10-km radius of the beneficiary schools were identified and deleted (Dadch & Co., 2020).

Estimation of the micromodels follows a rich literature on micro agricultural household modelling (Singh, Squire and Strauss, 1986; Taylor and Adelman, 2003). The micromodels include estimates of how the SFP schools spend their cash, how farms and businesses supply food to the SFP schools, how farm and non-farm businesses demand inputs and use them to produce food and other goods and services, and how various household groups spend their incomes.

[1] As the data are annual, most LEWIE results can be considered short-run annual impacts. Many aspects of the local economy can change as a result of the SFP and other factors, which can alter the parameters of the model. On the other hand, if the structure of the local economy does not change significantly, the LEWIE results can be representative of a longer time horizon.

FIGURE 1. **MAP OF SÉDHIOU REGION AND SCHOOLS BY TYPE OF SCHOOL FEEDING PROGRAMME**



Notes: SFVs - School food vouchers; CMNESF - households in catchment areas of schools receiving cash assistance from the National Ministry of Education's school feeding programme; HGSF - home-grown school feeding; non-SF - no school feeding programme at time of survey.

Source: Adapted from Map No. 4174 Rev. 4 UNITED NATIONS, November 2020.

This study used data from the school survey to build the schools component of the SFP LEWIE model, which involved estimating the share of programme funds that schools allocate to each food item obtained locally or from other parts of Senegal.

Data on businesses from the household and non-agricultural business surveys were used to estimate production functions relating to inputs and outputs in retail and other non-agricultural production activities. Data from the household survey were the basis for estimating production functions for crop activities. Inclusion of crop activities is necessary in order to model how the demand of schools and households for food affects output and input demand for crops. Household expenditure data were used to estimate production functions for crops, livestock products, retail purchases and other locally produced non-agricultural goods. They were also used to estimate the expenditure functions of households (Table 1).

TABLE 1. **SUMMARY OF SURVEYS AND DATA USED**

Survey	Type of data	Use
Household	Expenditure and production	Estimation of separate production functions for crops, livestock products, retail purchases and other locally produced non-agricultural goods. Estimation of expenditure functions for the different household groups.
Business	Expenditure and production	Estimation of separate production functions for retail and non-retail businesses. Combined with the household survey business section in order to enable more precise and representative estimates.
School	Expenditure	Estimation of school expenditures by programme group, including local and non-local crop, meat, retail and non-retail expenditures.

Source: Authors' own elaboration.

Once a micromodel is constructed from the survey data for each economic actor (household groups and schools), the study used well-established literature on general equilibrium modelling to integrate or "nest" the micromodels within a general equilibrium model of the local economy, as explained in Taylor and Filipski (2014). This step involves imposing market-clearing conditions, which determine the prices for locally supplied non-tradable goods and services, or – for tradable goods and services – net trade with the rest of the country at the prices set in regional, national or international markets.

The completed Senegal SFP LEWIE model was used to carry out simulations for assessing the impacts of the SFP through its three modalities, while considering production and income spillovers. The following simulations were used:

- The impact of giving cash to schools. In this simulation, schools spend cash – as revealed in the school survey data – on food items from local and/or non-local sources, and the model is used to estimate the resulting income and production spillovers in the local economy.
- The impact of providing schools with vouchers to purchase food from local businesses. This is simulated by increasing the demand for food from local businesses.
- The impact of giving food to schools. This is simulated by increasing the demand for locally supplied food by an amount equal to the amount procured from local sources by the SFP. If the programme does not procure any food from local sources, the impact on the local economy is nil; all impacts will be found outside the local economy.

Descriptive statistics and model parameter estimates

This section presents summary statistics on selected variables from the survey data. Its purpose is to give a sense of the characteristics of the surveyed households and how they might or might not vary between eligible and ineligible households and from one school catchment area to another. The numbers in Table 2 are the sample means of the variable for each of the household groups. The following are the household groups:

- SFVs: Households in SFP districts located within a 10-km radius (the catchment area) from schools that benefit from the voucher scheme allowing them to buy from local shops, from other parts of the country or abroad (food purchased in local shops may be produced locally or elsewhere).
- CMNESF: Households in the catchment areas of schools receiving cash assistance from the National Ministry of Education's SFP.
- HGSF: Households in the catchment area of schools that will benefit from the Purchase from Africans for Africa extension project.
- Non-SF: Households in villages that do not have access to SFP schools.
- Treatment group: All households in the SFVs, CMNESF or HGSF groups (but not the non-SF households).

Table 2 shows that, on average, households had more than eight members, with little difference among household groups, and similar numbers of male and female members. About eight out of ten households in the sample were female-headed, and the average age of the household head was slightly more than 50 years. Average school attainment of household heads was about six years of schooling completed, slightly higher in non-SF (6.43 years) than treatment (5.95 years) households. The survey data reveal little difference in the dependency ratio across household groups (with 1.42 to 1.46 elderly

or child members per household member of working age). While treatment households had higher total education expenditure and savings, the non-SF group spent a noticeably more on food and non-food consumption. In terms of household production, the treatment group had a significantly higher value of crops harvested, which may largely account for its higher average household savings and investments in education. By contrast, the non-SF group worked on livestock production for an average of 71 days per year, and hence had a relatively greater value of livestock production. In addition, while the HGSF group received the highest average remittance (CFAF 31 058), the non-SF households accepted the largest amount of social assistance (CFAF 68 627).

TABLE 2. **SUMMARY STATISTICS FROM HOUSEHOLD SURVEY (SAMPLE MEANS)**

Variable	SFVs	CMNESF	HGSF	Non-SF	Treatment
Expenditures					
Education	78 220	64 728	69 699	68 928	70 767
Food (total)	722 940	732 770	699 176	739 607	716 796
Crops	202 896	179 173	169 658	195 790	182 745
Livestock	79 443	103 058	87 971	79 400	90 019
Retail	401 217	419 661	432 215	407 339	418 875
Non-food from retail	227 421	226 478	230 773	245 839	228 427
Non-food non-local	27 605	37 577	24 206	31 152	29 362
Non-food local	54 575	53 819	54 031	72 516	54 132
Non-food from services	55 975	79 374	45 513	68 860	59 136
Total non-food	365 575	397 248	354 523	418 366	371 057
Total livestock value	101 745	143 036	78 058	134 589	108 896
Demographics					
Members in the household	8.3	8.72	8.07	8.54	8.34
Females in the household	4.25	4.37	4.04	4.26	4.2
Males in the household	4.14	4.43	4.07	4.41	4.2
Female head	0.82	0.83	0.81	0.82	0.82
Age of household head	53.13	52.57	51.81	52.32	52.45
Years of education of household head	5.6	6.29	5.9	6.43	5.95
Dependency ratio	1.45	1.47	1.47	1.42	1.46
Household members <= 17 years old	0.1	0.08	0.07	0.06	0.08
Household members >= 60 years old	3.82	3.95	3.72	4.11	3.82
No child in the household	0.51	0.59	0.56	0.48	0.55

Variable	SFVs	CMNESF	HGSF	Non-SF	Treatment
Household members with disabilities	0.57	0.67	0.8	0.37	0.69
Adults in the household	4.81	5.07	4.6	4.93	4.81
Days worked in agriculture	160.65	166.74	155.35	167.75	160.48
Days worked in livestock	58	55.06	43.72	71.91	51.57
Household savings	204 914	7 891	10 160	9 494	68 875
Remittances	22 557	30 599	31 058	25 268	28 432
Social assistance	53 762	59 447	64 237	68 627	59 499
Transfers (in)	11 816	8 424	9 959	11 964	9 977
Transfers (out)	13 353	13 185	21 787	11 393	16 417
Observations	511	516	648	339	1 675

Legend: SFVs - school feeding vouchers; CMNESF - households in catchment areas of schools receiving cash assistance from the National Ministry of Education's school feeding programme; HGSF - home-grown school feeding; non-SF - no school feeding programme at time of survey.

Notes: Owing to data constraints, "dependant" here refers to a person who is under 17 or over 60 years of age, which is slightly different from the definition of the International Labour Organization. The unit of currency is the CFAF (*Communauté financière d'Afrique* or African Financial Community franc).

Source: Authors' own elaboration.

In order to test whether these differences are significant econometric methods that control for all of the variables in Table 2 are required. Table 3 presents the results of a linear probability model and probit regressions of a 0–1 indicator of access to SFP s on the variables. The table shows that there is considerable overall distinction between the two groups, based on the F (for the linear probability model) and Chi-squared (x^2, for probit) statistics which examine whether the characteristics of eligible and ineligible households are jointly the same. Both the F and x^2 statistics are larger than the critical values for significance at the 0.01 level, implying substantial difference between treatment and non-SF household groups. The estimators for variables related to livestock production are particularly significant in both regressions, suggesting that household groups with access to SF are likely to rely more on revenue from livestock to purchase food items while working fewer days on livestock production. Such households also tend to spend less on non-food items. Other than these variables, however, few of the variables are significant predictors of treatment or non-SF group. The only exception is the number of disabled household members (households in the treatment group are likely to have more disabled members). Therefore, the source of the difference between the two groups is likely to be attributed to distinction in livestock production, to a large extent.

TABLE 3. **DIFFERENCES BETWEEN TREATMENT AND NON-SF GROUPS**

	(1)	(2)
Variables	**Ordinary least square**	**Probit**
Members in the household	-0.007	-0.026
	(0.005)	(0.021)
Females in the household	0.005	0.019
	(0.007)	(0.027)
Female-headed household	0.009	0.048
	(0.026)	(0.105)
Age of household head	1.10e−04	2.63e−04
	(6.77e−04)	(0.003)
Number of adults in the household	0.002	0.010
	(0.007)	(0.027)
Dependency ratio	0.007	0.030
	(0.009)	(0.036)
Disabled household members	0.018***	0.104***
	(0.006)	(0.032)
Total education expenditure	1.52e−09	-1.47e−08
	(9.44e−08)	(3.79e−07)
Food expenditure from crops	-1.60e−08	-5.92e−08
	(2.60e−08)	(9.77e−08)
Food expenditure from livestock	9.24e−08**	4.11e−07*
	(4.70e−08)	(2.12e−07)
Food expenditure from retail	7.12e−09	2.61e−08
	(1.80e−08)	(7.18e−08)
Household savings	1.96e−09	1.99e−08
	(3.73e−09)	(7.10e−08)
Days worked in agriculture	4.63e−05	2.37e−04
	(1.44 e−04)	(0.001)
Days worked in livestock	-3.24e−04***	-0.001***
	(9.90e−05)	(3.85 e−04)
Non-food expenditure from retail	-4.19e−08	-1.61e−07
	(3.29e−08)	(1.25e−07)
Non-food expenditure from outside the local economy	-8.61e−09	-3.99e−08
	(7.93e−08)	(3.14e−07)
Non-food expenditure from production	-3.35e−07***	-1.25e−06***
	(9.22e−08)	(3.71e−07)

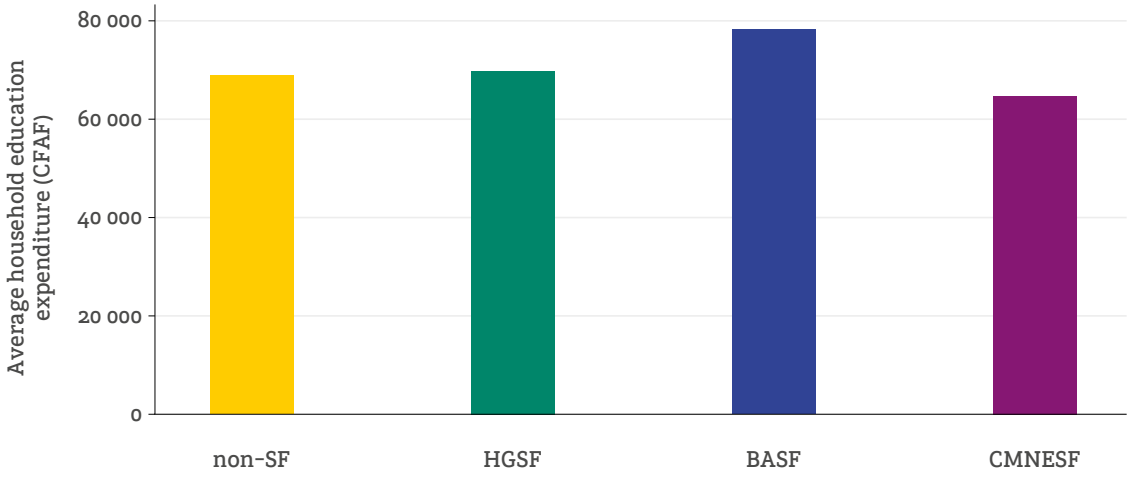
Variables	(1) Ordinary least square	(2) Probit
Non-food expenditure from services	-3.01e−08	-1.17e−07
	(4.69e−08)	(1.85e−07)
Constant	0.855***	1.028***
	(0.042)	(0.174)
Observations	1 867	1 867
Log likelihood	-788.272	-821.663
R^2	0.024	
Test statistic (F for OLS, x^2 for probit)	2.50	44.96
Critical value for p = 0.10 (0.05) (0.01)	1.44 (1.60) (1.93)	25.989 (28.869) (34.805)

Note: Standard errors in parentheses: * p < 0.1; ** p < 0.05; *** p < 0.01.

Source: Authors' own elaboration.

Figures 2 and 3 show average expenditures on education in the four types of catchment area. Average total household expenditure on education range from CFAF 60 000 to CFAF 80 000 and are highest in the SFVs group, lowest in the CMNESF group, and very similar in the HGSF and non-SF groups.

FIGURE 2. **MEANS OF EDUCATION EXPENDITURE, BY HOUSEHOLD GROUP**

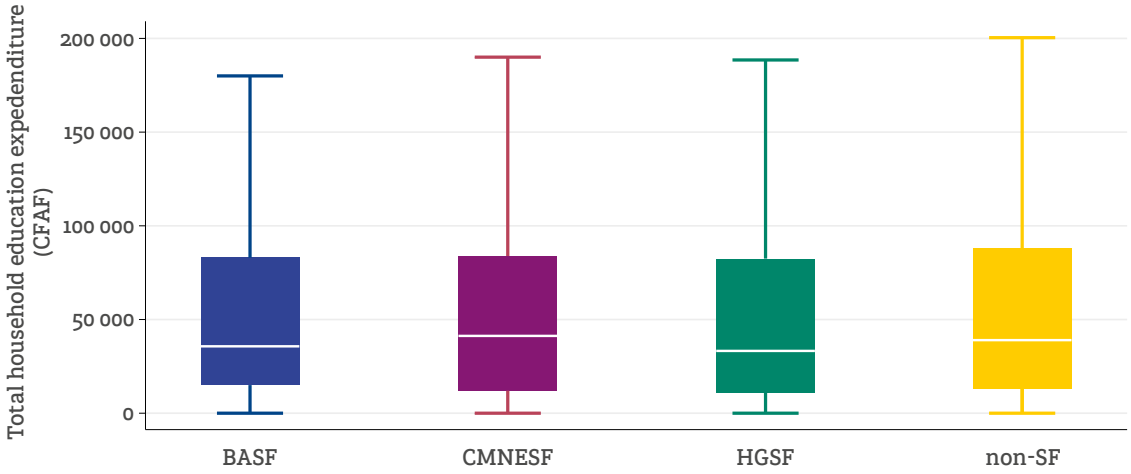


Notes: SFVs - school feeding vouchers; CMNESF - households in catchment areas of schools receiving cash assistance from the National Ministry of Education's school feeding programme; HGSF - home-grown school feeding; non-SF - no school feeding programme at time of survey.

Source: Authors' own elaboration.

Figure 3 shows the average household education expenditures in the four catchment areas, with their 95 percent confidence intervals (the boxes) and ranges (bars) after excluding outliers. A comparison of Figure 2 with the corresponding in Table 1 shows the influence of outliers. Table 1 showed that average education expenditure is highest in the SFVs households. However, adjusting for outliers shows that the result was due largely to outliers with large education expenditures. Figure 3 shows that CMNESF and non-SF households have the largest education expenditures of the four groups.

FIGURE 3. **TOTAL EDUCATION EXPENDITURE, BY HOUSEHOLD GROUP (EXCLUDING OUTLIERS)**

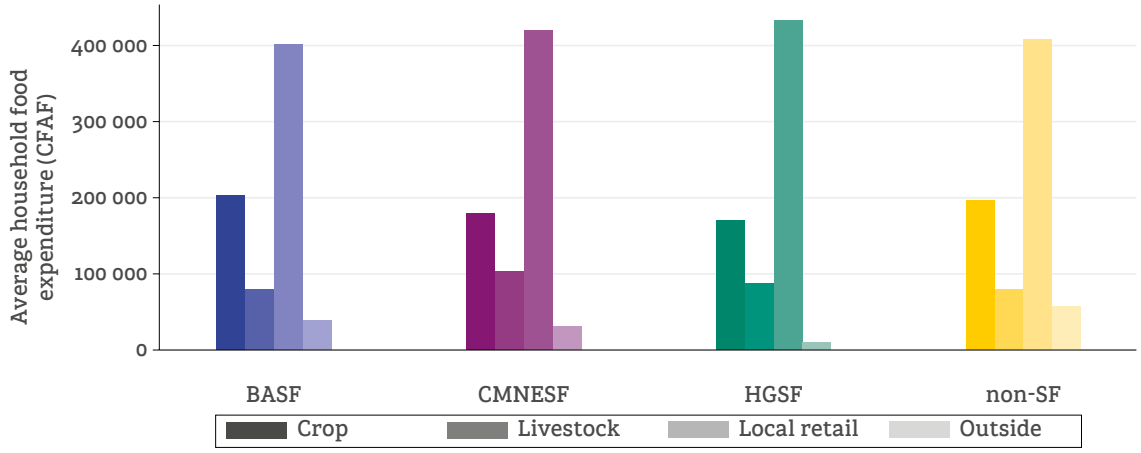


Notes: SFVs - school feeding vouchers; CMNESF - households in catchment areas of schools receiving cash assistance from the National Ministry of Education's school feeding programme; HGSF - home-grown school feeding; non-SF - no school feeding programme at time of survey.

Source: Authors' own elaboration.

Figures 4 and 5 give breakdowns of food and non-food expenditures by source. The sources of the food expenditure are relatively homogeneous across groups (Figure 4), while local retail establishments play a particularly dominant role in supplying households with both food and non-food items, regardless of location. Following local retail is crop production, which accounts for around CFAF 20 000 of expenditure in each group. In contrast, food expenditure from livestock production and "other sources" is relatively minor. Local retail accounts for approximately half of the non-food expenditure for all groups (Figure 5). The magnitude of non-food expenditures from production and services is very similar across groups, except that CMNESF group has higher expenditure from services.

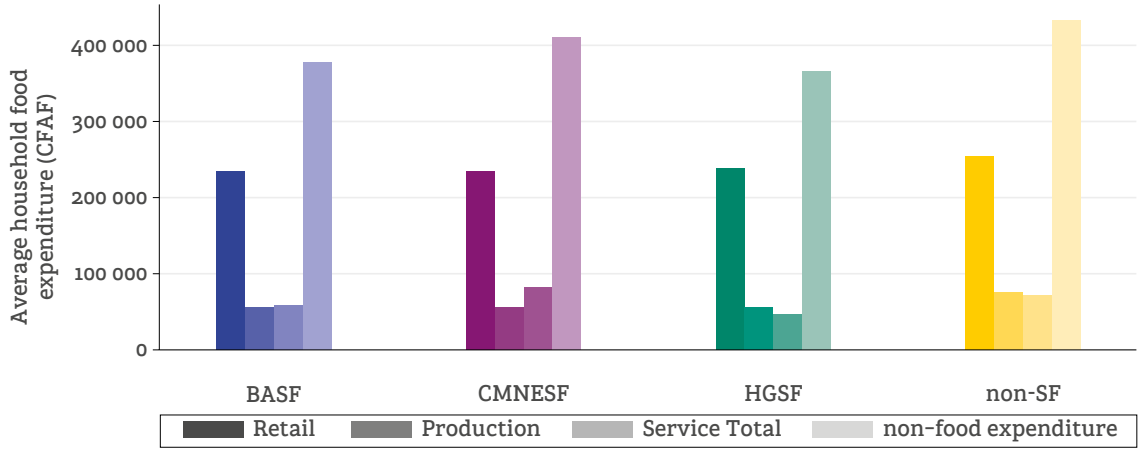
FIGURE 4. **MEANS OF FOOD EXPENDITURE, BY HOUSEHOLD GROUP**



Notes: SFVs - school feeding vouchers; CMNESF - households in catchment areas of schools receiving cash assistance from the National Ministry of Education's school feeding programme; HGSF - home-grown school feeding; non-SF - no school feeding programme at time of survey.

Source: Authors' own elaboration.

FIGURE 5. **MEANS OF NON-FOOD EXPENDITURE, BY HOUSEHOLD GROUP**



Notes: SFVs - school feeding vouchers; CMNESF - households in catchment areas of schools receiving cash assistance from the National Ministry of Education's school feeding programme; HGSF - home-grown school feeding; non-SF - no school feeding programme at time of survey.

Source: Authors' own elaboration.

The Senegal school feeding local economy-wide impact evaluation model and parameters

This section describes the Senegal SF LEWIE model and reports on the key model parameters that were estimated from the surveys of schools, households and local businesses.

THE LEWIE MODEL

The model for the Senegal SF LEWIE analysis builds on the model constructed to analyse the impacts of Kenya's HGSF (Taylor *et al.*, 2019). It expands the basic LEWIE methodology described in Taylor and Filipski (2014) to quantify the likely impacts of the various types of SFPs in Senegal. LEWIE combines micromodels of individual actors (schools, traders and other local businesses, farmers, and households) in a general equilibrium model of the local economy, defined here as the 10-km catchment area around each school. Data from the school, business and household surveys were used to construct microeconomic models of households, farmers and businesses around the schools "treated" by a type of SFP. The construction of these models draws from a rich tradition of microeconomic modelling of agricultural households (Singh, Squire and Strauss, 1986; Taylor and Adelman, 2003). The micromodels capture the ways in which funds are spent on food for schools in type of SFP programme; how traders and other businesses supply food to schools (or, in the case of the HGSF programme, how programme administrators spend programme funds); how farmers and other businesses use labour, capital and other inputs to produce food and other goods and services; and how households spend their incomes.

Combining the micromodels into a general equilibrium model of the local economy includes setting market clearing conditions that determine local prices. Prices play a crucial role in transmitting impacts among households, businesses and other economic actors in a LEWIE model. The Senegal SF LEWIE model has three key groups of actors: the schools and (in the case of HGSF) programme administrators who use programme funds to buy food; the traders and other businesses that supply food and other items to schools, businesses and households; and the households situated within the catchment area of each school in the SFP. An SF LEWIE model was constructed for each type of SFP

and the completed models were used to simulate the local-economy impacts of each programme, as described in the following section.

SCHOOL EXPENDITURES

Table 4 summarizes schools' expenditure on the SFP. The numbers were compiled from the school surveys and do not necessarily reflect the schools' use of the funds they receive from the three types of SFP. For example, the SFVs programme requires all vouchers to be used for purchasing from businesses. The spending of HGSF funds depends on where the particular HGSF programme procures food for schools, for which there are two scenarios: the HGSF funds given to local traders cover the procurement of cereals from local farms; or the funds given to local traders cover the procurement from local farms of cereals, vegetables, fruits and half the value of the nuts, pulses and unfortified vegetable oil used. The next section explains how the numbers in Table 4 are used in simulations of SFP impacts.

The first row of the table indicates that schools under the SFVs modality reported the highest total expenditure on school feeding, while HGSF schools spent the least.[2] Schools under all three modalities reported making the largest share of their SF purchases from local retail, including traders, reflecting the importance of the retail sector in the local economy. Schools currently covered by SFVs reported spending 54 percent of their SF funds in local retail establishments, 23 percent on local services, and 24 percent outside the local economy or catchment area. CMNESF programme schools spent less (34 percent) in local retailers and more (47 percent) outside the local economy. Schools covered by the HGSF programme reported spending 40 percent in local retail establishments, 34 percent on local services, and almost nothing outside the local catchment area. However, the figures for HGSF schools cover a very small sample of only five schools.

TABLE 4. **SCHOOL EXPENDITURES ON SFPS (SCHOOL SURVEY) (CFAF)**

Variable	SFVs	CMNESF	HGSF[a]	HGSF[b]
	Mean	Mean	Mean	Mean
Total Expenditures				
local cereal crops[a]	-	-	240 000	240 000
local other crops[b]	-	-	-	210 000
retail goods	1 425 778	806 560	933 600	723 600
services	609 000	443 739	606 000	606 000
outside local economy	629 199	1 123 388	9 600	9 600
Total on school feeding	2 663 977	2 373 687	1 789 200	1 789 200

[2] When school expenditures are broken down further, the expenditure of SFVs schools ranks top with regard to every item.

Variable	SFVs	CMNESF	HGSF[a]	HGSF[b]
	Mean	Mean	Mean	Mean
Expenditure shares				
Local cereal crops[a]	-	-	0.13	0.13
Local other crops[b]	-	-	-	0.12
Local retail	0.54	0.34	0.52	0.40
Local services (cooks, staff, etc.)	0.23	0.19	0.34	0.34
Outside the local economy	0.24	0.47	0.01	0.01
Observations	**32**	**23**	**5**	**5**

Legend: SFVs - school feeding vouchers; CMNESF - households in catchment areas of schools receiving cash assistance from the National Ministry of Education's school feeding programme; HGSF - home-grown school feeding; non-SF - no school feeding programme at time of survey.

Notes:
[a] Assumes that cereals purchased from local traders come from local farms.
[b] Assumes that cereals, fruits and vegetables purchased from local traders come from local farms, and that half the value of locally produced of nuts, pulses, and unfortified vegetable oil used comes from local farms.

Source: Authors' own elaboration.

PRODUCTION ACTIVITIES

Tables 5, 6 and 7 report on parameters in the production functions for local agricultural, livestock and non-farm production activities. They were estimated econometrically using data from the household and business surveys. The estimated parameters for a given factor can be used in several ways: as the exponent in the Cobb-Douglas production function, the factor's share in total value-added from the activity, and the elasticity of activity output with respect to the factor (the percentage change in predicted output associated with a 1 percent increase in the factor's use). The numbers in parentheses are the t-statistics associated with each parameter estimate. A t-statistic greater than 1.65 (1.96) (2.58) indicates that the estimated parameter is different from zero at the 0.10 (0.05) (0.01) significance level. With only a couple of exceptions, all of the estimates are highly significant, reflecting that there is a considerable degree of precision in these estimates. Separate production function estimates for crop and livestock activities (Tables 5 and 6) are available by catchment area, While sample size considerations made it necessary to pool estimates for non-farm production functions (Table 7).

Local crop production is labour-intensive, especially in family labour, whose share in crop value-added ranges from 0.45 (HGSF) to 0.76 (CMNESF). Hired labour is less important, with shares ranging from 0.07 (CMNESF) to 0.12 (SFVs). In the LEWIE modelling of SFP impacts, these numbers are important for two reasons: first because labour is a variable input that, unlike land and capital, households can change easily in response to changes in input and output prices (caused by, for example, changes in school demand for local foods; And second because large labour shares indicate that changes in production translate into large payments to labour, which become part of household incomes that, in turn, are spent on goods and services, contributing to local income multipliers.

TABLE 5. PARAMETERS IN LOCAL CROP PRODUCTION FUNCTIONS (HOUSEHOLD SURVEY)

Factors	Non-SF	HGSF	SFVs	CMNESF
Amount of land owned (acres)	0.210***	0.379***	0.036	0.096
	(4.06)	(6.44)	(0.50)	(1.15)
Family labour (days)	0.580***	0.455***	0.641***	0.760***
	(9.98)	(5.45)	(7.20)	(7.68)
Hired labour (CFAF)	0.082**	0.113	0.124*	0.072
	(3.10)	(1.92)	(2.40)	(1.85)
Purchased inputs (CFAF)	0.056**	0.131***	0.113**	0.075**
	(2.34)	(4.91)	(3.00)	(2.99)
Value of crop assets (CFAF)	0.071**	-0.077*	0.086***	-0.002
	(3.25)	(-2.20)	(3.58)	(-0.13)
Constant	7.874***	7.912***	7.198***	7.021***
	(22.47)	(16.78)	(13.57)	(15.80)
Observations	**183**	**328**	**290**	**292**

Notes: t statistics in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. 1 acre = 0.405 ha. SFVs - school feeding vouchers; CMNESF - households in catchment areas of schools receiving cash assistance from the National Ministry of Education's school feeding programme; HGSF - home-grown school feeding; non-SF - no school feeding programme at time of survey.

Source: Authors' own elaboration.

Table 6 shows factor input shares in livestock production, which are much smaller for labour. Family labour shares in livestock value-added range from only 0.39 (SFVs) to 0.11 (non-SF). Hired labour parameters are higher, ranging from 0.12 (non-SF) to 0.27 (SFVs). This indicates that changes in livestock production have impacts on the households that supply wage labour for this activity. The parameters for land, herd value and other inputs are generally higher than for family labour. Land and herd value cannot change easily, especially in the short run, in response to local market shocks, including new food demand from SFPs. Other inputs can be changed, but most are purchased outside the local economy and thus do not contribute in an important way to local income multipliers.

TABLE 6. PARAMETERS IN LOCAL LIVESTOCK PRODUCTION FUNCTIONS (HOUSEHOLD SURVEY)

Factor n	Non-SF	HGSF	SFVs	CMNESF
Land (acres owned)	0.276***	0.290***	0.167	0.315***
	(5.27)	(5.02)	(1.88)	(4.36)
Family labour (hours)	0.110***	0.078*	0.039	0.066
	(3.39)	(2.15)	(1.00)	(1.83)
Hired labour (CFAF)	0.125**	0.264***	0.270**	0.188***
	(2.81)	(4.81)	(3.01)	(4.48)
Inputs (purchased and Owned) (CFAF)	0.254***	0.236***	0.356***	0.086
	(5.09)	(5.07)	(6.13)	(5.94)
Herd (CFAF)	0.234***	0.132***	0.167***	0.345
	(7.64)	(3.91)	(3.65)	(1.27)
Constant	7.844***	9.043***	9.097***	6.829***
	(16.43)	(28.79)	(23.72)	(10.14)
Observations	**192**	**245**	**262**	**270**

Notes: t statistics in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. 1 acre = 0.405 ha. SFVs - school feeding vouchers; CMNESF - households in catchment areas of schools receiving cash assistance from the National Ministry of Education's school feeding programme; HGSF - home-grown school feeding; non-SF - no school feeding programme at time of survey.

Source: Authors' own elaboration.

Similar to crops, retail and service activities are intensive in family labour, with factor shares of about 0.58. (in Table 7 services include a small number of other non-farm production activities such as food processing.) They also employ wage workers; hired labour shares are 0.13 in retail and 0.20 in services. Much of the stock of items that local retail shops sell comes from outside the local economy, and purchases of them do not contribute to local income multipliers. The large labour shares in Table 7 reveal that most of the value-added created by the mark-up, or difference between sale and purchase prices of merchandise, goes to local labour, with part of it covering operating expenses. Logically, value-added is positively related to the value of business assets, including the stock on the shelves. The asset shares in value-added of about 0.60 are consistent with profit margins of about 6 percent.

TABLE 7. **PARAMETERS IN NON-FARM PRODUCTION FUNCTIONS (HOUSEHOLD AND BUSINESS SURVEYS)**

Factor	Retail	Services/ other
Family labour (hours)	0.577***	0.576***
	(10.39)	(8.89)
Hired labour (hours)	0.131**	0.199***
	(2.62)	(4.07)
Operating expenses (CFA)	0.233***	0.160**
	(6.59)	(3.01)
Value of business assets (CFA)	0.058**	0.065*
	(3.22)	(2.00)
Constant	6.144***	6.719***
	(14.27)	(12.84)
Observations	**599**	**316**

Notes: t statistics in parentheses. *$p < 0.05$, **$p < 0.01$, ***p.

Source: Authors' own elaboration.

HOUSEHOLD EXPENDITURES

Household expenditure is crucial in transforming income changes into changes in demand for goods and services within and outside the local economy. The expenditure data from the household survey were used to econometrically estimate marginal budget shares, or the changes in predicted household expenditures resulting from a change of CFAF 1 in household income.[3] Table 8 reports these budget shares, together with the t-statistics associated with them.

The first row of the table shows that households spend between CFAF 0.08 and CFAF 0.17 of each additional CFAF 1 of income on locally produced crops. These marginal budget shares on locally produced foods are all statistically significant at well below p=0.01. They indicate that, as local household incomes go up, there is a significant impact on the demand for locally produced crops.

[3] These expenditure functions were estimated from seemingly unrelated regressions using total expenditures and the various expenditure sources.

Household expenditure shares on local livestock and livestock products are smaller (0.05 to 0.12) but statistically significant, nonetheless. Taken together, these findings imply that a CFAF 1 increase in household income results in an increase in demand for local agricultural (crop plus livestock) goods equal to CFAF 0.16–0.27. These agricultural linkages can create important positive feedback effects from income changes in local crop production.

The largest marginal budget shares are for retail goods: between CFAF 0.49 and CFAF 0.66 of a CFAF 1 change in household income goes to purchase goods from local retail businesses. These goods may include locally produced food sold by local shops, but they mainly represent household demand for non-food items typically found on the shelves of village shops, from cooking oil to soap. A high retail share is an almost universal finding from household expenditure surveys. Households spend about CFAF 0.10 of an additional CFAF 1 of income on local services. Between CFAF 0.03 and CFAF 0.08 is used on the purchases that households make outside the local catchment area. Smaller shares go to savings and transfers (cash or in-kind) to other households. Households may also receive transfers from other households, but the table shows that in most cases transfers from other households decrease as a household's income rises. The transfer results shown at the bottom of the table are for the most part not statistically significant.

TABLE 8. **ESTIMATED HOUSEHOLD MARGINAL BUDGET SHARES** (HOUSEHOLD SURVEY) (CFAF)

Expenditure type	Non-SF	HGSF	SFVs	CMNESF
Food expenditures from crops (own production or gifts)	0.173***	0.119***	0.154***	0.079***
	(8.38)	(7.47)	(8.49)	(5.01)
Food expenditures from livestock or livestock by-products (own production or gifts)	0.049***	0.070***	0.117***	0.076***
	(6.26)	(7.60)	(11.78)	(7.72)
Total expenditures on local retail	0.515***	0.655***	0.493***	0.655***
	(19.51)	(34.94)	(21.88)	(28.27)
Non-food expenditures on local services	0.137***	0.122***	0.124***	0.091***
	(13.1)	(15.49)	(12.58)	(9.32)
Total expenditures on outside goods and services	0.066***	0.031***	0.083***	0.056***
	(5.54)	(5.41)	(9.09)	(6.08)
Household savings in the last 12 months	0.010***	0.005*	0.014***	0.002
	(3.70)	(2.52)	(6.87)	(1.14)

Expenditure type	Non-SF	HGSF	SFVs	CMNESF
Local transfers to the household (cash and in-kind)	-2.82e−04	2.71e−04	-9.52e−05	-6.34e−04
	(-0.45)	(0.52)	(-0.15)	(-1.22)
Local transfers out of the household (cash and in-kind)	6.11e−04	2.24e−03*	1.30e−04	5.01e−05
	(1.03)	(2.41)	(0.20)	(0.08)
Observations	**338**	**645**	**510**	**515**

Legend: SFVs - school feeding vouchers; CMNESF - households in catchment areas of schools receiving cash assistance from the National Ministry of Education's school feeding programme; HGSF - home-grown school feeding; non-SF - no school feeding programme at time of survey.

Notes: t statistics in parentheses. $*p < 0.05$, $**p < 0.01$, $***p$.

Source: Authors' own elaboration.

School feeding local economy-wide impact evaluation simulations

The completed school feeding LEWIE models were used to simulate the local-economy impacts of each of the three types of SFP, obtaining the local income and production multipliers of each. An income multiplier is defined as the change in local income that results from a CFAF 1 change in spending on an SFP. A production multiplier is the change in a production activity's output resulting from a CFAF 1 change in SFP spending.

SIMULATION DESIGN

This section describes how each of the simulations was implemented. Specific transfers are not known, such as the yearly CFAF amount for the CMNESF or the SFVs programme, or the amounts for the HGSF pilot and the other modules. Because of this, the model is used to simulate a 1 percent increase in each SFP, which is a reasonable way of deriving multiplier effects per CFAF transferred under the various SFPs. It is unlikely that the multipliers reported in the following would be appreciably different if actual values were simulated.

SFVs: Schools receiving support under this programme redeem their vouchers at retail businesses located within or outside the catchment area – specifically, traders who have indicated that they supply food to schools. Voucher purchases are allocated between local and outside traders in the proportions reported by the schools that purchase food for SFPs, as shown in Table 4. The schools reported purchasing 54 percent of the food for the programme from local traders and 24 percent from outside traders. Thus, the share redeemed with local traders was calculated as 0.54/(0.54 + 0.24) = 0.69. The remainder, 0.31, is allocated outside the local economy. The share that schools reported spending on services were omitted from this calculation because of the requirement that vouchers be redeemed in retail businesses.

CMNESF: Under the cash-based programme, schools spend their SF funds in the same way as they reported spending funds for SFPs in the survey. The share used to purchase food from local traders is 0.40, the share spent on local services (including cooks, staff, etc.) is 0.17, and the outside share is 0.43 (see Table 4).

HGSF: Under HGSF, programme administrators rather than schools purchase food for schools. The share of HGSF funds currently spent on food produced by local farmers as opposed to local traders is not known, which is important because the local traders surveyed purchase only a small fraction of their food from local farmers (6–15 percent). However, the goal of HGSF is to purchase as much food as possible from local farmers. In light of the uncertainty about HGSF purchases from local farmers, the SF LEWIE model was used to simulate two scenarios:

- Scenario 1 assumes that the HGSF programme purchases all cereal crops (maize, rice and millet) from local farmers while other food is purchased outside the local economy. In this scenario, HGSF accounts for 13 percent of total food purchases by SFPs, which is considered the lower bound of the local share of HGSF programme food purchases.
- Scenario 2 explores the local-economy impacts if the HGSF programme is more successful than traders at sourcing food from local producers. It simulated the impact that would result if the HGSF programme purchased from local farms all the cereal, vegetables and fruits and 50 percent of the pulses, nuts and unfortified vegetable oil that it supplies to SFPs, and if it accounted for an average of 25 percent of total SF food expenditures. This is an ambitious target for three reasons: First because agriculture is more productive, and therefore more able to meet programme needs, in some catchment areas than others; second because farmers produce different foods in different localities, and if a food item desired by the programme is not locally available, it must be purchased from outside; and third because agricultural production tends to be seasonal, so even when a food item is produced locally, it is likely to be more available at certain times of year (around harvest time) than others.
- HGSF productivity simulations explore the impacts of raising the productivity of farms that supply food to schools. Specifically, they simulate the percentage impacts on incomes and production of increasing the total factor productivity (TFP) of farms supplying food to schools by 10 percent. An increase in TFP raises the productivity of all inputs used to produce crops for schools. An example might be the use of higher-yielding seed varieties.

SIMULATION RESULTS

Table 9 presents the multiplier effects of a CFAF 1 change in funding for cash and vouchers and two versions of the HGSF programme. The upper part of the table shows the nominal or cash income multipliers and the real income multipliers, which are adjusted for impacts on local prices of food and other items. Accounting for price effects is important, because inflation can result if local supplies are not perfectly responsive, or elastic, to changes in demand caused by the SFP's injection of new

funds into local economies. The lower part of Table 9 reports the multiplier effects on gross value of production, total and for each production sector. The numbers in parentheses are 95 percent confidence intervals (CIs) around the total income and total production multipliers. The CI was estimated by performing 500 iterations of the simulation while making repeated draws from all of the parameter distributions in the model, as described by Taylor and Filipski (2014).

The simulations show that each SFP has both direct and indirect effects on the local economy. The indirect effects can easily be calculated by subtracting one from the total income multipliers reported in the following. This is because the multipliers measure the total effects of each CFAF transferred to schools. Subtracting one (the CFAF transferred to schools) gives the part of the multiplier that arises indirectly through increasing local production activities. Although most sales are expected to occur through farmers' groups, and not directly from farmers, ultimately, farmers benefit by supplying food through their groups. As farmers increase their food production, they unleash multiple rounds of indirect impacts in the local economy.

The cash programme (CMNESF, first data column of Table 9) produces a total nominal income multiplier of 2.19, with a 95 percent CI of 1.92–2.74 This multiplier includes the CFAF 1 allocated to schools plus an additional CFAF 1.19 spill-over effect on local household incomes. The nominal income multiplier overstates the programme's actual welfare effects for households, because it does not consider inflation. The increased demand for food of schools, businesses and households, and for other goods and services of businesses and households, puts upward pressure on local prices. Because of this, the real income multiplier is lower than the nominal income multiplier, at 1.63 (CI of 1.5–1.94) and 2.19 respectively. The CIs for both the real and nominal income multipliers lie above 1.0, indicating that each CFAF 1 spent on the programme raises local incomes by significantly more than CFAF 1.

The CMNESF programme creates these income multipliers by stimulating production activities in the local economy. These include activities that supply food for the SFP (food traders, local farmers) and goods and services for households and other businesses, whose demand increase as the SFP contributes to local income growth. Although CFAF 0.47 of every CFAF 1 given to schools leaves the local economy, the remainder increases local demand, stimulating local production. Crop and livestock producers gain nearly CFAF 0.3 per CFAF 1 of programme expenditure. The largest production impacts are on retail (0.66) and trader (0.42) activities, which is not surprising given that schools buy food from traders, and (as shown in Table 7) households spend most of their income gains in local retail establishments. The total value of local production rises by CFAF 1.59 for every CFAF 1 spent on the programme (CI of 1.34–1.92).

The SFVs programme (second column of Table 9) has a somewhat larger multiplier effect because schools redeem more of their vouchers by purchasing food from local traders; only CFAF 0.31 of every CFAF 1 spent on this programme leaves the local economy via redemption in outside markets. The nominal and real income multipliers for this programme are 2.19 (CI of 1.99–2.47) and 1.93 (CI of 1.73–2.19), respectively. As in the cash programme, higher prices result in a real income multiplier that is lower than the nominal multiplier, although it is still significantly above 1.0. The multiplier effect on total production value is also higher – 2 compared with 1.59. The combined value of crop and livestock production is 0.36, compared with 0.29 under the cash programme. These findings demonstrate the local income and production gains that can be achieved with a voucher programme

that encourages schools to buy food from local traders. In practice, the SFVs multipliers could be even higher if schools redeem a larger percentage of their vouchers through local rather than outside traders.

TABLE 9. **MULTIPLIER EFFECTS OF SFPS ON LOCAL INCOMES AND PRODUCTION (CFAF)**

Multiplier	School feeding programme			
	CMNESF	SFVs	HGSF 13% local crops	HGSF 25% local crops
Nominal income	2.19	2.19	1.56	2.05
	(1.92–2.74)	(1.99–2.47)	(1.46–1.66)	(1.88–2.12)
Real income	1.63	1.93	1.45	1.87
	(1.5–1.94)	(1.73–2.19)	(1.36–2.15)	(1.71–2.03)
Total production	1.59	2.00	0.73	1.40
	(1.34–1.92)	(1.73–2.32)	(0.63–0.84)	(1.17–1.88)
Crops	0.24	0.39	0.14	0.27
Livestock	0.05	0.08	0.03	0.05
Retail	0.66	0.75	0.37	0.71
Traders	0.42	0.65	0.00	0.00
Services/production	0.22	0.13	0.06	0.12
Crops sold to schools	-	-	0.13	0.25

Source: Authors' own elaboration.

HGSF RESULTS

The last two columns of Table 9 report findings from the HGSF simulations. Like the other two programmes, the HGSF programme potentially generates local multiplier effects, but these effects depend critically on how much of the food the programme administrators source locally. If the programme procures locally produced cereals (13 percent of the crops sold to schools), the total nominal income multiplier is 1.56 (CI of 1.46–1.66) and the real multiplier is 1.45 (1.36–2.15). Both are significantly greater than 1.0, but they are much smaller than the CMNESF and SFVs multipliers. Total production value in the local economy increases by CFAF 0.73 for every CFAF 1 spent. If, on the other hand, the HGSF programme obtains cereal crops, fruits, vegetables and half of the value of the nuts, pulses and unfortified vegetable oil it uses from local producers, the nominal and real income multipliers jump to 2.05 and 1.87, respectively, which are comparable to the SFVs and CMNESF programmes. Total production value now increases by CFAF 1.4 per CFAF 1 spent on the programme, local crops, and crops sold to schools and livestock output rise by CFAF 0.57. These

two HGSF simulations demonstrate the important impact on local incomes and production that local sourcing of food for SFPs can have.

Table 10 shows the disaggregated results of the two HGSF simulations to highlight the spillovers to eligible and ineligible groups. It is based on the same simulations as Table 9 (the sum of effects across groups is identical to the corresponding multiplier in Table 9, for example, nominal income – 0.30 + 0.26 + 1.0 = 1.56). To obtain the disaggregated effects, data from eligible farmers in HGSF areas and ineligible farmers from across the region were used.[4] This procedure generates income multipliers by household type, and reveals large spillover effects.

Beneficiary households capture the majority of spillovers from either version of the HGSF programme. For example, the eligible group captures CFAF 0.25 in spillovers from each CFAF 1 transferred to schools under the HGSF 13 percent local purchase design, and the ineligible group captures CFAF 0.20. The same is true for total production effects, but not for most individual production activities. The impacts on crops sold to schools are large and positive for eligible households but nil for ineligible ones. On the other hand, spillovers in most other production activities favour ineligible households. This is particularly the case for retail activities, whose gross sales increase by CFAF 0.23 for ineligible households compared with CFAF 0.14 for eligible households under the 13 percent local purchase design, and by CFAF 0.45 and CFAF 0.26, respectively, under the 25 percent local purchase design. This finding is not surprising as the programme targets farmers who can produce food for schools and not households engaged in retail activities. As local incomes rise, households' expenditure on food increases. The resulting impact on crop production is slightly larger for ineligible households than for eligible households, which are more focused on providing food for schools. Spillovers to service production are larger for eligible households, but only slightly.

TABLE 10. **DISAGGREGATION OF HGSF PROGRAMME SPILLOVERS (CFAF)**

Multiplier	Eligibility	HGSF 13% local crops	HGSF 25% local crops
Income			
Nominal	Eligible	0.30	0.56
	Ineligible	0.26	0.49
	Schools	1.00	1.00
Real	Eligible	0.25	0.48
	Ineligible	0.20	0.39
	Schools	1.00	1.00

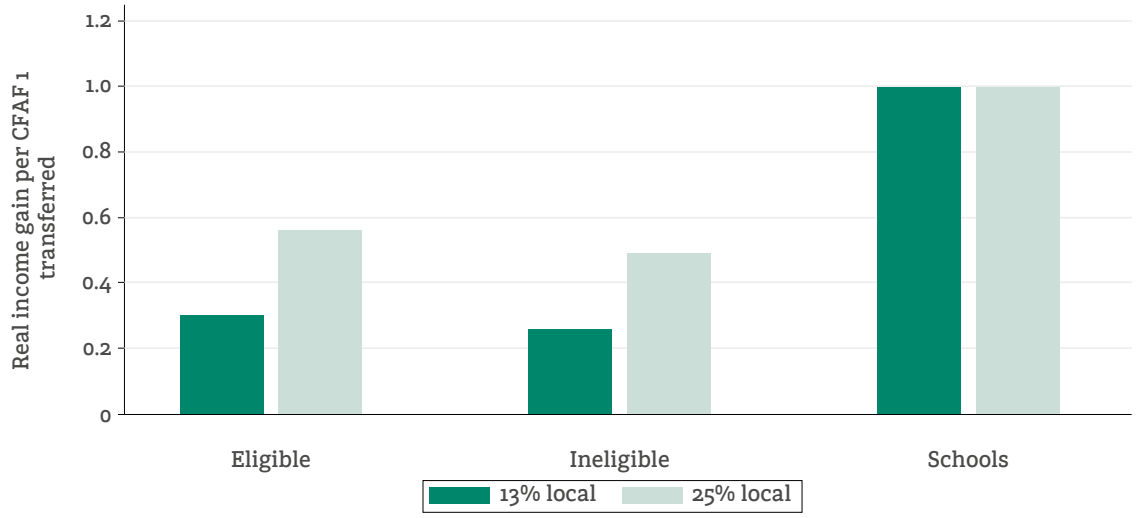
[4] Data from ineligible farmers across the whole region were used for increased precision in estimates of programme effects.

Multiplier	Eligibility	HGSF 13% local crops	HGSF 25% local crops
Production			
Total production	Eligible	0.38	0.72
	Ineligible	0.35	0.67
Crops	Eligible	0.06	0.12
	Ineligible	0.08	0.15
Livestock	Eligible	0.01	0.02
	Ineligible	0.01	0.03
Retail	Eligible	0.14	0.26
	Ineligible	0.23	0.45
Services/production	Eligible	0.04	0.07
	Ineligible	0.02	0.05
Crops sold to schools	Eligible	0.13	0.25
	Ineligible	0.00	0.00

Source: Authors' own elaboration.

Figure 6 illustrates the real income multiplier impacts of an additional CFA transferred to participating schools under each of the two HGSF programme designs. Participating schools receive the CFAF 1 of transfer regardless of how much of the food is sourced locally. The eligible household farms that are targeted by the programme benefit more when more food is sourced locally. Under each programme design, they benefit more than ineligible households, but ineligible households clearly benefit under both programme designs. Moreover, the benefits to ineligible households are only slightly smaller than the benefits to eligible households. This figure provides a striking illustration of the importance of spill-over effects in transmitting the impacts of the HGSF programme to both eligible and ineligible households in the local economy.

FIGURE 6. **MULTIPLIER EFFECTS OF HGSF PROGRAMMES, BY HOUSEHOLD GROUP**



Source: Authors' own elaboration.

IMPACTS OF INCREASING THE PRODUCTIVITY OF FARMERS WHO SUPPLY SCHOOLS

The SF LEWIE model was used to simulate the impacts of making farmers who supply food to schools more productive. Table 11 shows the impacts of a 10 percent increase in TFP for "crops sold to schools". The impacts reported in the table are percentage changes and should not be confused with the income multipliers presented in previous tables. The multiplier effects of making farmers more productive cannot be derived without knowing the cost of providing farmers with new technologies. Nevertheless, the percentage changes in Table 11 can be compared with the 10 percent TFP change to obtain the elasticities of incomes and production with respect to the productivity of farms selling crops to schools. For example, the total real income effect of making these farmers more productive, 8.59 percent, divided by the 10 percent productivity increase gives the percentage change in household real income that results from a 1 percent increase in productivity. In this case, 8.59/10 = 0.859, meaning that a 1 percent increase in productivity of farms supplying food to schools raises total income in the local economy by 0.859 percent. This is a large impact, particularly given that producing food for schools represents a relatively small share of total production in the economy. The CI in parentheses gives a 95 percent confidence bound of 0.402 to 1.380 around this elasticity.

The largest percentage impact on real (and nominal) income accrues to eligible households: their real income increases by 9.74 percent when farmers supplying food to schools become 10 percent more productive. Nevertheless, spillovers to ineligible households are only slightly smaller: the real incomes of ineligible households rise by 7.49 percent. This is evidence that income spillover effects are

substantial. The gross output of production activities also rises, particularly in retail (59.67 percent) and crops sold to schools (34.28 percent). Impacts on other production activities are smaller but still important, ranging from 1–2 percent for crops to nearly 6 percent for livestock activities.

TABLE 11. **IMPACTS OF INCREASED PRODUCTIVITY ON FARMS SUPPLYING FOOD TO SCHOOLS (PERCENTAGE CHANGES)**

	10% increase in TFP of crops sold to schools	
Income		
Nominal		11.16
		(6.71–17.16)
	Eligible	12.26
	Ineligible	10.10
Real		8.59
		(4.02–13.80)
	Eligible	9.74
	Ineligible	7.49

	10% increase in TFP of crops sold to schools	
Production		
Total production		5.14
		(3.16–7.78)
Crops	Eligible	1.46
	Ineligible	1.37
Livestock	Eligible	5.83
	Ineligible	5.90
Retail	Eligible	59.67
	Ineligible	-1.17
Services/ production	Eligible	2.69
	Ineligible	3.08
Crops sold to schools	Eligible	34.28
	Ineligible	-7.11

Source: Authors' own elaboration.

Conclusions

This study used a LEWIE analysis to assess the likely impacts of Senegal's SFPs on local incomes and production within the 10-km catchment areas surrounding beneficiary schools. The SF LEWIE model was constructed with data from surveys of schools, local businesses and households. The model's parameters were estimated econometrically, making it possible to construct confidence intervals around simulation results.

The simulations provide evidence that SFPs not only benefit students but also create positive multiplier effects on local incomes and production activities. All of the SFPs considered have an impact on local real (price-adjusted) income that significantly exceeds the programmes' costs.

The cash (CMNESF) programme generates a local real income multiplier of CFAF 1. CFA per CFAF 1 transferred. This includes the real value of the CFAF transferred to schools plus an additional income spillover of CFAF 0.63. Income spillovers result from the programme's positive effect on local demand, which stimulates local production and incomes and generates additional rounds of income gains. The 95 percent confidence interval round the real income multiplier (1.5–1.94) indicates that the spillover effect is significantly greater than zero. It is noteworthy that the cash programme has these positive income and production effects even though schools spend a substantial share of their cash (CFAF 0.47 of each CFAF 1 spent on SFP) sourcing food outside the local economy. (This simulation assumes that schools spend new CMNESF cash payments in the same way that they report spending SFP funds in the survey.)

Simulations with other types of SFP reveal that programme design shapes local economic outcomes. The more an SFP sources food locally, the larger the income and production multipliers it creates. A voucher (SFVs) programme that targets local traders creates a real income multiplier of 1.93. An HGSF programme produces a smaller real income multiplier (1.66) if the programme sources its cereals from local producers (13 percent). However, the multiplier is higher (2.17) if programme administrators increase the locally sourced food share to 25 percent by including fruits and vegetables and at least half the value of the nuts, pulses and unfortified edible oil used. An implication of HGSF is that concerted efforts are made to buy locally. These simulations reveal the important impacts that local food sourcing can have on household incomes and local production activities.

The multiplier analysis presented in this study offers evidence that markets transmit the benefits of SFPs from schools to food producers and households. It also documents important spillover effects on non-food producing sectors. It shows that although more of the income spillovers created by HGSF programmes accrue to beneficiary farm households, ineligible households also benefit substantially. In all of the simulations, crop and livestock production increases as a result of SFPs, but the largest impacts are found in non-agricultural activities, especially local retail, including village stores. This is where households spend most of their income gains, and increases in retail sales are important in spreading benefits to households that are not targeted by the programme.

These findings of significant multiplier effects of SFPs in Senegal compare favourably with findings from elsewhere. An analysis of the local-economy impacts of Kenya's HGSF programme found that each Kenyan shilling (KES) given to beneficiary schools created an additional KES 1.11 of real (inflation-adjusted) income in households in the programme sub-counties. This is very close to the real income multiplier estimated for the Senegal CMNESF programme. In Senegal, as in Kenya, programmes that source more food from local producers, and interventions that raise the productivity of the farms supplying food to schools, can generate substantially larger local production and income gains.

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Home-grown school feeding programmes have seen a considerable growth around the world. These programmes play a key role in supporting the improvement of child health and facilitating access to education, as well as in stimulating economic development through local procurement. The rigorous evaluation of the effects of these programmes on children and local economy poses several challenges due to the presence of multiple treatment arms, complex targeting criteria and the difficulties from lack of treatment randomization. This report presents the results of a simulation analysis of different food procurement modalities employed by Senegal's current school feeding programme (SFP) by using local economy-wide impact evaluation (LEWIE). The LEWIE methodology was designed to capture both the direct and the indirect impacts of a wide range of governmental programmes and policies in local economies. The findings suggest that SFPs in Senegal have significant positive impacts on production and income within a 10-km radius of beneficiary schools. These impacts grow as SFPs increase their sourcing from local traders and food producers.

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