

The Economywide Impacts of School Meals: Simulation Results for Ghana and Malawi

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Draft not for citation / April 2026*

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Abstract

School meal programs are widely implemented social protection and human capital interventions, yet their broader economywide impacts remain insufficiently understood. This study applies an economywide model combined with microsimulation and environmental modules to assess the economic, welfare, and environmental impacts of school meal programs in Ghana and Malawi. The analysis captures short-run effects through production, consumption, and labor market linkages, as well as long-run benefits arising from improvements in human capital and labor productivity. Results show that school meals generate modest but positive short-run welfare effects, including reductions in poverty and improvements in diet quality among rural households. At the macroeconomic level, short-run economywide benefit–cost ratios (BCRs) range from 1.24 in Malawi to 1.56 in Ghana under current program designs. Over the longer term, human capital gains substantially increase returns, with the present value of future economic benefits equivalent to 26 percent of current GDP in Malawi and 29 percent in Ghana. Over this horizon, BCRs are more than three times larger than short-run estimates. These findings highlight the potential of school meal programs—under current designs or with higher-quality meals or expanded coverage—as economically viable long-term investments in human capital and inclusive economic development.

Keywords: School meals; computable general equilibrium models; Sub-Saharan Africa.

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1 Introduction

School meal programs are multisectoral interventions underpinned by evidence on impacts spanning education, health, nutrition, social protection and economic development (Alderman et al., 2024; Lundborg et al., 2022). Their impact pathways are complex and context-specific, depending on program design, delivery modalities, and the socioeconomic environments in which they operate (Greenhalgh et al., 2007). Some school-meal impacts are immediate, while others take longer to manifest.

In the short term, school meal programs work as a social safety net providing an in-kind transfer to beneficiary students. The households in which these students reside benefit from savings on food expenditure (Alderman et al., 2025), while farmers and other suppliers of food or nonfood inputs into school meals may also benefit from increased turnover (Sumberg & Sabates-Wheeler, 2011). Home-grown school feeding programs that procure locally have the potential added advantage of shortening supply chains, stimulating local food production, and reducing transaction and transport costs (Espejo and Galliano, 2009). By establishing procurement contracts with suppliers, these programs may also contribute to the development of structured markets (Sumberg & Sabates-Wheeler, 2011); such contracts might also be used to encourage environmentally sustainable production practices (Pastorino et al., 2023) or to promote the supply of high-quality, nutritious, or (bio)fortified foods (Finkelstein et al., 2019; Scott et al., 2018). Lastly, school meal programs can generate direct employment opportunities for other value chain actors in the community, including cooks, caterers, or transporters (Heirman et al., 2024).

In the longer term, school meal programs have the potential to improve employment prospects and enhance labor productivity and lifetime earnings by increasing school attendance and improving learning outcomes, particularly among girls (Alderman et al., 2025). Regular meals contribute to better concentration, classroom behavior, and cognitive development, strengthening the foundation for academic performance (Kristjansson et al., 2007). They may also shape dietary habits beyond the school environment, potentially reducing long-term risks associated with unhealthy diets, though this area is relatively understudied. These longer-term benefits can result in high returns on investment, especially when considered over the lifetime of beneficiaries (Lundborg et al., 2022).

In this study, we use economywide models for Ghana and Malawi to capture and quantify a range of economic, welfare, and environmental costs and benefits of school meal programs. These include both the effects of programs in their current form and scale in Ghana and Malawi, as well as the potential effects of hypothetical programs with expanded coverage or improved meal quality. Economic costs and benefits across several channels are assessed, including: (i) employment creation within a formalized school-meal sector; (ii) production multipliers associated with demand for school meal inputs; (iii) household income effects from employment or in-kind meals; (iv) government budget implications, including the opportunity cost of funding

school meals; and (v) longer-term labor-productivity gains resulting from improved nutrition and learning from children receiving school meals. Regarding household welfare outcomes, we assess changes in poverty, diet quality, and consumer welfare (equivalent variation), while on the environmental front we evaluate both the direct and indirect implications for greenhouse gas emissions and water use.

Our integrated model framework, the Rural Investment and Policy Analysis (RIAPA) model (IFPRI, 2025), offers several advantages over simpler simulation tools. First, with a computable general equilibrium (CGE) model at its core, RIAPA captures the full set of direct and indirect production, employment, and income linkages associated with policy changes. RIAPA models include detailed representations of national agrifood systems (see Thurlow et al., 2025), making them particularly suitable for analyzing food-supply and consumption effects of school meal programs. Second, RIAPA incorporates survey-based microsimulation modules for evaluating household welfare outcomes, including changes in poverty (see Arndt et al., 2012) and diet quality (see Pauw et al., 2023). Finally, the integrated RIAPA framework also includes an environmental module for estimating changes in emissions and water footprints at the economywide level (Aragie et al., 2025).

As we demonstrate in this study, RIAPA also provides an analytical foundation for a potential future True Cost Accounting (Global Alliance for the Future of Food, 2019) exercise on school meals, in that it measures not only the direct and indirect economic costs and benefits of such programs, but also provides key inputs required to estimate the monetary equivalent of a wide range of non-economic positive and negative externalities, such as changes in poverty, diet quality, or environmental footprints.

The paper is organized as follows. Section 2 sets the scene with a comparative analysis of Ghana and Malawi's existing school meal programs and the economic contexts in which they are implemented. Section 3 presents the RIAPA modeling framework. Various technical modeling considerations are considered in more depth in the appendix. Section 4 presents and discusses the key results, while section 5 concludes.

2 School Meals in Ghana and Malawi

2.1 Economic Context

The economies of Ghana and Malawi are at different stages of development. As shown in Table 1, Malawi, which is classified as a low-income country (LIC) by the World Bank, had a GDP of \$10.4 billion in 2019, compared with \$64.1 billion in Ghana. With an average GDP per capita of \$2,109, Ghanaians are nearly four times wealthier than Malawians, on average. Most Malawians (82.8 percent) live in rural areas, many of whom are engaged in farming. Agriculture accounts for 24.4 percent of GDP in Malawi, while the broader agrifood system—including farming, agroprocessing, food trade and transport, and food services (see Thurlow et al. 2025)—

contributes 43.3 percent. By contrast, only 43.3 percent of Ghanaians live in rural areas, and agriculture and the agrifood system account for 18.5 percent and 33.3 percent of GDP, respectively.

Table 1. Key Economic Indicators: Ghana and Malawi

	Malawi	Ghana
Country income classification ^a	LIC	LMIC
GDP and population (2019) ^b		
National GDP (current \$ billion)	10.4	64.1
Population (million)	18.0	30.4
GDP per capita (current \$)	577	2,109
Rural population share (%)	82.8	43.3
Agricultural GDP share (%)	24.4	18.5
Agrifood system GDP share (%)	43.3	33.3
Development outcome indicators ^c		
Poverty rate (% , international poverty line)	73.5	25.3
Poverty rate (% , official poverty line)	50.7	23.4
Diet quality index (0-100)	35.7	44.8
Education and labor force ^d		
Net primary enrolment (%)	89.0	84.1
Adults finish primary school (%)	46.8	64.6
Net secondary enrolment (%)	34.2	66.6
Employment-to-population (%)	63.6	61.1

Source: World Development Indicators (WDI) (World Bank, 2025), FAOSTAT (FAO, 2025), UN Data Portal (2026), and Malawi and Ghana RIAPA model baselines.

Notes: ^a World Bank classification. LIC = low-income country; LMIC = lower-middle income country. ^b GDP measured at current market prices in 2019 and converted at the official exchange rate. Base years for the Malawi and Ghana RIAPA models are 2023 and 2019, respectively. The table reports 2019 values for both countries for comparability. Agrifood system GDP is the sum of GDP in primary agriculture, agroprocessing, food-related trade and transport, and food services (or restaurants). ^c Poverty rates reflect the proportion of the population below the international \$2.15 (World Bank, 2025) or countries' official poverty lines. The diet quality index measures the average quality of diets and is derived from the Reference Diet Deprivation (ReDD) index $[100 \times (1 - \text{ReDD})]$ (see Pauw et al., 2023). A higher value indicates better quality diets, on average. Poverty and diet quality estimates are estimated using household expenditure data in the 2016/17 Ghana Living Standards Survey (GLSS7) and the 2019/20 Malawi Integrated Household Survey (IHS5). ^d Education and labor force data from WDI, except for net primary enrolment rates, which are imputed using data cross-referenced from UN data. Net enrolment rates differ from gross enrolment rates in that they only include age-appropriate students.

At 73.5 percent, Malawi has one of the highest poverty headcount rates in sub-Saharan Africa when measured against the \$2.15 international poverty line (in 2017 PPP prices). At the government's official poverty line, 50.7 percent of the population is classified as poor. By contrast, only about one-quarter of Ghanaians are poor under either measure. Consistent with these differences, the diet quality indicator—based on a comparison of observed food consumption with the reference quantities of the EAT-Lancet planetary health diet (Willett et al., 2019)—shows that diets in Ghana are, on average, of higher quality than those in Malawi. Poor diet quality partly reflects the high cost of acquiring a healthy diet, particularly for poorer

households (Herforth et al., 2022). Reducing poverty is therefore critical for improving dietary outcomes. However, unhealthy diets may also arise from food supply chain constraints or suboptimal dietary choices, suggesting that complementary investments in food system infrastructure and behavior change are often required (Bai and Masters, 2024). School meals have the potential to help address these challenges.

The final section of Table 1 reports education enrolment and completion rates. Both countries have high net primary school enrolment rates (84.1–89.0 percent), indicating that school meal programs in primary schools offer an effective way to reach large numbers of beneficiaries. However, fewer people in Malawi complete primary school (46.8 percent versus 64.6 percent in Ghana), implying that beneficiaries in Ghana are likely to be exposed to school meal programs for longer periods. Prolonged participation in school meal programs has been shown to improve nutrition and learning outcomes (Adelman et al., 2008). Enrolment rates decline sharply at the secondary level, particularly in Malawi. Ghana’s higher secondary enrolment likely reflects a 2017 policy decision to provide free secondary education in public schools (Republic of Ghana, 2017). Employment-to-population ratios are similar in the two countries (61.1–63.6 percent), suggesting comparable rates of transition into the workforce. By improving nutrition and educational outcomes, school meal programs can help raise future labor productivity, conditional on school meal graduates entering the labor force and finding employment (Alderman et al., 2025).

2.2 School Meal Program Design

School meal programs in Malawi and Ghana differ in their design, targeting, and meal composition. In Malawi, the program operates as a donor-funded hybrid model jointly led by government and non-governmental organizations, with strong community involvement in implementation (GoM, 2024). Malawi’s program reaches an estimated 1.87 million primary school children—about 41 percent of the primary school–age cohort—and does not apply explicit poverty or geographic targeting criteria. Day-to-day activities, including food preparation and distribution, rely heavily on unpaid community volunteers, resulting in relatively limited formal (paid) employment generation.

The standard school meal in Malawi is a simple, porridge-based vegetarian meal with small quantities of fruits and vegetables. Although Malawi has not adopted formal guidelines on meal composition, Table 2 presents a reference meal based on menus used in school meal programs in the Zomba region (Katundu and Katola, 2022). Using typical calorie contents of the foods included, we estimate that a standard meal provides approximately 25 percent of a child’s daily calorie requirements. Based on prices from the Malawi RIAPA model, we further estimate a food cost of about \$0.091 per child per day, which falls within the range of costs reported in a recent government assessment (\$0.04–0.16) (GoM, 2024).

Table 2. School Meals in Ghana and Malawi

	Malawi ^a		Ghana ^b	
	Standard meal	Quality meal	Standard meal	Quality meal
<i>Grams per day by food group</i>				
Cereal grains	79.2	52.1	40.0	40.0
Roots and tubers	25.6	10.2	6.7	6.7
Legumes and nuts	15.0	25.4	14.5	30.0
Fruits and vegetables	15.8	101.7	23.6	133.0
Animal source foods	-	59.7	9.4	59.9
Fats and oils	9.9	10.6	8.8	8.8
Total grams per day	145.5	259.7	103.1	278.5
Estimated daily calories (%) ^c	~25%	~30%	~20%	~30%
Estimated daily cost (\$/meal) ^d	\$0.091	\$0.158	\$0.175	\$0.403

Source: Authors' compilation.

Notes: ^a The Malawi “standard” meal is an average of several sample meal plans for a school meals program in Zomba in southern Malawi (see Katundu and Katola 2022). Malawi’s “quality” meal is a hypothetical alternative to the standard meal. Food quantities in this meal are roughly in proportion to those in the EAT-Lancet planetary health diet (Willet et al. 2019). ^b The Ghana “standard” meal follows official guidelines (World Bank 2023), while the quality meal is also hypothetical but in this instance was proposed by Colombo et al. (2025). ^c The share of daily calories assumes an average requirement of 1,676 calories per primary school-aged child per day is assumed. ^d Daily meal costs are based on prices in the respective RIAPA country models and include cost of food and nonfood inputs as well as wages.

Ghana’s school feeding program is the largest government-funded safety net in the country and one of the largest such programs in Africa (World Bank, 2023). It serves approximately 3.62 million children in public primary schools—around 55 percent of the age cohort—with explicit targeting of schools in so-called deprived districts. The program is publicly financed and implemented with support from private caterers, generating an estimated 12.2 formal (paid) catering jobs per 1,000 pupils (World Bank, 2023). This is an important distinguishing factor between the two countries’ programs and—as we show later—drives large differences in value-added per school meal produced.

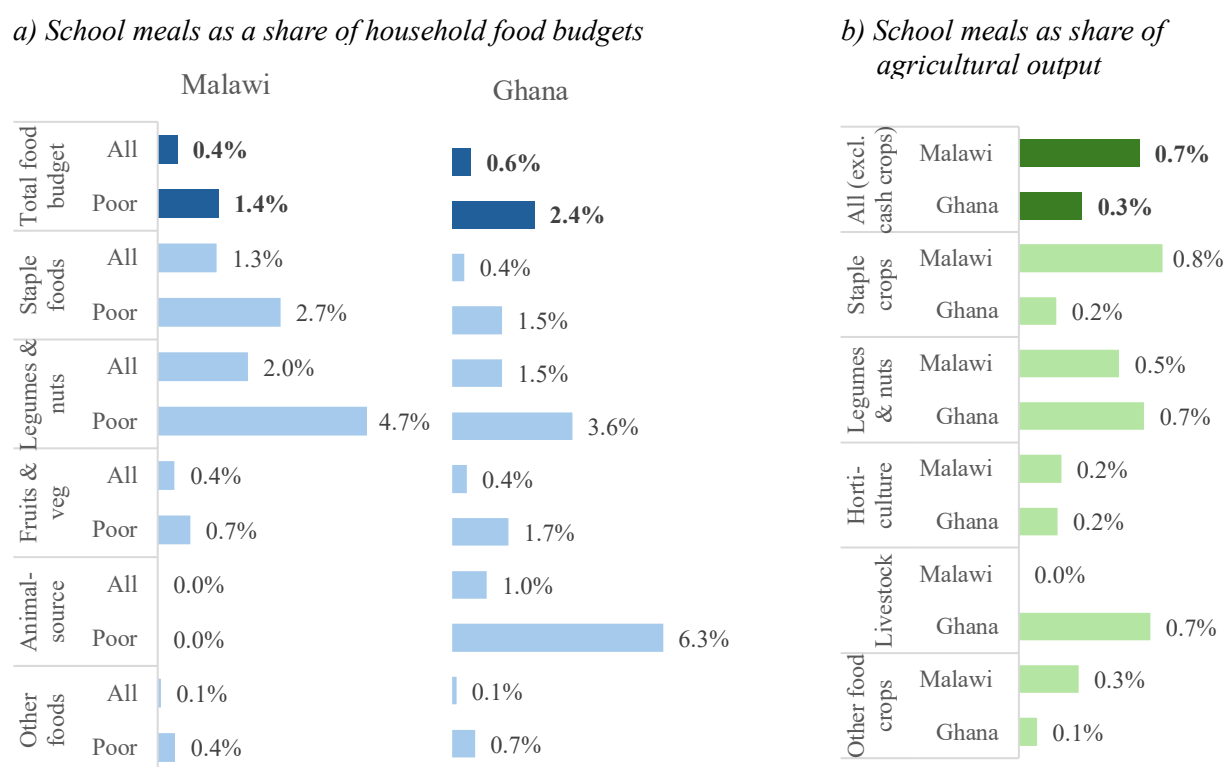
Ghana’s school meal plan follows government guidelines. Although Ghana’s standard meal is more diversified than Malawi’s (see Table 2), it provides smaller portions of calorie-dense foods and therefore meets only about 20 percent of daily calorie requirements, based on our rough estimates. However, the inclusion of animal-source foods substantially increases the cost per meal compared to Malawi. Based on national average prices from the Ghana RIAPA model, we estimate a daily cost of approximately \$0.175 per child, which is comparable to the \$0.21 estimated by Alderman et al. (2025) using local price data.

Whereas the economywide analysis presented later unpacks the direct and indirect effects of school meal programs in detail, we anticipate the direct impacts to be relatively small for several reasons. First, school meal programs reach roughly 10 and 12 percent of Malawi and Ghana’s total populations. Second, children attend school for about 180–200 days per year, or roughly 50–55 percent of days in the year. Third, as noted, school meals provide approximately 20–25

percent of daily calorie requirements, and young children require far fewer calories than adults. Taken together, these factors imply that school meals account for around one percent of total food consumed in these countries. If we additionally assume that school meals are prepared using relatively inexpensive foods compared to the typical meals consumed at home, that share is likely to be even smaller.

Estimates based on household food expenditure and agricultural production estimates in the Malawi and Ghana RIAPA models confirm our expectation. Panel (a) of Figure 1 reveals that the value of school meals accounts for only 0.4 and 0.6 percent of household food budgets in Malawi and Ghana, respectively. Their contribution is more substantial for poor households (1.4 and 2.4 percent). The larger shares in Ghana reflect the higher value of school meals, broader coverage, and explicit targeting of poorer districts. Across food groups, the emphasis on staples and legumes in Malawi's school meal program is reflected in the large shares for these categories, particularly among poor households (2.7 percent and 4.7 percent, respectively). In Ghana, the inclusion of meat translates into a sizable contribution to poor households' animal-source food budgets (6.3 percent).

Figure 1. Potential Economic Footprint of School Meals



Source: Authors' estimates based on Malawi and Ghana RIAPA model baselines

The agricultural footprint of school meal programs provides an indication of the extent to which they can generate income-earning opportunities for farmers. Panel (b) of Figure 1 expresses the

value of food inputs embodied in school meals as a share of total food crop and livestock production (i.e., excluding nonfood cash crops, notably tobacco in Malawi and cocoa in Ghana). At the national level, school meal programs' demand for food inputs is equivalent to 0.7 percent and 0.3 percent of non-cash-crop agricultural output in Malawi and Ghana, respectively. In Malawi, the staples sector is the largest contributor to school meals, accounting for 0.8 percent of that sector's output, while in Ghana sectors such as legumes and livestock benefit most from participation in school meal programs (0.7 percent of output each).

These estimates provide an early indication that school meal programs are unlikely to generate large structural changes in the economy or significant income gains at national level. Admittedly, such programs can generate substantial benefits for direct participants, but these are best examined using micro-econometric evaluation methods. Nevertheless, the economywide modeling framework adopted here remains useful for addressing other questions, particularly those related to the indirect effects of school meal programs via production multiplier effects and feedback effects arising from changes in household expenditure patterns. The RIAPA framework also allows us to assess associated welfare and environmental impacts, as well as the longer-term implications of labor productivity gains, which can be more substantial than the immediate benefits.

Another advantage of a simulation approach is the ability to explore alternative program design options. In this regard, we consider combinations of (i) different funding mechanisms, (ii) programs with expanded coverage, and (iii) alternatives that offer higher-quality meals. With respect to the latter, Table 2 presents both a standard meal plan, representative of current meals offered in Malawi and Ghana, and higher-quality meals. These are hypothetical menus that provide more calories and a wider range of micronutrients, with larger quantities of animal-source foods, legumes, fruits, and vegetables, and smaller quantities of calorie-dense staples.

The Ghanaian quality meal is drawn from a linear programming exercise by Colombo et al. (2025), who generated meal plans satisfying nutrient targets and acceptability constraints. Despite a lower staple content, this meal is estimated to provide approximately 30 percent of daily calorie requirements at a cost of \$0.403 per meal, more than double the cost of the standard meal (note that no budget constraint was imposed in the design of this particular meal variant). Because no comparable exercise exists for Malawi, the quality meal for this country is our own construct, with relative food quantities informed by the EAT–Lancet planetary health diet (Willet et al. 2019) and scaled to provide 30 percent of daily calorie requirements, equivalent to Ghana's quality meal. The estimated cost of this meal is \$0.158. These costs include food and nonfood inputs as well as wages. Lower costs in Malawi partly reflect the relatively larger quantities of low-cost staples and the greater reliance on unpaid volunteers to prepare food in schools. These alternative meals are incorporated into selected RIAPA model simulations to assess their hypothetical impacts in comparison to the standard meals currently offered.

3 Modeling School Meal Impacts

3.1 Literature Review

A substantial body of impact evaluations documents the positive effects of school meal programs on a range of outcomes. Many studies focus on human capital, consistently finding that school meal programs are associated with increased enrolment and attendance, as well as improved learning outcomes—particularly in mathematics and literacy. These gains are often strongest for girls and children from poorer households or regions (Aurino et al. 2024; Gelli et al. 2019). Evidence also points to nutritional benefits, including improved linear growth among younger children. Importantly, recent analysis suggests that the long-term benefits of school meals, operating through higher future labor productivity, can exceed program costs, yielding favorable benefit–cost ratios (Alderman et al. 2025).

Despite this strong evidence base, less is known about the broader spillover effects of school meal programs beyond direct beneficiaries. Empirical evidence on impacts transmitted through food supply chains and smallholder farmers, or on wider economic, social, and environmental outcomes across multiple impact channels, remains limited (Gelli et al. 2021). Where these broader impacts have been examined, potential trade-offs emerge. For example, improving meal quality often entails greater reliance on animal-source foods, which can increase environmental footprints and pose challenges for environmental sustainability (Colombo et al. 2025). These gaps highlight the need for analytical frameworks capable of jointly assessing economic linkages, distributional effects, and sustainability trade-offs.

Recent work by Gupta et al. (2025) illustrates the potential of economywide modeling approaches to address some of these questions. Using a local or “village” economywide model of school meal programs in Kenya, the authors estimate sizable income multipliers, reflecting strong local production and consumption linkages beyond the direct participants in school meal programs. Importantly, local economywide models are designed to capture impacts within specific communities or districts; they typically do not fully capture spillovers to the rest of the economy or account for national financing and macroeconomic constraints. Gupta et al. (2025) partially address this limitation by incorporating a separate production zone in their model that interacts with and supplies inputs to the school meal district. However, in contexts where school meal programs operate at national scale, rely on procurement from across the country or beyond, or where government financing considerations are central to school meal policy decisions, a national economywide model is arguably better suited, even if it is less effective at measuring localized multiplier effects near schools.

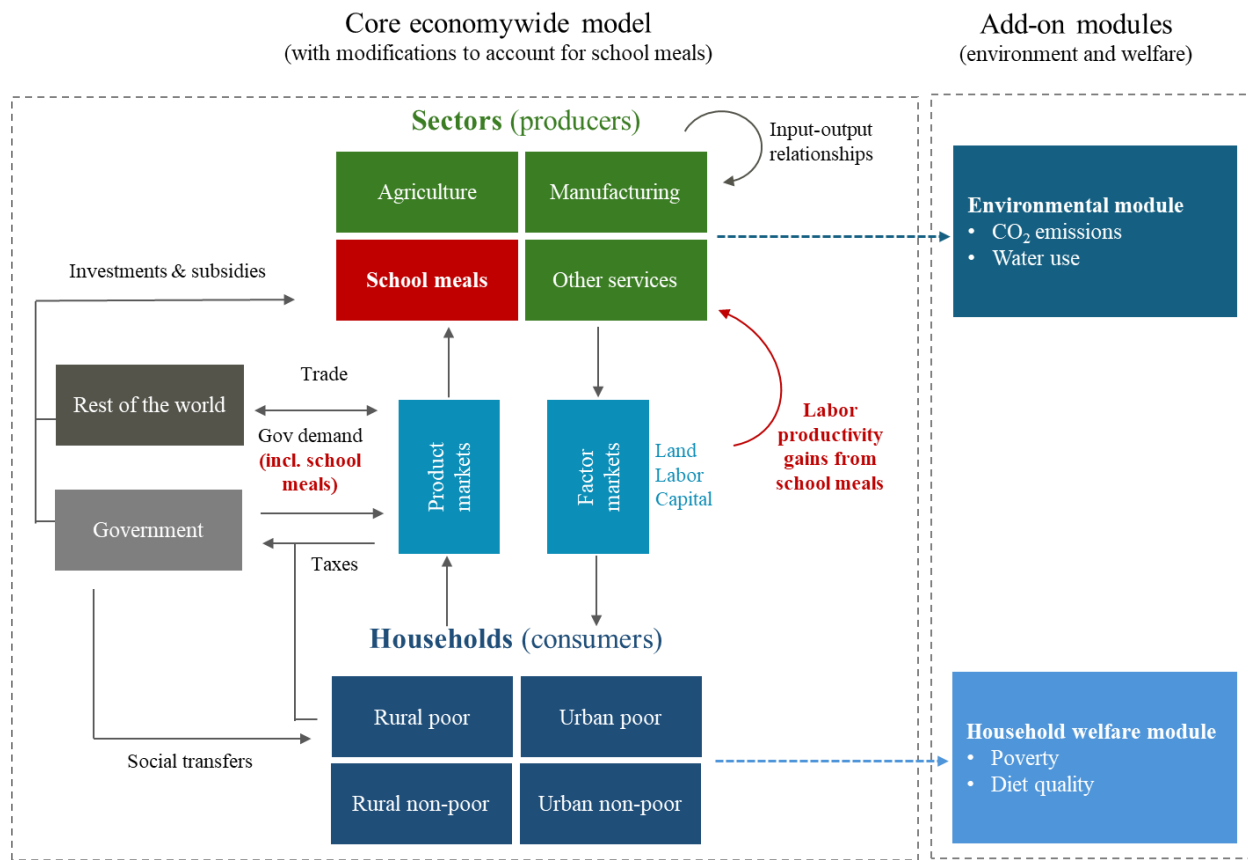
In summary, while impact evaluations provide robust evidence on direct human capital effects and local economywide models offer valuable insights into localized production and income linkages, neither approach is well suited to assessing economywide spillovers, macroeconomic constraints, or trade-offs across economic, social, and environmental dimensions at national scale. Addressing these gaps requires a modeling framework that can simultaneously capture

multisectoral linkages, distributional effects across households and regions, and interactions between public financing, markets, and the environment. To this end, we use the RIAPA model (IFPRI 2025) to evaluate school meal programs in Malawi and Ghana. As we elaborate in the next sub-sections, RIAPA is an integrated framework that combines a single-country computable general equilibrium (CGE) model with survey-based microsimulations models for estimating welfare outcomes (such as poverty or diet quality) and environmental modules for analyzing changes in water use and greenhouse gas emissions.

3.2 Computable General Equilibrium Model

IFPRI's standard CGE model (Lofgren et al. 2001) is at the core of the RIAPA framework. The CGE model is a multi-sector, multi-agent representation of an economy that captures the interlinkages among producers, households, government, and the rest of the world as they participate in product or factor markets (see Figure 2). Producers combine factors of production—labor, capital, and land—with intermediate inputs to generate output. Subject to technological constraints, producers adjust factor input ratios in response to relative factor price changes to maximize profits. Labor is assumed to be fully employed, with wages adjusting to equilibrate labor supply and demand along an upward-sloping, inelastic labor supply curve. Under a Leontief specification, intermediate inputs are used in fixed proportions to total output.

Figure 2. Adapted RIAPA Model Framework and Simulation Design



Source: Authors' representation

Households earn income from factors of production and various transfers. Disposable income (net of taxes and savings) is allocated to the consumption of food and nonfood goods and services purchased in the product market. Under a Linear Expenditure System (LES) specification, consumption of each commodity comprises a subsistence (minimum) component and a discretionary component, with the latter responding to changes in relative prices across commodities and household income. International trade is modeled using the Armington assumption of imperfect substitutability between domestic and imported commodities, while producers allocate output between domestic and export markets. The optimal quantities of imports and exports depend on the ratios of domestic to world import and export prices.

Macroeconomic consistency is ensured through explicit closure rules that govern the adjustment of key aggregates, including the savings and investment account, the government account (revenues and expenditures), and the external account (foreign exchange inflows and outflows). For this study a balanced savings–investment closure is adopted whereby investment is a fixed share of domestic absorption, with private savings rates adjusting to generate the required level of savings (domestic absorption is the sum of private and public consumption and fixed capital formation). For Ghana, direct tax rates are adjusted exogenously to raise enough government revenue to finance the school meal program. For Malawi, we assume an increase in foreign

donor support to government equivalent to the program’s cost. A flexible exchange rate regime is assumed for both countries. Under a recursive-dynamic specification (see Diao and Thurlow 2012), the model is solved over multiple periods, with investment in one period determining capital accumulation in subsequent periods. Labor force growth rates and productivity changes are imposed exogenously, following their historical trends.

CGE models are calibrated to Social Accounting Matrixes (SAMs). A SAM is a comprehensive and internally consistent economywide database that provides a snapshot of all income and expenditure flows among economic agents. Calibration ensures that the model exactly replicates the observed economic structure in the base year. Starting from this base year, the model is used to produce a “business-as-usual” baseline trajectory for the simulation period against which results from counterfactual simulations can be compared. For the Ghana model we use the country’s official SAM for 2019 (GSS, ISSER, and IFPRI 2023) to calibrate the model, while for Malawi we use a 2019 SAM developed by IFPRI (Kankwamba et al. 2023), which we update to a 2023 base year.

Both SAMs distinguish 30 agricultural sectors, 40 industrial sectors (including 18 agroprocessing sectors), and 12 services sectors. The detailed representation of agrifood value chains, including their on-farm and off-farm components, makes these SAMs particularly well suited for analyzing the linkages between school meal programs and their key input suppliers. The SAMs further include separate accounts for agricultural land; agricultural and non-agricultural capital; eight labor categories (disaggregated by rural/urban location and four education levels); as well as 15 representative household groups, comprising rural farm and nonfarm as well as urban households, each disaggregated divided further into per capita expenditure quintiles.

3.3 Microsimulation and Environmental Modules

Household welfare impacts are assessed using microsimulation models linked sequentially to the CGE models and based on nationally representative household surveys conducted as close as possible to the CGE model base years—i.e., the Ghana Living Standards Survey conducted in 2016/17 (GSS, 2019) and Malawi Integrated Household Survey conducted in 2019/20 (NSO, 2021). Linking entails mapping *individual* households in the survey to their respective representative household *groups* in the CGE model. Simulated percentage changes in real consumption of household groups are applied to consumption of individual households in the survey to generate unique expenditure distributions associated with each simulation, which in turn allows an estimation of changes in welfare indicators, including poverty (see Arndt et al., 2012) and diet quality based on household consumption (Pauw et al., 2024).

The environmental module similarly entails a post-simulation calculation outside of the core CGE model. The module is calibrated using externally validated data on water use and carbon emission of the various economic sectors represented in the CGE model. Percentage changes (from baseline) in sector output are applied to the baseline water and emissions levels to calculate changes in environmental footprints at sector or national level (see Aragie et al., 2025).

for details on data sources and methods). Such a multiplier approach with fixed emissions and water use coefficients is appropriate since our simulations do not consider the implications of energy or water use efficiency changes. Figure 2 shows how the welfare and environmental modules are sequentially linked to the consumers and producer accounts of the CGE model.

3.4 Model Adaptations

The purpose of the economywide modeling exercise is to compare key economic variables in an economy with a school meal program to a counterfactual scenario in which no such program is implemented. We start with the assumption that the country SAMs represent these counterfactuals for Ghana and Malawi. The modeling strategy then involves modifying each SAM by introducing latent school meal sectors representing programs that provide standard and quality meals, respectively. These latent sectors are initially calibrated at a very small scale—producing meals for only one-thousandth of the eventual number of beneficiaries—but are structured to mimic fully scaled school meal sectors in terms of their input–output and employment coefficients. Food inputs per beneficiary are based on the meal plans presented in Table 2. Nonfood inputs, such as electricity, transport, and cleaning materials, are derived from input–output coefficients in each country’s restaurant sector and cross-checked against program-specific information. In Ghana, informed by program data, we assume the sector employs 12.2 workers per 1,000 beneficiaries, whereas in Malawi, where many school meal workers are unpaid volunteers, we assume half that number (i.e., 6.1 paid positions per 1,000 beneficiaries).

Figure 2 illustrates how the school meal sector is incorporated into the broader economywide model framework. As shown, each newly created latent school meal sector purchases inputs from product markets and hires labor from factor markets. Importantly, households do not purchase school meals directly from product markets. Instead, we model all school meals as being purchased by the government and subsequently provided to schoolchildren as an in-kind transfer to households. The expenditure on school meals is therefore captured as government expenditure rather than household expenditure.

The scale of the school meal program is controlled in the simulations by adjusting government demand for school meals. For example, to replicate the Ghana program, we exogenously increase government demand for standard school meals from a negligible base level of 3,620 meals to 3.62 million meals per day. As the school meal sector expands to meet this demand, it purchases additional food and nonfood inputs and hires workers to prepare meals. The sector competes for these inputs with other sectors and households, which affects market prices. At full scale, Ghana’s program, for instance, procures approximately 28,000 metric tons of cereal grains annually and employs 44,000 cooks. Changes in national GDP at factor cost (or value-added) therefore originate within the newly established school meal sector itself as well as in sectors that directly or indirectly supply its food and nonfood inputs.

Unlike cash transfers, school meals provided in-kind do not *directly* raise the disposable income of households. (They may do so *indirectly* via employment generation and value-addition in

input-supplying sectors, but we disregard that for the moment). As such, total expenditure of beneficiary households will not change; however, school meals may induce changes in their patterns of consumption, since they effectively free up household resources that would otherwise have been spent on children's meals. These implicit savings can be used to either buy more food for the household or it could finance nonfood consumption expenditure.

We adapt the model to account for these consumption substitution effects in two ways. First, we assume the additional household resources available for other consumption expenditure is equivalent to the value of the meal received by the household. In practice, some household may have spent more than the value of school meals in the absence of the program since they do not benefit from economies of scale in school meal preparation, while others may have spent less, so our assumption that savings are equal to the value of school meal is reasonable. Secondly, we assume that households' marginal budget shares in the LES demand system, which represents revealed preferences, will determine how these resources are distributed across food and non-food commodities. Section 7.1.1 in the appendix provides a technical explanation of how the LES demand system parameters are adjusted to allow for this behavioral change within beneficiary households.

Our consumption substitution assumptions have important implications for the modeled impact of school meal programs. First, at beneficiary household level, we expect to observe a reduction in food expenditure and an increase in nonfood expenditure, but the overall food intake will increase because the quantity of food embedded in the free school meal will always exceed the reduction in the quantity of food purchased. Second, at economywide level, the net increase in food demand induced by the program will be smaller than the direct food demand generated by the school meal sector itself. Consider a simple example. Suppose a government-funded school meal program procures \$100 million of food. An initial response from recipient households is to reduce their expenditure on food by \$100 million. However, these "savings" can now be reallocated to food and non-food commodities of their choice. If the marginal food budget share is 60 percent, they will allocate \$60 million to food and \$40 million to nonfood commodities. The net result for beneficiary households is a \$40 million decline in food expenditure, but food intake increases by \$160 million. Additionally, their nonfood expenditure increases by \$40 million.

When assessing poverty and diet quality impacts in the RIAPA framework, the default approach is to link changes in household expenditure to the welfare module. However, in this application, that would underestimate the welfare impacts of the program since a portion of food intake is now provided through the school meal program. We therefore link both food and nonfood purchases as well as the value of food and nonfood commodities embedded in school meals received (but not purchased) by households when assessing changes in poverty and diet quality.

While the short-run scenarios focus on the immediate economic, social, and environmental impacts of establishing or expanding school meal programs, we also examine potential long-term effects arising from higher labor productivity. Exposure to school meal programs has been shown

to improve nutrition and learning outcomes, ultimately enhancing future labor productivity, which in turn results in increased output per worker and higher earnings (see Figure 2). Evidence from Ghana indicates that two years of exposure to school meals increase wages by 2.30 percent relative to non-participants (Alderman et al. 2025), reflecting productivity gains. In our long-run scenarios, we therefore assume that each year of exposure to a school meal program increases a participant’s productivity by 1.15 percent relative to non-participants, conditional on entering the labor force and securing employment. Although higher-quality meals cost more, existing studies suggest that they can raise labor productivity by an additional 0.03–0.06 standard deviations compared to regular meals. Accordingly, we assume that each year of exposure to a program offering *quality* meals increases productivity by 1.22 percent (i.e., 1.15×1.06) relative to non-participants.

3.5 Simulations Design

We conduct four simulations for each country. These are summarized in Table 3. The first simulation replicates the current school meal programs in Malawi and Ghana. Therefore, in this scenario, the school meal sector supplies a standard meal (see Table 2) and targets 1.87 million beneficiaries in Malawi (or 41 percent of the age cohort) and 3.62 million in Ghana (55 percent coverage). The second simulation targets the same beneficiaries but replaces the standard meal with a higher-quality meal. Although this raises program costs, the quality meal is expected to have larger poverty and diet quality impacts, at least among beneficiary households. In the long run, the quality meal also translates into larger labor productivity and wage income gains than the standard meal due to improved nutrition and learning outcomes.

Table 3. Simulation Setup

Simulation name	Description	No. of beneficiaries (mil.) (and % of age cohort reached)	
		Malawi	Ghana
Current program	Existing number of beneficiaries receiving standard meal plans	1.87 mil. (41%)	3.62 mil. (55%)
Quality meal	Same coverage, but higher-cost quality meal (with larger long-run productivity effects)	1.87 mil. (41%)	3.62 mil. (55%)
Include all districts	Standard meal expanded to all public primary schools	3.87 mil. (85%)	5.10 mil. (78%)
Expand to high school	Nationally scaled program further expanded to include all public secondary schools	4.18 mil. (62%)	7.85 mil. (83%)

Source: Authors

The third simulation reverts to the standard meal but expands coverage to all public primary schools. In Malawi, this increases coverage from 41 to 85 percent of the relevant age cohort, corresponding to the estimated share of primary school children enrolled in public schools. In Ghana, where the program currently targets poorer districts, expanding to all public primary schools raises coverage to 78 percent of the age cohort. This rate is slightly lower than in Malawi

because a larger share of Ghanaian children is enrolled in private primary schools that are excluded from the program. The fourth simulation expands the nationally scaled program to include all public secondary schools. Because secondary school attendance rates are lower in Malawi (see Table 1), the number of beneficiaries increases only modestly—from 3.87 to 4.18 million—and the coverage rate declines to 62 percent. In contrast, Ghana’s higher enrolment rate in public secondary schools results in a substantial increase in beneficiaries (7.85 million) and raises coverage to 83 percent.

Just as higher-quality meals increase projected labor productivity gains, expanded coverage too has important long-run productivity implications. First, as the number of children exposed to school meal programs increases, the proportion of program graduates in the labor force grows more rapidly, thus accelerating growth in average labor productivity. Second, extending the program into secondary school increases the duration of exposure, which in our model proportionally raises beneficiaries’ relative labor productivity. To capture these dynamics, we developed detailed school passthrough models for each program design option and for rural and urban children. These models project how beneficiaries progress through the education system, transition into the labor force, and contribute to higher average productivity over time. The passthrough models are used for estimating the annual labor productivity increase over the baseline. They are described in more detail in the appendix (section 7.3).

4 Model Results

4.1 Short Run Economywide Impacts

We begin by analyzing the short-run economywide impacts of school meal programs in Ghana and Malawi, with results assessed relative to a business-as-usual baseline without school meals. The objective is to capture the immediate general equilibrium adjustments in production, incomes, and resource allocation following program introduction, prior to the realization of longer-term labor productivity gains. The analysis focuses on key macroeconomic indicators, including changes in GDP at factor cost and sectoral value added, as well as program benefit–cost ratios. It further examines distributional effects through impacts on household welfare and considers selected environmental consequences associated with shifts in production patterns.

Table 4 shows that establishing a school meal program generates modest gains in GDP, primarily driven by the expansion of the school meal sector and its upstream linkages to agriculture, which supplies most of the required inputs. In Malawi, where the program is donor-funded, increased foreign inflows lead to an appreciation of the exchange rate, adversely affecting export competitiveness (see appendix, section 7.1.2). This is reflected in declines in GDP in the cash crop subsector—particularly tobacco—and in industry. Overall, Malawi’s economy expands by between 0.01 and 0.05 percent under the various modeled scenarios. In Ghana, the internally financed program relies on higher taxation, which reduces disposable incomes, especially among wealthier households, and thereby moderates overall economic gains. Nevertheless, Ghana’s

relatively larger program size and higher value addition within the school meal sector, linked to the use of paid rather than primarily volunteer labor, result in somewhat stronger aggregate GDP impacts, ranging from 0.10 to 0.22 percent. Although the provision of quality meals in Ghana results in higher overall GDP, gains are marginally smaller in Malawi under this scenario, in part because of a larger exchange rate appreciation as donor inflows increase further while value-addition in the school meal sector remains unchanged. In both countries, scaling up the program leads to progressively larger GDP gains.

The lower part of Table 4 presents program benefit–cost ratios (BCRs). We follow Arndt et al. (2015) in using the change in real absorption (that is, private and public consumption and investment) as a measure of the economywide benefits of a public program. For internally financed programs, such as Ghana’s, absorption is already net of the taxes collected to finance the program. Following standard practice, these internalized costs are added to absorption when calculating total program benefits. Under Malawi’s donor-funded program, net and total benefits are identical.

$$BCR = \frac{\text{Total Benefit}}{\text{Total Cost}} = \frac{\text{Absorption Gain} + \text{Internalized Cost}}{\text{Donor Contribution} + \text{Internalized Cost}}$$

Under the current program design, short-run BCRs are 1.22 in Malawi and 1.56 in Ghana. The lower BCR in Malawi reflects the relatively lower value addition within the school meal sector, as well as the adverse effects of an appreciating exchange rate on export performance. Programs offering quality meals are associated with lower BCRs in both countries due to the higher cost of the meals themselves, although a fair assessment of the desirability of such programs requires also considering their impacts on poverty, diet quality, and the long-run economic benefits of increased labor productivity. Total benefits increase alongside GDP as the program expands in scale. However, program costs also rise roughly proportionately with benefits, and therefore BCRs do not differ substantially from those estimated for the current program, at least in the short run.

Table 4. Short-run Changes in GDP at Factor Cost and Program Benefit-Cost Ratios (BCRs)

	Malawi					Ghana				
	Deviation from baseline (\$ mil.)					Deviation from baseline (\$ mil.)				
	Baseline (\$ bil.)	Current program	Quality meal	Include all districts	Expand to high school	Baseline (\$ bil.)	Current program	Quality meal	Include all districts	Expand to high school
National GDP	12.8	4.3	1.5	6.0	6.2	66.0	67.0	82.3	94.4	145.2
<i>GDP % increase</i>		0.03%	0.01%	0.05%	0.05%		0.10%	0.12%	0.14%	0.22%
Agriculture	4.0	3.3	3.9	8.5	9.2	12.2	9.4	24.1	12.8	19.4
Food crops	2.1	4.4	2.9	9.7	10.5	8.5	7.9	19.3	10.7	16.1
Cash crops	0.2	-0.6	-1.1	-1.4	-1.5	1.1	0.1	0.3	0.2	0.3
Livestock & other	1.5	-0.4	2.0	0.1	0.2	1.1	1.3	3.9	1.7	2.6
Industry	2.7	-2.6	-8.8	-12.0	-13.5	21.9	20.3	45.4	28.7	44.5
Food processing	1.0	-1.9	-2.5	-3.7	-3.9	2.0	1.6	3.1	2.3	3.5

Other industry	1.7	-0.7	-6.2	-8.3	-9.6	19.9	18.7	42.3	26.5	41.0
Services	6.2	3.6	6.4	9.5	10.4	31.8	37.3	12.8	52.8	81.4
School meals		5.5	5.5	11.4	12.3		56.1	56.1	79.0	121.7
Program BCR		1.22	1.14	1.20	1.20		1.56	1.31	1.56	1.56
Program cost		33.9	58.8	70.0	75.6		123.9	284.3	174.6	268.8
Absorption	15.8	41.5	67.2	84.1	90.8	71.3	69.0	87.0	97.2	149.7
Total benefit		41.5	67.2	84.1	90.8		192.9	371.3	271.8	418.5

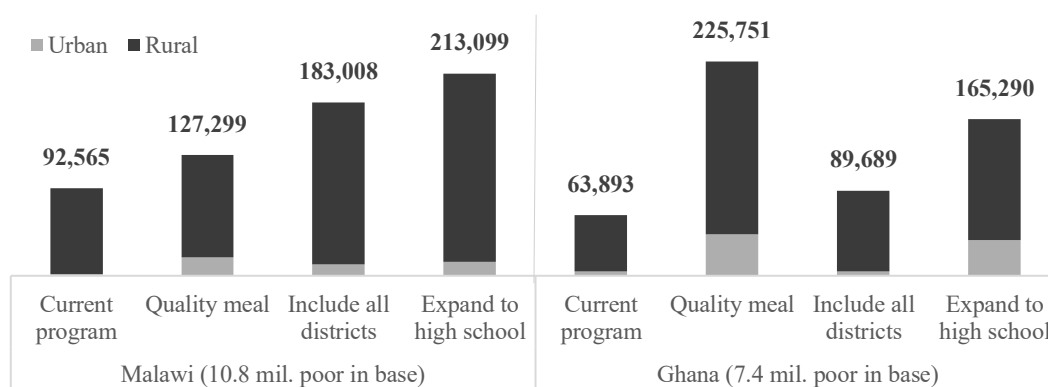
Source: RIAPA model results

Notes: Baseline values reported in billions of dollars and modeled deviations in millions of dollars. BCR = Benefit Cost Ratio. Domestic absorption is used as a measure of net program benefit. Total benefit is absorption plus internalized program cost. Since Malawi's program is donor-financed there are no internalized costs.

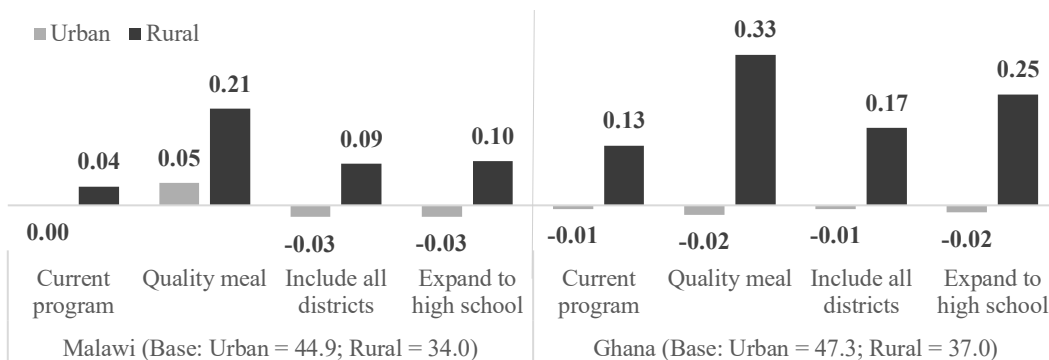
Figure 3 summarizes the short-run average household welfare impacts of school meal programs across beneficiary and non-beneficiary populations. Panel (a) presents changes in the number of people lifted out of poverty, where the poor are defined as those living below the official poverty line in each country. Malawi has a baseline poverty rate of 50.7 percent (10.8 million people), while Ghana's poverty rate is 23.4 percent (7.4 million people) (see Table 1). All program variants reduce poverty in both countries, with the largest effects observed under the higher-quality meal scenarios, particularly in Ghana. Most of the poverty reduction occurs in rural areas, reflecting both the targeting of school meal programs toward poorer rural districts (e.g., in Ghana) and the higher incidence of poverty in rural areas generally. Poverty is reduced via two channels. First, school meals are a direct in-kind transfer to households that can lift poor households above the poverty line, especially those close enough to it. This impact channel accounts for roughly 90 percent of the observed poverty reduction in Malawi. Second, school meals create paid employment opportunities, which too can reduce poverty. This impact channel is more prominent in Ghana, explaining approximately 60 percent of the total reduction in poverty.

Figure 3. Short-run Household Welfare Impacts

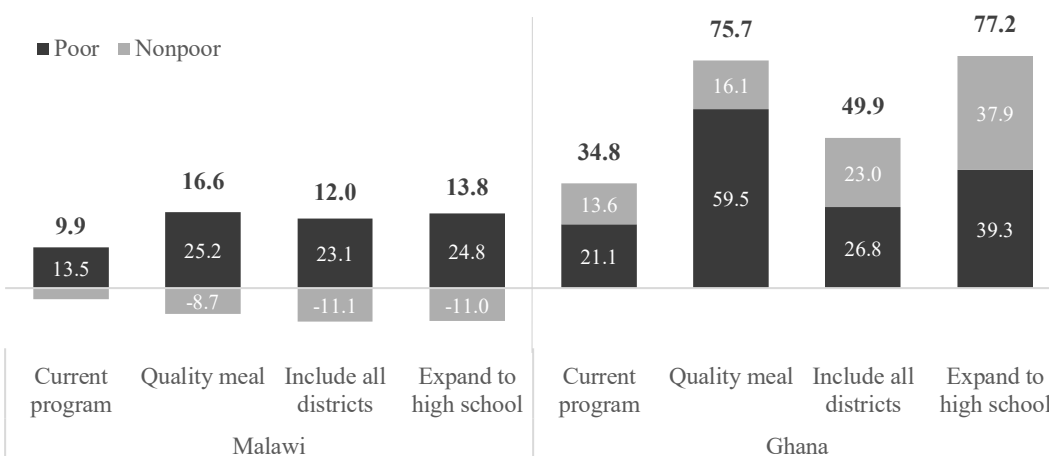
a) Number of people lifted out of poverty (number)



b) Changes in household diet quality (index point change)



c) Changes in household welfare (equivalent variation) (\$ mil.)



Source: RIAPA model results

The impacts of school meals on diet quality are presented in panel (b) of Figure 3. The diet quality index shows that diets in Ghana are, on average, closer to the EAT-Lancet healthy reference diet than those in Malawi, with an index value of 44.8 compared to Malawi's 35.7 (see Table 1). Urban diets are also generally of higher quality than rural diets in both countries, largely reflecting differences in diet affordability. School meals result in declines in consumption shortfalls across multiple food groups, therefore contributing to small improvements in diet quality in rural areas. Urban diets, however, deteriorate marginally, except under the high-quality meal scenario in Malawi. As with the poverty results, this pattern reflects both the targeting of the program toward rural populations and the distribution of the program's financing burden. Ghana's more diverse meal composition tends to generate stronger dietary improvements, with the high-quality meal variants producing the largest positive effects on rural diets in both countries.

Consumer welfare effects are presented in panel (c) of Figure 3 and are measured using equivalent variation following Hicks (1939). Equivalent variation measures the amount of income that would need to be given to (or taken from) households at initial prices to make them

as well off as they would be after the policy change, thereby providing a monetary measure of the welfare impact. The equivalent variation measures estimated here include the monetary value of free school meals. The results indicate that school meal programs are welfare-enhancing overall, with gains ranging from \$9.9 to \$16.8 million in Malawi and \$34.8 to \$75.7 million in Ghana under the different scenarios. However, the distributional patterns differ across countries. In Ghana, equivalent variation increases for both poor and nonpoor households. At the current scale of the program, most of the benefits accrue to poor households, which reflects its targeting of poorer districts. However, as program coverage expands, the distribution of welfare benefits becomes more balanced as more non-poor districts are included in the program. By contrast, only poor households gain in Malawi, while nonpoor households experience small welfare losses. This is primarily associated with the negative GDP effects in Malawi's industrial sectors, which are more likely to employ workers from nonpoor households (see Table 4).

We finally turn to the short-run environmental impacts of school meal programs. We measure changes in emissions and water use both at national level and per school meal supplied. These estimates account not only for emissions and water use associated with preparing school meals, but also those of sectors directly supplying inputs, such as agriculture, or those responding to meet changing consumer demands. Table 5 summarizes the main results. For brevity, results are shown only for the current program and the program variant offering quality meals. Overall, given their relatively small economic footprint, school meal programs have only marginal effects on national-level water use and greenhouse gas emissions. In Malawi, national water use increases by between 0.08 and 0.13 percent, while in Ghana the increases range from 0.06 to 0.19 percent. Similarly, emissions rise by between 0.52 and 0.59 percent in Malawi and by 0.40 to 0.52 percent in Ghana. These environmental impacts are proportionately larger than the associated GDP effects reported in Table 4, which reflects structural shifts towards relatively water-intensive sectors (such as agriculture) or higher-emitting sectors (such as industry).

Table 5. Environmental Impacts: Water and Emissions Footprints

	Malawi		Ghana	
	Standard meal	Quality meal	Standard meal	Quality meal
<u>Water footprint</u>				
Change in national water use (mil. m ³)	60.0	39.2	71.2	233.8
Percent change (%)	0.13%	0.08%	0.06%	0.19%
Average water requirement/meal (liter)	475.9	416.3	335.8	1,660.7
Change in national water use/meal (liter)	164.4	107.5	100.9	331.2
<u>Emissions footprint</u>				
Change in national emissions ('000 tons CO ₂ e)	70.7	61.5	142.4	184.2
Percent change (%)	0.59%	0.52%	0.40%	0.52%
Average emissions/meal (g CO ₂ e)	286.6	287.0	176.0	230.3
Change in national emissions/meal (g CO ₂ e)	193.9	168.7	201.7	261.0

Source: RIAPA model results

The environmental implications of improving meal quality differ between the two countries. In Malawi, shifting from standard to higher-quality meals results in lower water use and emissions, whereas the opposite pattern is observed in Ghana. Estimates of the average water and emissions footprints per meal help explain this result. In Ghana, higher-quality meals are more water- and emissions-intensive because of their relatively high meat content, which is supplied by the resource-intensive livestock sector (see Colombo et al. 2025). In Malawi, emissions per meal are comparable between standard and quality meals, but the standard meal is more water-intensive because staple foods grown in Malawi exhibit relatively low levels of water-use efficiency (see Diao et al. 2025).

The final row of each section of Table 5 expresses the change in national water use or emissions on a per-meal basis. Using Malawi’s standard meal as an example, we see that although producing a single school meal requires on average 475.9 liters of water, the total change in national water use *per meal supplied* is only 164.4 liters (calculated as 60 million cubic meters of water divided by 1.87 million beneficiaries each receiving 195 meals per year). Similar patterns are observed for water use in Ghana and emissions in Malawi, but emissions per meal exceeds the average emissions per meal produced in Ghana. These differences reflect economywide adjustments induced by the school meal programs, particularly through changes in household consumption. Specifically, increased household demand for manufacturing goods at the expense of food or agricultural goods results in a decline in average water use but an increase in average emissions. This is at least true in Ghana, where industrial GDP responds positively, compared to Malawi where the exchange rate appreciation hurts the industrial sector (see Table 4).

4.2 Long Run Benefits and Costs

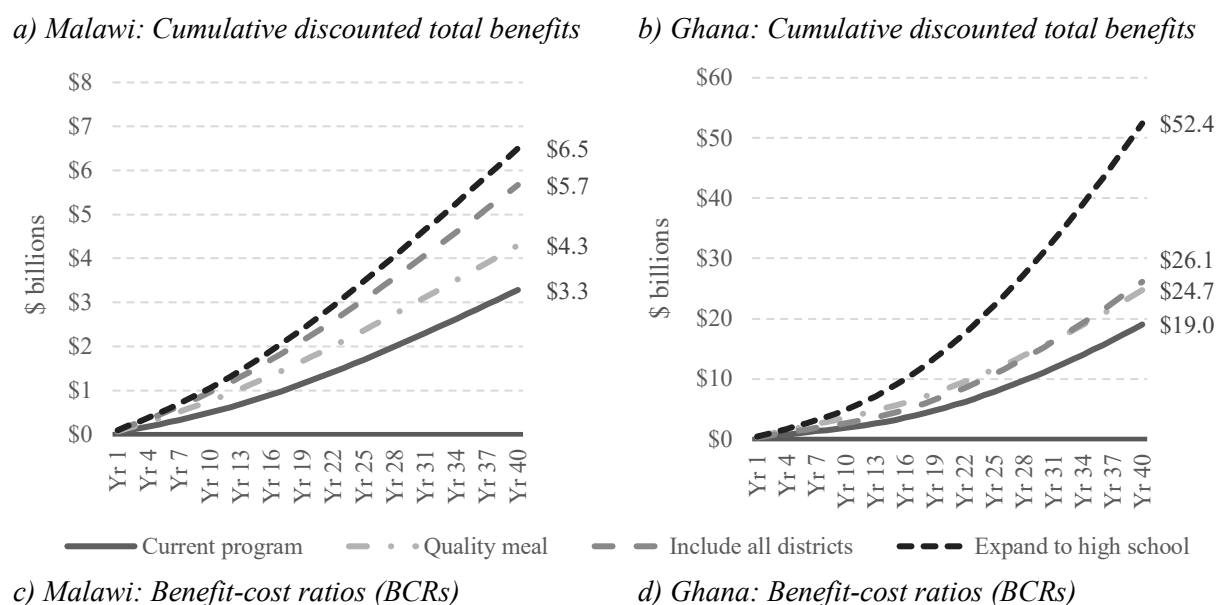
School meal programs generate substantial long-run benefits through improvements in human capital and labor productivity. Following Alderman et al. (2025), we assume that workers who participated in school meal programs experience a labor productivity premium of 1.15 percent for each year of program exposure relative to their peers, rising to 1.22 percent under the higher-quality meal scenario. As shown earlier in Table 4, total benefits—measured as domestic absorption plus internalized program costs—already exceed costs in the short run. While program costs will increase broadly in line with birth rates, which gradually decline over time, total benefits grow exponentially as the productivity premiums of school meal graduates persist and the share of program participants in the labor force increases.

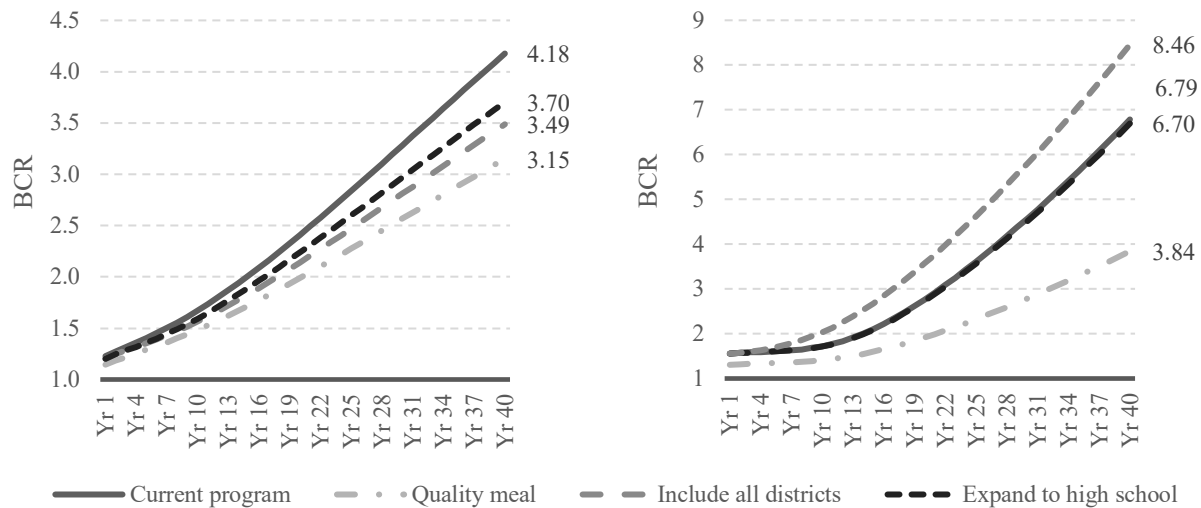
Panels (a) and (b) of Figure 4 show the cumulative discounted total benefits over the modeled 40-year horizon. A four percent annual discount rate is applied to future benefits. Under Malawi’s current program, the cumulative present value of future benefits is estimated at \$3.3 billion, equivalent to 26 percent of current GDP, while in Ghana the present value reaches \$19.0 billion, or 29 percent of GDP. Cumulative benefits increase further under programs offering higher-quality meals or those with expanded coverage. Ghana’s relatively larger program implies

a faster replacement of non-beneficiaries by school meal graduates in the labor force. As a result, we estimate that over the 40-year period, labor productivity gains account for 83 percent of total benefits in Ghana compared with 57 percent in Malawi. The remaining benefits arise from the direct income, consumption, and production linkages generated by school meal programs.

Panels (c) and (d) of Figure 4 present program BCRs. The BCRs in the first year of program implementation are the short-run BCRs reported in Table 4. Over time, BCRs increase due to labor productivity gains and the compounding effects of economic growth. After 40 years, BCRs are on average three times larger than the short run BCRs in Malawi and four to five times larger in Ghana. These BCRs are found to be consistent with those in the literature (see Alderman et al, 2025; Lundborg et al, 2022). This implies that the longer a government's planning horizon, the more favorable investments in school meal programs appear. In principle, gains from labor productivity improvements would eventually approach a saturation point once all non-beneficiaries in the labor force have been replaced by school meal beneficiaries, although reaching such a point would require universal program coverage among school children who eventually enter the workforce.

Figure 4. Combined Short- and Long-run Benefits and Costs





Source: RIAPA Model Results

5 Conclusions

This study applied an economywide modeling approach to assess the direct and indirect economic, welfare, and environmental impacts of school meal programs. By capturing linkages across sectors, households, and markets, the analysis provides a broader perspective on the economywide program costs and benefits than partial assessments focused solely on education or nutrition outcomes. Such evidence can inform program design and financing options, help mobilize donor and government resources, and support policymakers in anticipating potential economic, welfare, and environmental trade-offs.

The simulation results show that school meal programs reduce poverty and improve diet quality in the short run through both direct and indirect channels. Direct benefits arise from the provision of free food to beneficiary households, which plays a particularly important role in Malawi. Indirect benefits operate through production linkages and employment creation, a mechanism that is especially prominent in Ghana. Consistent with these findings, the analysis of equivalent variation indicates that school meals generate positive consumer welfare gains overall and tend to be pro-poor. However, the distribution of these gains is not uniform. While poorer households experience the largest welfare improvements, some non-poor households—particularly in Malawi—experience modest welfare losses associated with exchange rate adjustment under a donor-financed program.

Program design—and the mechanism used to finance the program—affects both the size and the structure of the economic growth induced by school meals. Nevertheless, the results indicate that the programs are economically justified even in the short run. Total short-run benefits—defined as domestic absorption plus internalized program costs—exceed costs from the outset, with benefit–cost ratios (BCRs) of 1.24 in Malawi and 1.56 in Ghana under current program designs. These short-run BCRs are lower than the income multiplier of 2.24 estimated by Gupta et al.

(2025) using a local economywide model for a Kenyan district with behavioral assumptions comparable to those of the RIAPA framework. Importantly, however, that estimate does not account for financing trade-offs, which are explicitly incorporated into the present analysis.

Although the immediate economywide impacts of school meal programs are modest, the long-run returns can be substantial due to improvements in human capital and labor productivity. Over a 40-year horizon, current programs are expected to generate future benefits with a present value equivalent to 26 percent of current GDP in Malawi and 29 percent of GDP in Ghana.

Correspondingly, long-run BCRs are three times larger than short-run estimates in Malawi and four to five times larger in Ghana. These BCRs are furthermore found to be consistent with those in the literature (see Alderman et al, 2025; Lundborg et al, 2022).

It is important to recognize that our modeled impacts are sensitive to underlying assumptions, including parameters related to school passthrough rates, labor force participation, employment probabilities, and the magnitude of labor productivity gains linked to exposure to school meal programs. Continued investment in rigorous program evaluation is therefore essential to strengthen the empirical evidence base and improve the assumptions that underpin economywide modeling exercises such as this one.

Although the present analysis captures a wide range of short- and long-run economic, welfare, and environmental impacts, several potential benefits of school meal programs remain outside the scope of our analysis. First, school meal programs may contribute to broader agricultural transformation by creating structured markets for smallholder farmers, potentially encouraging the adoption of improved technologies or environmentally sustainable farming practices not only for foods supplied to the program but also for agricultural production more generally. Secondly, school meals may have spillover effects on household dietary behavior, whereby the presence of school meals encourages healthier eating among other household members. Thirdly, beyond labor productivity gains, additional benefits could arise from improved health outcomes, such as reduced disease burden, lower mortality, and fewer years lived with disability. Future work should explore these dimensions further.

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7 Technical Appendix

7.1 Household Behavior and Poverty

Household consumption is modeled using a Linear Expenditure System (LES). In this framework, total consumption expenditure on commodity c by household h ($p_c q_{ch}$) is composed of a subsistence component and a discretionary component. The subsistence quantities (γ_{ch}) represent minimum required consumption levels, while the marginal budget shares (β_{ch}) determine how households allocate any supernumerary income after subsistence needs are met across goods and services. Thus, once basic needs are satisfied, households distribute additional resources according to fixed marginal spending patterns.

$$p_c q_{ch} = p_c \gamma_{ch} + \beta_{ch} \cdot (y_h - \sum_c p_c \gamma_{ch})$$

Free school meals are in-kind transfers that do not enter directly into measured household consumption expenditure ($p_c q_{ch}$). However, they reduce the quantity of food that households must finance themselves. We account for this implicit saving by reducing the subsistence parameters (γ_{ch}) by the exact quantities of commodities embedded in school meals received by different households (q_{ch}^s). This adjustment does not increase disposable income (y_h) directly, but it raises supernumerary income by lowering subsistence requirements. As a result, households gain additional discretionary spending power and can reallocate resources toward other goods and services without reducing food intake.

For the analysis of poverty and diet quality the full value of free school meals is added to total consumption expenditure when measuring changes in poverty or diet quality. The augmented

consumption measure is therefore defined as $p_c q_{ch} + p_c q_{ch}^S$. This adjustment ensures that poverty indicators reflect the total consumption of households, including the in-kind benefits received via school feeding programs.

7.2 Financing School Meals

How governments choose to finance school meals has important macroeconomic implications. Although the simulations presented in the main text were designed to reflect existing funding choices in Malawi (donor-funded) and Ghana (government-funded), we illustrate in this section how alternative government funding mechanisms matter. We use Ghana's existing school meal program as example.

A standard macroeconomic closure in CGE modeling is to assume that an increase in government spending is funded either by drawing down public savings (or the recurrent budget surplus) or by increasing government borrowing (or the recurrent budget deficit). The term "deficit financing" is often used to describe either mechanism. A decline in public savings reduces the total pool of public and private savings available to finance current investments. This crowding out effect will have implications for future capital formation and hence growth potential in the economy. Table A 1 demonstrates how a deficit-financed school meal program in Ghana results in a \$41.7 million decline in fixed investment.

Table A 1. GDP Impacts of School Meals Under Different Macroeconomic Closures: Ghana

	Baseline (\$ bil.)	Deviation from base (\$ mil.)			
		Deficit financing	Tax- funded	Donor- funded	Balanced closure
GDP at market prices	70.5	61.2	59.1	59.6	69.8
Domestic absorption	71.3	61.3	59.2	185.0	68.9
Private consumption (C)	52.5	-29.4	-43.8	18.8	25.1
Fixed investment (I)	13.9	-41.7	-29.4	33.8	13.6
Government cons. (G)	4.9	132.4	132.4	132.4	30.2
Trade balance	-0.8	-0.1	-0.1	-125.4	0.9
Exports (X)	26.9	0.7	-1.1	-65.8	34.9
Imports (M)	27.8	0.8	-1.0	59.7	34.0
Indirect taxes	4.5	-0.3	-0.4	7.4	2.9
GDP at factor costs	66.0	61.6	59.5	52.2	66.9

Source: RIAPA model results

Note: Compare Table 4.

As an alternative to deficit financing, government could choose to finance a new program by raising taxes. When the instrument is direct (or income) tax, this will typically cause household disposable income to fall, with negative welfare implications, especially for wealthier households who bear most of the tax burden under progressive tax systems. In instances where the school meal program actively targets lower-income households, tax financing will likely lead

to greater equality in the distribution of disposable incomes. Nevertheless, as shown in Table A 1, under this macroeconomic closure, in the case of Ghana, total household consumption declines by \$43.8 million.

Another option is donor-financing. When donors agree to provide direct budget support for a new government program, it mitigates the adverse effects on investment (via the reduction in government savings) or private consumption (via tax increases) as seen with the previous two closures. However, this mechanism triggers an increase in donor inflows from abroad equal to the cost of the program, which results in an exchange rate appreciation. This implies less competitive exports and an increase in imports, resulting in a \$125.4 million decline in the trade balance.

Given our interest in both short- and long-term impacts of school meal programs, we require a macroeconomic closure that ensures a stable long-term growth path. Under a balanced closure private savings rates and government expenditure adjust so that the shares of investment and government spending in domestic absorption are fixed. As shown in the final column of Table A 1, this spreads the macroeconomic costs and benefits of the program equally across the components of domestic absorption. Since government expenditure itself is constrained, it also means that at least part of the \$123.9 million cost of the program (see Table 4) is financed by reducing expenditure on health, education, and other government services, with the net change in expenditure now only \$30.2 million. Rather than assuming that reduced government spending in these areas has negative consequences on social outcomes such as health, education, or public infrastructure maintenance, we assume that these savings are achievable through more efficient use of resources.

In our main analysis we use a “hybrid” version of the balanced closure where government raises taxes in the case of Ghana and donors transfer funds from abroad in the case of Malawi to cover direct program costs, but investment and government (non-school meal spending) shares in domestic absorption are fixed following the balanced closure principles.

7.3 School Passthrough Model

Our long-term analysis estimates the future labor productivity gains of individuals who were exposed to school meal programs during childhood. To do so, we develop a cohort-based passthrough model that tracks beneficiaries as they progress through the education system and eventually enter the workforce. The model combines age-specific school attendance and transition rates with assumptions about labor force participation, and unemployment to predict whether, when, and at what level of education school meal beneficiaries enter employment.

We illustrate the approach using Ghana’s school meal program, which serves 3.62 million beneficiaries in the first year (see Table A 2). Household survey data are used to distribute these beneficiaries across age cohorts enrolled in kindergarten and primary school. Although Table A 2 presents national aggregates, the model used also distinguishes between rural and urban

populations, which have different school enrolment rates. Because kindergarten attendance in Ghana is optional while primary education is compulsory, the largest beneficiary group is the six-year-old cohort enrolled in primary school (521.7 thousand in Year 1). As the population grows, new cohorts enter the school system each year, and the size of the program expands accordingly. Over the 40-year simulation period, we assume an average annual birth rate of 0.5 percent, based on UN projections. As cohorts age, their size declines modestly in line with age-specific mortality rates.

After completing the sixth year of primary school, beneficiaries graduate from the school meal program, but the model continues to track their educational and labor market trajectories. For example, of the 460.8 thousand 11-year-old beneficiaries in Year 1, 346.5 thousand are projected to enroll in junior high school in Year 2, reflecting a 24 percent decline in enrollment between primary and junior high school. Those who leave the education system at this stage cannot legally enter the workforce until age 15 and are therefore tracked until they reach working age. Of the 345.3 thousand who complete junior high school by Year 4, 326.1 thousand transition to senior high school in Year 5. Individuals who exit after junior high are of legal working age and may enter the labor force, subject to participation and employment assumptions. Of the 324.8 thousand who complete senior high school in Year 7, only 26.5 thousand continue to tertiary education, where attendance rates are substantially lower. The 26.4 thousand tertiary students who graduate in Year 10 are assumed to enter the labor force in Year 11.

A similar progression is modeled for all age cohorts. For instance, of the 271.3 thousand children who enter the school meal program at age four, 30.7 thousand eventually complete tertiary education by Year 17. These individuals would have been exposed to school meals for eight years. To capture a meaningful share of beneficiaries' working lives, the model is run for an additional 23 years beyond the point at which this earliest cohorts enter employment.

Individuals who exit the education system may enter the labor force, provided they have already reached age 15. We assume a labor force participation rate of 70 percent and an unemployment rate of 25 percent among participants. Those who obtain employment are allocated to one of four labor categories in the RIAPA model defined by educational attainment (tertiary, secondary, primary, or incomplete primary). As older workers retire and new school meal beneficiaries enter employment, the share of exposed individuals in the workforce gradually increases over time.

Following Alderman et al. (2025), we assume that each year of exposure to the school meal program increases an individual's labor productivity by 1.15 percent relative to non-exposed peers. Using the projected number of employed beneficiaries in each education category, we calculate a weighted average labor productivity increase for each labor group in the model. As successive cohorts of exposed individuals enter and remain in the workforce, average labor productivity rises accordingly.

This passthrough model is necessarily stylized, and the magnitude of the simulated productivity gains is sensitive to assumptions regarding population growth, school attendance and transition

rates, labor force participation and unemployment, and the productivity returns to each year of exposure. The exercise should therefore be interpreted as an illustration of the potential long-term contribution of school meal programs to labor productivity rather than as a precise forecast. Further empirical research is required to refine the underlying parameters and strengthen the robustness of the projections.

Table A 2. School Passthrough Model for Ghana (Thousands of Students)

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	...
	Age	3,620	3,682	3,739	3,783	3,817	3,843	3,866	3,891	3,906	3,920	3,934	3,949	3,963	3,978	3,993	4,007	4,022	...
Kindergarten	4	271.3	272.3	273.3	274.3	275.3	276.3	277.3	278.4	279.4	280.4	281.4	282.5	283.5	284.6	285.6	286.7	287.7	...
	5	386.8	395.4	396.9	398.4	399.8	401.3	402.8	404.2	405.7	407.2	408.7	410.2	411.7	413.2	414.7	416.3	417.8	...
Primary	6	521.7	520.1	533.7	535.7	537.7	539.6	541.6	543.6	545.6	547.6	549.6	551.6	553.7	555.7	557.7	559.8	561.8	...
	7	514.1	520.0	518.4	532.0	533.9	535.9	537.9	539.8	541.8	543.8	545.8	547.8	549.8	551.8	553.9	555.9	557.9	...
	8	502.5	512.6	518.4	516.8	530.4	532.3	534.3	536.2	538.2	540.2	542.1	544.1	546.1	548.1	550.2	552.2	554.2	...
	9	488.8	501.2	511.2	517.0	515.4	528.9	530.9	532.8	534.8	536.7	538.7	540.7	542.7	544.7	546.7	548.7	550.7	...
	10	473.8	487.7	500.0	510.0	515.8	514.2	527.7	529.6	531.6	533.5	535.5	537.5	539.4	541.4	543.4	545.4	547.4	...
	11	460.8	472.9	486.7	499.0	509.0	514.8	513.2	526.6	528.6	530.5	532.5	534.4	536.4	538.4	540.3	542.3	544.3	...
Junior high	12		346.5	355.6	366.0	375.2	382.7	387.1	385.4	396.9	398.4	399.8	401.3	402.8	404.3	405.7	407.2	408.7	...
	13			345.9	355.0	365.4	374.6	382.1	386.4	384.8	396.3	397.7	399.2	400.6	402.1	403.6	405.1	406.6	...
	14				345.3	354.4	364.7	373.9	381.4	385.8	384.1	395.6	397.0	398.5	400.0	401.4	402.9	404.4	...
Senior high	15					326.1	334.7	344.5	353.2	360.2	364.3	362.0	375.4	376.7	378.1	379.5	380.9	382.3	...
	16					0.0	325.5	334.0	343.8	352.5	359.5	363.6	361.3	374.6	376.0	377.4	378.8	380.1	...
	17					0.0	0.0	324.8	333.3	343.0	351.7	358.7	362.8	360.5	373.8	375.2	376.5	377.9	...
Tertiary	18								26.5	27.2	28.0	28.7	29.3	29.6	29.3	30.9	31.0	31.1	...
	19									26.5	27.2	28.0	28.7	29.2	29.6	29.2	30.8	30.9	...
	20										26.4	27.1	27.9	28.6	29.1	29.5	29.1	30.7	...

Source: Author's illustration

Note: All numbers are in thousands.