Infrastructure investments for improved market access in sub-Saharan Africa: A CGE analysis

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Abstract

Many governments adopt agricultural policies that affect production incentives across commodities. In addition, severe market failures in the form of high marketing margins often lower the prices that farmers receive. Yet the impacts of excessive market-access costs for farmers has not been sufficiently analysed, particularly in sub-Saharan Africa (SSA). Using the newly available FAO/MAFAP dataset, we augment the GTAP model with domestic support and border protection, as well as data on market development gaps (MDGs) in selected SSA countries. We undertake several policy simulations to explore the impacts of changes in excessively high marketing costs. Our findings indicate that addressing MDGs can bring positive overall benefits, with particularly strong gains accruing to sectors and countries with very negative MDGs, such as the non-traditional crops in Ethiopia. In other cases, reducing positive MDGs, which operate as protection of certain sectors from imports, is projected to lead to a decline in exports and output, such as in the case of Ethiopian oilseeds.

Key words: policy distortions; market failures; infrastructure investments; sub-Saharan Africa; CGE modelling

1. Introduction

Governments in many countries adopt policies that affect the agricultural sector and influence farmers' behaviour through various channels. Such trade and domestic market policies may affect the prices farmers receive for their produce, and the prices of the inputs they purchase. In addition, governments often use budgetary transfers to support specific agents, either directly or indirectly, through expenditure on and investments in public goods (research, infrastructure, etc.). While these policies and their incidence have long been monitored and analysed by the OECD for member countries and selected emerging non-OECD countries, there is very little literature focusing on developing countries, especially those in sub-Saharan Africa (SSA). This is largely due to challenges related to data quality and availability in this region, which has resulted in a paucity of research on topics such as the efficacy and efficiency of input subsidies, or the return on public spending in agricultural research and infrastructure as opposed to transfers on private goods (Fan & Chan-Kang 2004; Boopen 2006; Barret 2008; Short *et al*. 2014). This paper contributes to filling the gap in the policy literature by applying a computable general equilibrium (CGE) model to selected developing SSA countries, allowing us to account for cross-sector and inter-regional linkages while analysing the impact of reductions in market development gaps (MDGs).

Following an experiment by Krueger, Schiff and Valdés (1988), first Anderson and Valenzuela (2008), and then Anderson and Nelgen (2013), took a first step to bridge this gap in the literature by estimating the distortions to agricultural incentives in developed and developing countries. More recently, the Food and Agriculture Organization (FAO) implemented the Monitoring and Analysing Food and Agricultural Policies (MAFAP) programme, with the objective of updating this kind of dataset for developing countries. More generally, the MAFAP programme seeks to establish country-owned and sustainable systems to monitor, analyse and reform food and agricultural policies to enable more effective, efficient and inclusive policy frameworks in a growing number of developing and emerging economies. Recent MAFAP data show that multiple SSA countries have adopted agricultural, trade policy or budgetary transfers to stimulate agricultural production and productivity growth in an attempt to achieve food security (Angelucci *et al*. 2013; Balié & Nelgen 2016). Such policy decisions include a wide range of policy measures, from highly distortive administered producer or consumer prices, border protection or export restrictions, slightly less distortive input subsidies, and more WTO-compatible types of direct or indirect transfers, to agents or groups of economic agents to support marketing, research, extension and/or infrastructure (such as feeder roads and storage facilities).

An analysis of the MAFAP dataset suggests that there are additional factors, other than trade, market and price policies, which contribute to the pattern of production disincentives across commodities in SSA (De Janvry *et al*. 1991; Markelova *et al*. 2009). For example, border policies favourable to consumers are often combined with excessive market-access costs (transport, handling, storage, margins, etc.) that reveal inefficiencies in or underdevelopment of the value chains (Clark *et al*. 2004), therefore lowering the prices received by producers. This can be the case even when offsetting mechanisms for producers in the form of support and budgetary transfers, such as input subsidies, are in place. Ultimately, one of the recurrent MAFAP findings is that, when farmers receive price disincentives, this is not primarily and necessarily the result of explicit policies in the form of direct taxation, but rather because they face very high market-access costs (Goetz 1992; Jayne 1994; Staal *et al*. 1997; Poulton *et al*. 2006).

Governments in developing countries are increasingly recognising that long-term development issues, such as agricultural transformation, smallholder farmers' participation in markets and agribusiness development, are linked not only to short-term policies, but also to investment decisions, especially on infrastructure (Asiedu 2002; Ndulu 2006). Yet the specific issue of the excessive market-access costs for farmers and other agents in key value chains has not been analysed sufficiently to date. In MAFAP countries, these high marketing margins for exportable commodities represent a serious handicap in international competition, relative to the situation of the main emerging economies that benefit from better physical infrastructure. Strategic decisions are needed from governments on the types of targeted domestic investments that could bring these costs down. As budgetary allocations are usually a zero-sum game in most SSA countries, there is a need to account for the trade-offs in decisions on allocations for public expenditure. More evidence is needed to convince decision makers that a different mix in the allocation of public resources that favours transport infrastructure might be beneficial to the agricultural sector and the economy as a whole.

Exploiting the dataset compiled by MAFAP, we extended the standard Global Trade Analysis Project (GTAP) model and database to include agricultural border protection and export distortions, along with detailed data on market access costs, in a few commodity-specific value chains for selected SSA countries. The countries currently covered by the MAFAP dataset are Bangladesh, Benin, Burkina Faso, Burundi, Ethiopia, Georgia, Ghana, India, Kenya, Malawi, Mali, Mozambique, Nigeria, Rwanda, Senegal, Tanzania and Uganda. In the current study, we focus on nine of the SSA countries covered by MAFAP.

The aim of this paper is to shed light on the likely impacts of selected policy-reform scenarios in selected SSA countries. We performed four different policy simulations to explore the issue of modifying disincentives to agricultural production and market participation resulting from high marketing costs under alternative assumptions. Our paper is unique in two ways: firstly, this is a novel attempt to employ a global CGE model to comprehensively analyse the effects of various agriculture-related policies using the newly available MAFAP dataset; secondly, we incorporate the distortions in agricultural markets and MDGs, as well as the economic cost of public investment to alleviate them.

In the following section, we discuss and analyse the MAFAP dataset. We then introduce the methodology used and explain how the MAFAP dataset is incorporated into the GTAP model to facilitate modelling of the selected policy simulations. In the fourth section, we explain the policy simulations undertaken and present our results. Finally, we summarise our findings and offer concluding comments.

2. Overview of the MAFAP dataset methodology, and price incentive analysis

In this second section, the MAFAP dataset and methodology are succinctly introduced, while in sections 3 we show how certain indicators for price incentives have been extracted from this dataset and integrated into the GTAP database.

2.1 Methodology for price incentive analysis

The MAFAP methodology produces five country- and commodity-specific indicators: (i) price gap; (ii) nominal rate of protection (NRP); (iii) effective rate of protection (ERP); (iv) nominal rate of assistance (NRA); and (v) MDG. The first two are calculated at three points along the value chain (retail, wholesale and farm gate), while the latter three are only calculated at farm-gate level (MAFAP 2015; Tokgoz *et al*. 2016). The price gap and the NRP are calculated in two alternative forms: (i) observed and (ii) adjusted. Observed indicators include all direct policies over the specific commodity, while the adjusted indicators additionally account for indirect taxation and market inefficiencies. The MDG summarises the gap between observed and adjusted NRPs. Indicators have been computed annually from 2005 onwards and are updated regularly. Commodities are selected based on their contribution to the country's agricultural GDP, food security, the import bill and export revenue. Products with high potential in promising or emerging value chains are also taken into account.

The MAFAP database currently includes 14 SSA and three Asian countries, of which we are analysing nine SSA countries in this study. All indicators (see Table 1) are publicly available on the MAFAP website.[1]

Table 1 includes output data (or the so-called MAFAP indicators) in column 1 that are generated by building on the input data (or data elements) listed in column 2, which are typically gathered at country level.

Some of these indicators have already been used for research focusing on methodological advances in the measurement of policy effects and externalities (Suarez *et al*. 2013), or for empirical research, for example on the role played by policy interventions in farmers' supply responses to price signals

[1] http://www.fao.org/in-action/mafap/en/; Data elements are available upon request.

(Magrini *et al*. 2017), or on commodity-specific value chain and market dynamics (Popat & Tostão 2016; Ghins *et al*. 2017a).

Table 1: List of MAFAP indicators

Publicly available	Available upon request
Price gaps Nominal rates of protection (NRP) Nominal rates of assistance (NRA) Effective rates of protection (ERP) Market development gaps (MDG)	Benchmark prices Access costs Output prices Input prices Quantities Quantity conversion factors Quality conversion factor Nominal exchange rate

The data elements for the estimation of the MAFAP price and market distortion indicators are based on data from the countries' national institutions. The data are comparable and consistent across countries, and data inputs required for the analysis are provided, along with potential sources. In order to calculate the MAFAP indicators, the following data are required:

- The benchmark prices are the annual nominal prices of the commodity at the country's border where the commodity is imported or exported. For net imports, the benchmark price is the CIF (cost of insurance and freight) price. For a net export, the benchmark price is the FOB (free on board) price. The sources usually include the UN Comtrade database, the BACI database (world trade database developed by CEPII), the FAOSTAT trade database and national sources (e.g. Ministry of Trade or Statistics).
- The exchange rate is the annual average of the nominal exchange rates between the local currency and USD. The main sources are the International Monetary Fund database and the World Bank World Development Indicators (WDI) database.
- Domestic prices at the wholesale, farm gate or retail levels are annual nominal prices. The point in the value chain where the domestic product competes with the internationally traded product is called the point of competition. For a net export, this may be the price at the international auction or the price at the border. For a net import, the price at the point of competition is the price at the main wholesale market where the product is traded domestically. The nominal producer price is sought at the commodity's main production area. Usually, the main source of data is at the national level, e.g. commodity boards, producer organisations, ministries of agriculture, statistics bureaus, planning or trade directorates. Occasionally, MAFAP also uses the FAO's Food Price Monitoring and Analysis (FPMA) database, as well as the CountrySTAT database.
- Input costs and quantities at farm level are necessary to measure the effective rate of protection (ERP), which is based on value added. The MAFAP country-level teams use data from the annual crop budgets of representative farmers in the main producing areas of the relevant value chains. Prices and applied quantities of the main tradeable inputs, such as seeds, fertilisers and energy, are taken into consideration.
- Access costs from the border to the point of competition, from the farm gate to the point of competition and from the point of competition to retail are also very important data requirements to compute MAFAP indicators. Marketing costs include border clearance costs, storage and handling, domestic transport, government taxes and fees, bribes, marketing margins of traders and processors, etc. The main sources of data include national sources (e.g. commodity boards, producer organisations, ministries of agriculture, statistics, planning or trade); private companies (i.e. processors, estates, etc.); value chain and marketing studies/publications; as well as estimates of the port costs, for example MAFAP relies on the Doing Business and/or Enabling the Business of Agriculture databases produced by the World Bank Group. Data are usually collected with

annual frequency, even if in some cases this is not possible. In these cases they are inferred using the available information for previous years.
- Average quantity and quality conversion ratios are used to make products comparable at different stages of the value chain. In order to compare like with like between the internationally and domestically produced commodities, a conversion needs to be made that accounts for the difference in quality. The quantity conversation ratio relates to the volume of a given commodity generated from one unit of raw input of the same commodity. This information is only relevant for those commodities that undergo processing between the farm gate and the point of competition, or between the border and point of competition. To obtain both the quantity and quality conversion ratios, national sources (e.g. commodity boards, producer organisations, ministries of agriculture, statistics, planning or trade), including private companies (i.e. processors, estates, etc.) are favoured.

The NRPs estimated by MAFAP for a sub-set of countries are incorporated in the modelling, as is explained later.

2.2 A brief MAFAP analysis of price incentives and market distortions

The aggregate NRP indicator across commodities for the 14 African countries analysed here is close to zero on average (-2%), but some major fluctuations are visible over time, especially in 2009 and 2011. The general pattern is that of an evolution from substantial production disincentives from 2005 to 2011 to an overall situation of production incentives from 2012 to 2016, indicating an increased level of support for the agricultural sector after international markets had stabilised (Figure 1). Overall, the changes in trend were seemingly caused by the food price crises and policy interventions that were put in place to curb food prices in these years.

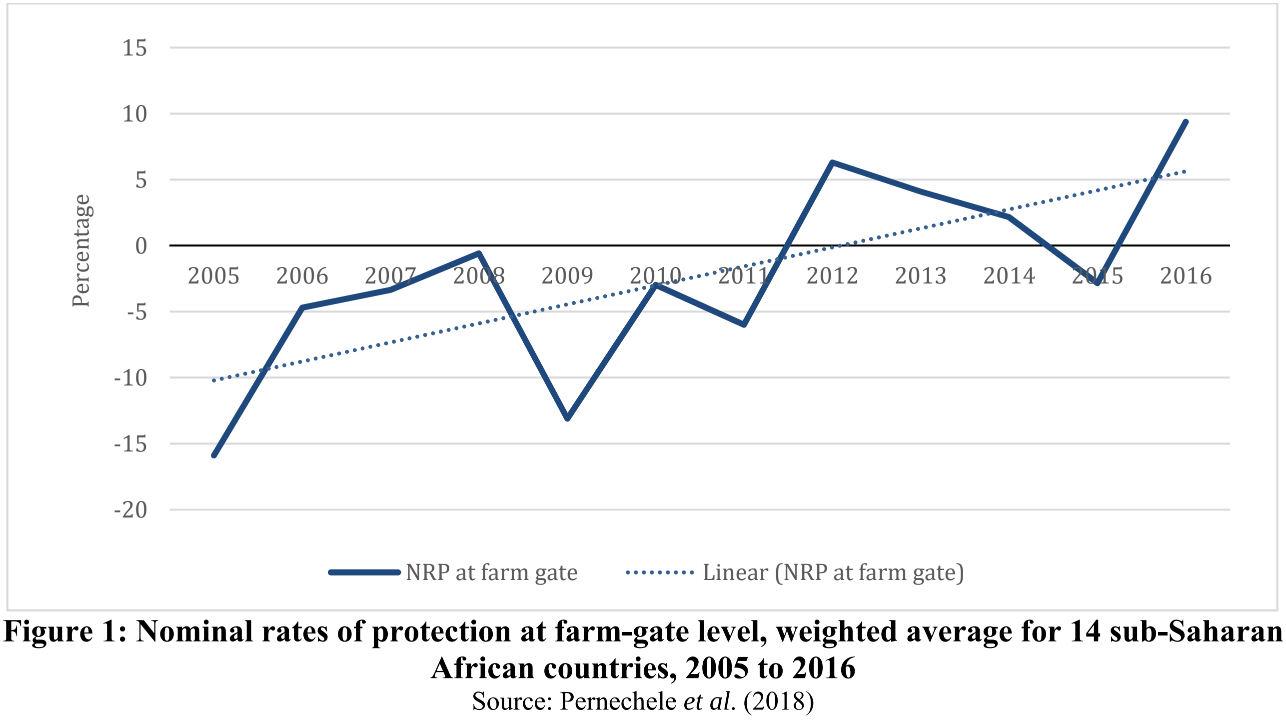

Figure 1: Nominal rates of protection at farm-gate level, weighted average for 14 sub-Saharan African countries, 2005 to 2016
Source: Pernechele *et al*. (2018)

As can be seen from **Error! Reference source not found.**, the level of support varies according to the trade status of the commodity analysed. Cash crops have been penalised, as farmers have generally obtained lower prices than those prevailing in the international market. However, food security crops, which are primarily import substitutes, have tended to receive increasing price incentives over the analysed period in the 14 SSA countries studied. This is fully consistent with previous political economy analyses of distortion to agricultural incentives, which revealed an anti-export bias (Anderson & Martin 2009; Anderson & Masters 2009; Anderson & Swinnen 2009; Martin & Anderson 2011).

It should be noted, however, that the trade status of a commodity in the MAFAP database is defined on the basis of the net trade position of a country for the product (export minus imports) in a given year. The net trade position makes it possible to determine the international benchmark price to be used in the computation of the NRP. In many developing countries it is not unusual to observe that a commodity is imported in one year and exported the following year, or may even not be traded any more once price incentives are removed (Anderson & Valdes 2008; Dawe *et al*. 2015). Therefore, the composition of the two groups (export and food security crops) should not be considered as predefined, but rather subject to evolution over the period of analysis.

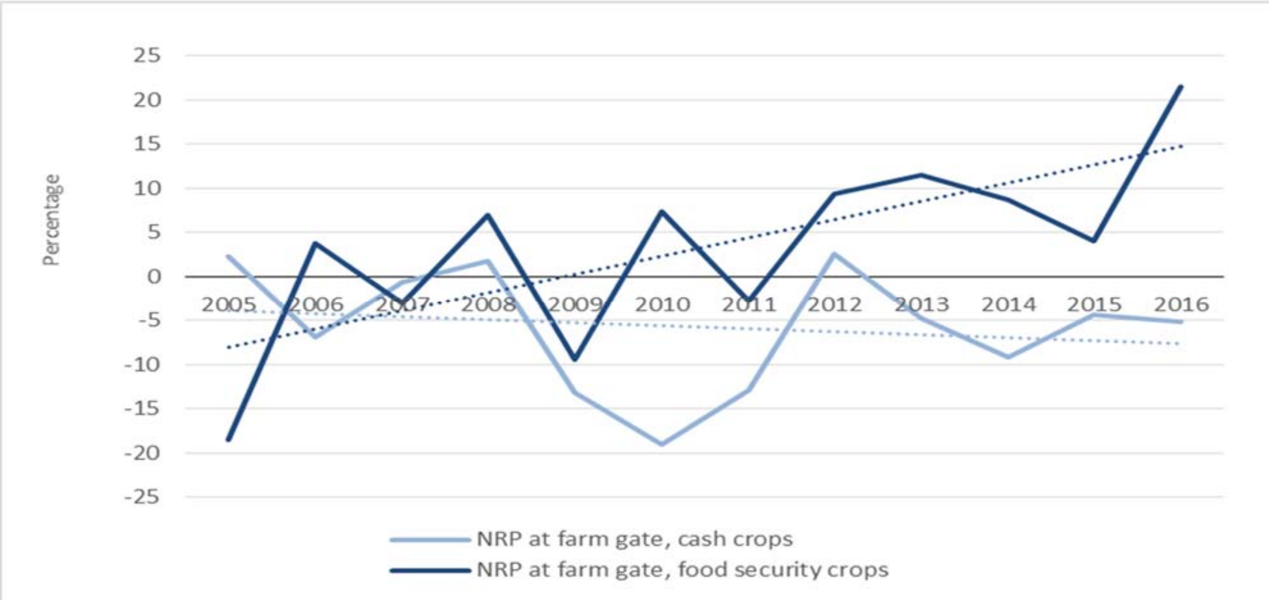

Figure 2: Nominal rates of protection (and related trend line) at farm gate for food security and cash crops; weighted average for 14 sub-Saharan Africa countries, 2005 to 2016
Source: Pernechele *et al*. (2018)

As mentioned previously, most policy analysts recognise that, in order to fully understand the source of disincentives to agricultural production, marketing and trade in the context of a developing country, it is often necessary to look beyond explicit price, market and trade policies, and to include the role of market inefficiencies at large in the analysis. In this study, these include market failures in the form of a lack of good infrastructure, restricted land rights, illicit taxes, limited access to credit markets and technologies, as well as bribes as sources of additional distortions. In the MAFAP methodology, these types of market inefficiencies are revealed by the MDG (see Figure 3). Moreover, explicit policies can have compensating effects on the agricultural sector and on farmers, therefore affecting the same indicator. The extreme case is that an indicator shows zero distortion, when in reality the incentives and disincentives to producers are levelling each other out, with each perhaps causing inefficiencies and ultimately discouraging farmers from producing, marketing and trading their produce.

The development of the MDG over the studied time period (Figure 3) indicates the significant role that market inefficiencies play in generating price disincentives, compared to the effects of all other policies (i.e. trade, price or other market policies) as revealed by the NRPs. The reasons for these market inefficiencies are mainly government taxes and fees, bribes, high transport and processing costs, and the concentration of rents among intermediaries. During the 2005/2016 period, the aggregate MDG, expressed as a percentage of the farm-gate price, was -4% on average, ranging between -5.5% in 2005 and -3% in 2007. Overall market inefficiencies reduced price incentives to farmers by about 4% on average. The trend remained stable across the period, with no clear improvement seen. High transport and processing costs, fees, bribes, as well as the apparent concentration of rents among intermediaries (e.g. excessive traders' profit margins) seem to remain major constraints to the development of the sector, at least on the price incentives side.

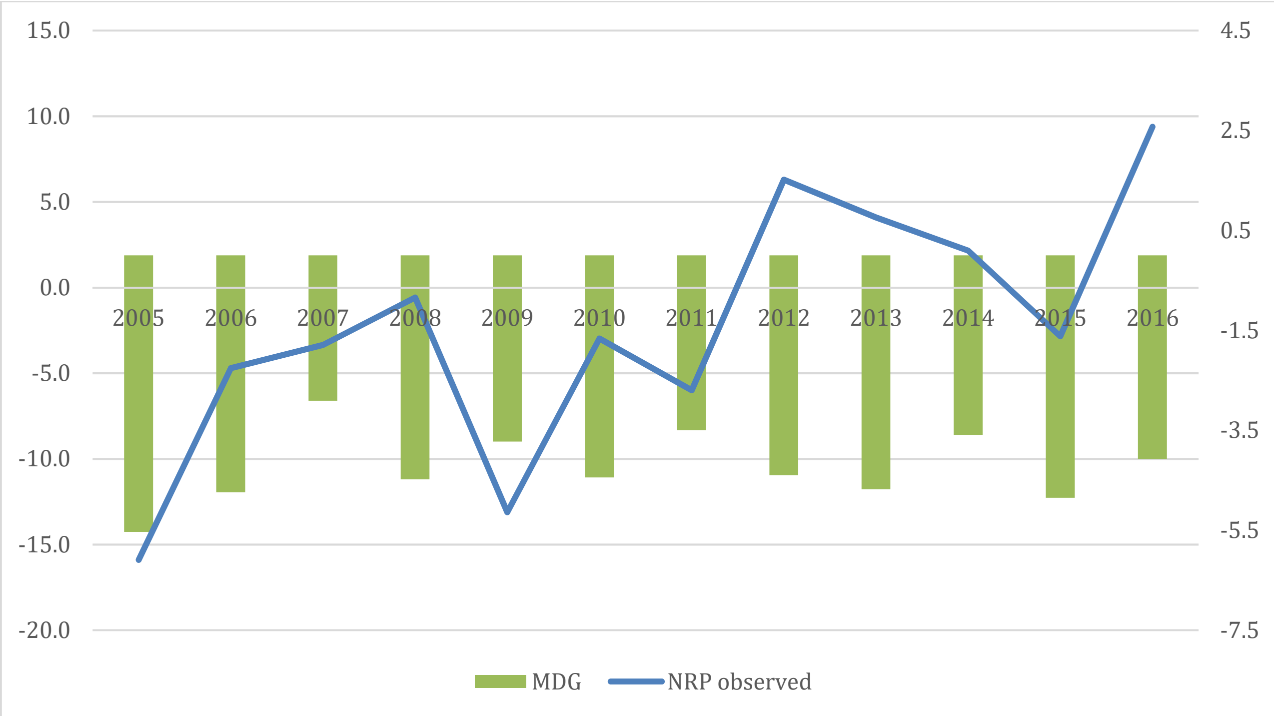

Figure 3: Market development gap* (right-hand axis, %), NRP observed (left axis, %), weighted average for 14 sub-Saharan African countries, 2005 to 2016

* The market development gap (MDG) is expressed as a percentage of the NRP observed at the farm gate. It includes the values for both the farm to wholesale and wholesale to border segments of the value chain.

Source: Pernechele *et al*. (2018)

There are offsetting mechanisms for producers resulting from other forms of support, including primarily budgetary transfers such as input subsidies. The use of inputs by farmers in SSA is constrained by substantial market failures, including a lack of access to credit, the high cost of inputs, which are generally imported, price variability, and high market and financial risks (Jayne & Jones 1997; Barrett 2008; Dorward & Chirwa 2011). It is generally recognised that input subsidies are not effective at improving productivity in the long run, and they are costly for typically scarce national budgets; therefore, they often are not sustainable (Haggblade *et al*. 2002; Dorward *et al*. 2005; Byerlee *et al*. 2007; Jayne *et al*. 2010; Ghins *et al*. 2017b). These findings question the suitability of investment in input subsidies to offset the price disincentives arising in output markets for most products. A more promising option seems to be the promotion of investments addressing the high marketing margins faced by farmers to allow them to be able to participate effectively in markets and trade. Marketing margins are the focus of the current research, although it is recognised that they are only one set of the non-policy-induced price disincentives.

Assuming that the objective of governments is to support farmers to achieve higher levels of outputs, it seems useful to explore whether investments aimed at reducing transaction costs and, more particularly, marketing margins could indeed result in better market-price transmission to farmers and in a substantial increase in production incentives. Yet market-access costs have several components, including transport cost, handling cost, storage cost, commercial margins, and others. Because they are distinct in nature and composition, each of these costs is not likely to be reduced as a result of one single policy intervention. Rather, in most cases, a set of policy measures will be necessary to achieve results in terms of a reduction in the overall marketing costs. However, in this initial analysis, and for practical reasons, we focus primarily on the potential benefits of targeted public investments in road infrastructure that could lead to a substantial reduction in transport costs.

3. Incorporating MAFAP data into GTAP database and designing the policy simulations

We now turn our attention to the GTAP database and model that we employ in this study. We use GTAP version 9A, with a base year of 2011 (Aguiar *et al*. 2016). The GTAP database is an assembly of trade, protection, input-output, consumption and macro-economic datasets from various established sources across the world. We aggregate the 140 regions and 57 sectors in the full GTAP database to 21 regions and 21 sectors, allowing a focus on the countries and sectors of interest. We model 21 sectors; however, we further aggregate the agricultural sectors for reporting purposes, as shown in Table 2.

Table 2: Sectors focused on in the modelling

Sectors modelled	Corresponding GTAP sectors[2]	Aggregated sectors for reporting purposes
Paddy and processed rice	pdr pcr	Grains
Wheat	wht	Grains
Coarse grains	gro	Grains
Vegetables and fruits	v_f	Vegetables and fruit
Oilseeds	osd	Oilseeds and vegetable oil
Vegetable oils	vol	Oilseeds and vegetable oil
Raw and processed sugar	c_b sgr	Other crops
Other crops	ocr	Other crops
Cattle, sheep and beef	ctl cmt	Beef and sheep
Milk and dairy	rmk mil	Dairy

Source: Authors' aggregation of the GTAP database

We augmented the GTAP database with data from MAFAP.[3] Table 3 provides an overview of the countries and commodities covered by the MAFAP programme on which we are focusing in the current study. It is important to note that only a subset of the MAFAP dataset and resulting indicators are used in the current study. We incorporated MDGs, along with observed NRPs, from the MAFAP database into our modelling. Given the 2011 base year of our GTAP data, we used the 2010 to 2012 averages for the MAFAP indicators.[4] We focused only on the sectors identified in Table 3 and on selected African countries: Burkina Faso, Ethiopia, Ghana, Kenya, Malawi, Mozambique, Tanzania, Uganda and Senegal.

[2] www.gtap.agecon.purdue.edu/databases/v9/v9_sectors.asp

[3] We employed the widely used Altertax method (Malcolm 1998), which enabled us to change the taxes and subsidies in the dataset while restricting other parts of the database from adjusting.

[4] In cases where several MAFAP products had to be aggregated into one GTAP sector, simple averages were used.

Table 3: MAFAP commodity coverage for the countries analysed in this study

Burkina Faso	Ethiopia	Ghana	Kenya	Malawi	Mozambique	Senegal	Tanzania	Uganda
Cattle	Barley	Cassava (raw)	Beans (dry)	Cotton	Cashew nuts (processed)	Onion	Cashew nuts	Cassava (raw)
Cotton	Beans	Groundnuts	Beans (green)	Groundnuts	Cashew nuts (raw)	Potatoes	Coffee	Cattle
Groundnut	Cattle	Maize	Cassava (raw)	Maize	Cassava	Rice	Maize	Coffee
Maize	Coffee	Palm oil	Cotton	Sugar	Cotton		Rice	Cotton
Onion	Lentils	Rice	Maize	Tea	Maize			Milk (cow)
Rice	Maize	Yam	Potatoes	Tobacco	Rice			Maize
Sesame	Sesame		Rice					Rice
Sorghum	Sorghum		Sorghum					Sugar cane
	Teff		Sugar cane					Tea
	Wheat		Tea					Wheat
			Wheat					

Source: Authors' analysis based on the MAFAP database

For border NRPs, we followed the methodology developed by Jensen and Anderson (2017) to incorporate a database on distortions to global agricultural incentives (Anderson & Nelgen 2013) into the GTAP model. In the MAFAP database, the NRPs generally are calculated at different levels of the value chain (farm gate, wholesale and retail). We used the farm gate indicators and followed the Jensen and Anderson approach of combining the raw and processed versions in the cases of rice, sugar, sheep and cattle, and milk, applying the distortions to these aggregated sectors (Table 2). For the observed border NRPs (Table 4), we first determined whether the product is primarily an importable or exportable product, based on the GTAP self-sufficiency ratio. We then modelled the distortion as an equivalent import or export price wedge. In particular, we assumed that the initial tariffs in the GTAP database form a component of the MAFAP border NRPs. We used these NRPs to estimate an ad valorem equivalent of the non-tariff barrier (NTB) to trade, which is equal to the MAFAP NRP minus the average tariff imposed by that region for a given sector in the GTAP database.

Once we had isolated the NTBs for the products classified as importable, we added the average import NTB impacting a country to the bilateral tariff structure already present in GTAP. This gave us a total import distortion that includes the average NTB from MAFAP, along with the bilateral tariff rates from the GTAP database. For sectors classified as exportables, we implemented the MAFAP NRPs identified for all regions. Since there are no relevant GTAP export distortions for these commodities and regions, we simply incorporated the average MAFAP export NRPs into the GTAP database.

Table 4: MAFAP border NRPs (%)

Commodity group	Burkina Faso	Ethiopia	Ghana	Kenya	Malawi	Mozambique	Tanzania	Uganda	Senegal
Rice	6.8[*]		-14.9[*]	27.7[*]		-27.8[*]	83.3[*]	87.4	18.9[*]
Wheat		5.1[*]		-2.5[*]				-19.4[*]	
Coarse grains	48.3	-36.5	-39.1	-3.8[*]	68.6	-1.8[*]	-20.4	50.7	
Vegetables & fruits	-47.0	-24.6	9.7	-3.6		-3.8	-3.6	15.5	-15.8
Oilseeds	6.9	-39.2	-13.3	-34.3[*]	-22.0	-12.7		8.7	33.2
Sugar				48.2[*]	3.5			-32.9[*]	
Other crops		-33.7		-6.4	-9.4		-53.8	4.5	
Beef & sheep	-22.9	-54.9						-30.8	
Dairy								-34.6	
Vegetable oil			-41.2[*]						

[*] Classified as importable, with all others classified as exportable
Source: Authors' calculations based on the MAFAP database

In the case of MDGs, which are the primary focus of the current study, we implemented these as domestic output tax equivalents. The MAFAP MDGs summarised in Table 5 are primarily a measure of inefficiency in market access due to excessive transport and transaction costs. This is calculated as the difference between the observed reference price and an adjusted reference price, which reflects the price in a perfectly functioning market. Therefore, it is initially calculated as an absolute measure in value terms (in local currency), then put in relation to the farm gate or adjusted reference price. A negative MDG at farm gate represents a cost to farmers and may therefore be viewed as a tax equivalent. The reasoning behind positive MDGs is that some market inefficiencies can also be seen as protection from imports, mainly at a wholesale level.

Since the GTAP database already includes output subsidies and taxes, we used the MDG tax equivalents summarised in Table 5 to augment the output distortions that already exist in the GTAP database. This is appropriate, since they are capturing quite different aspects of the relevant market.

Table 5: MAFAP MDG distortions (%)

	Burkina Faso	Ethiopia	Ghana	Kenya	Malawi	Mozambique	Senegal	Tanzania	Uganda
Rice	24.1		9.7	2.8		-1.5	-24.4	-2.7	0.2
Wheat		-0.1		3.7					0.0
Coarse grains	-29.7	-3.0	8.4	-6.2	-7.9	-0.4		-58.4	-3.2
Vegetables & fruits	-7.8	-5.9	-18.2	0.1		-5.7	24.9	-18.4	-10.7
Oilseeds	-10.5	4.9	-11.0	-18.5	-13.6	-10.1	-21.7		-2.4
Sugar				0.0	-2.6				
Other crops		-36.3		-3.0	-26.2			-4.6	-1.1
Beef & sheep	-9.6	-33.8							-26.7
Dairy									-32.1
Vegetable oil			-6.5						

Source: Authors' calculations based on the MAFAP database

We undertook four simulations to explore the impact of reducing MDG tax equivalents under alternative assumptions:

- Full removal of all MDG tax equivalents.
- A 50% reduction in the MDG tax equivalents.
- A 50% reduction in the MDG tax equivalents, along with a 2% improvement in total factor productivity.

- A 50% reduction in the MDG tax equivalents, along with a 2% improvement in total factor productivity plus a tax-replacement assumption.

The first scenario with full removal of all MDGs provides a useful benchmark, although we acknowledge it is probably unachievable in practice. The second scenario, of a fifty percent reduction in the MDG tax equivalents, might be viewed as a more realistic possibility, with the largest MDGs perhaps likely to be the most difficult to reduce to very low levels. In the third scenario, in addition to the same fifty percent reduction in MDGs as in the previous scenario, we incorporated the issue that reducing these barriers is likely to improve productivity in the affected sectors and regions.[5] The final scenario is the same as the third, but we now incorporated a tax-replacement assumption, whereby the government is assumed to levy consumption taxes that keep the ratio of tax revenue to income constant when we reduce the tax equivalents of the MDGs in the affected regions by fifty percent.[6]

While the first three scenarios assume that the MDGs can be reduced without direct cost to the country, this final scenario aims to capture some of the effects of countries having to fund part of the costs of reducing the MDGs, for example through imposing a consumption tax. Given that government revenue in SSA is rather scarce, with many competing demands for expenditure, our assumption in the final scenario, that government revenue remains constant relative to income despite the increase in expenditure, may be regarded as reasonable. Using a tax-replacement assumption has the effect of raising the consumption tax more for those regions where the initial MDG tax equivalents are relatively high, arguably appropriate since there are likely to be greater costs in removing these large MDGs. In our modelling, the consumption tax required in this tax-replacement scenario falls between 0.2% for Senegal and 5.1% for Tanzania (Table 6).

Table 6: Consumption tax estimated in Scenario 4

Country	Consumption tax
Burkina Faso	3.9
Ethiopia	2.2
Ghana	2.9
Kenya	1.2
Malawi	3.5
Mozambique	0.5
Tanzania	5.1
Uganda	1.7
Senegal	0.2

Source: Results from authors' model

4. Results

Table 7 presents estimates of the potential impact on real GDP for each country of focus in the above scenarios. In each of the scenarios, particularly strong gains are projected for Ethiopia, with a more than 3.5% (US$1.2 billion) projected increase in real GDP in the first simulation. Given that Ethiopia has some of the MDGs in the MAFAP data (see Table 5), it is perhaps not surprising that our results indicate that it is likely to experience particularly strong overall gains from these types of improvements in efficiency. For other countries, the impacts on real GDP are projected to be somewhat lower. Our results indicate that the total increase in real GDP for the focus countries will

[5] We modelled this productivity increase in all ten sectors, reflecting the possibility that, even where there are not specific MDGs in these sectors, there are positive spillover benefits resulting from overall reductions in MDGs for these agricultural sectors.
[6] For details of the regional household specification in GTAP, including the government revenue and expenditure mechanisms, see Hertel and Tsigas (1997).

be US$1.8 billion in the first scenario, with full removal of MDGs. If there is a 50% reduction in the tax equivalents of the MDGs, the results of our second scenario indicate a total US$1.1 billion gain in real GDP for the region, increasing to US$2.1 billion if the removal of the MDGs also leads to a 2% increase in productivity (Scenario 3). However, if a consumption tax is applied in an effort to fund the costs of reducing MDGs (Scenario 4), the total GDP increase for the region is lower, at US$1.9 billion.[7]

Table 7: Projected impact on real GDP of each scenario (% and US$ million)

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
	Percent			
Burkina Faso	0.19	0.14	0.47	0.28
Ethiopia	3.64	2.16	3.08	3.11
Ghana	0.09	0.11	0.62	0.47
Kenya	0.11	0.06	0.57	0.58
Malawi	1.69	1.14	1.85	1.75
Mozambique	0.05	0.03	0.42	0.32
Tanzania	0.58	0.41	0.94	0.73
Uganda	1.26	0.48	0.85	0.75
Senegal	0.22	0.21	0.47	0.54
	US$ million			
Burkina Faso	20	15	49	30
Ethiopia	1 199	712	1 014	1 023
Ghana	36	40	234	178
Kenya	38	22	202	205
Malawi	99	67	108	103
Mozambique	6	4	52	39
Tanzania	142	101	232	178
Uganda	190	72	128	114
Senegal	32	30	69	80
Total	1 763	1 063	2 089	1 951

Source: Results from authors' model

Turning to impacts on overall economic welfare as measured by an equivalent variation in income, Table 8 suggests that the largest gain in absolute value terms again is likely to accrue to Ethiopia. This is partly because Ethiopia has relatively large MDGs compared to other sub-Saharan countries, but also because Ethiopia is a relatively large economy – the third largest among the countries under focus. In addition to allocative efficiency and technology improvements, welfare may also be affected by changes in the terms of trade for a region. In the case of Ethiopia, and also Senegal, improvements in the terms of trade contribute positively to the impact on welfare. However, for other countries, including Tanzania, Uganda and particularly Ghana, there are unfavourable changes in the terms of trade that dampen the gains in welfare. In the first simulation, these negative terms of trade effects lower welfare in Ghana by US$94 million, more than offsetting the positive gains in allocative efficiency, leading to an overall slight welfare loss for Ghana. In the other scenarios, all countries are projected to experience increases in welfare, with particularly strong gains in the case of Ethiopia.

[7] We acknowledge that modelling this as a consumption tax in the GTAP model is an imperfect mechanism for demonstrating the costs on the economy of having to invest more in reducing MDGs. However, it does capture the fact that the taxpayers have to compensate for such expenditure via an increased tax burden, which in turn has economic costs that are captured in the model.

Table 8: Projected impact on welfare of each scenario modelled, US$ million

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Burkina Faso	24	17	49	22
Ethiopia	1 642	945	1 281	1 278
Ghana	-22	11	206	194
Kenya	58	28	229	420
Malawi	153	95	136	136
Mozambique	2	1	47	24
Tanzania	125	96	223	156
Uganda	177	66	117	80
Senegal	108	70	115	195

Source: Results from authors' model

We now focus on more detailed sectoral results, exploring these for the third scenario, which combines reductions in MDGs with increases in productivity. Table 9 shows the impacts on real sectoral output, first in percentage changes and then in US$ million. In terms of the percentage change, particularly large sectoral impacts are projected for the other crops sector in Ethiopia and the rice sector in Senegal (shown aggregated into the grains sector in Table 9). This should not be surprising, given that these are among the sectors with the highest MDGs (Table 5). In dollar terms, it is the vegetable and fruit sector in Ghana for which we simulate a particularly large increase in real output. While the percentage increase is at a relatively modest 6.7%, this is a large sector, contributing almost 10% of total baseline output in Ghana in the largest of our economies under focus.

While sectoral results differ for the other scenarios modelled, the overall pattern of effects found in terms of the third scenario is very similar to that in all scenarios: central to all of the simulations is the elimination or reduction of the MDGs noted in Table 5 and, where there are large changes in particular MDGs, these tend to drive the results.

Table 9: Projected impact on real sectoral output under Scenario 3 (% and US$)

	Grains	Vegetables and fruit	Oilseeds and vegetable oil	Other crops	Beef and sheep	Dairy
	Percent					
Burkina Faso	3.1	3.8	8.0	1.6	3.3	1.8
Ethiopia	0.6	1.7	-31.2	38.8	10.0	2.1
Ghana	-2.1	6.7	7.0	-1.0	1.3	1.1
Kenya	1.3	0.6	3.4	4.4	0.5	-1.8
Malawi	-0.6	1.0	1.4	20.8	5.2	-7.7
Mozambique	1.3	3.2	6.8	2.4	0.8	1.0
Tanzania	10.3	7.3	1.0	1.9	2.0	2.6
Uganda	1.0	2.1	-0.2	0.8	33.2	35.1
Senegal	33.2	-6.4	11.7	0.7	0.9	0.6
	US$ million					
Burkina Faso	32.7	6.2	14.4	2.4	24.3	3.4
Ethiopia	27.5	73.4	-129.5	821.8	147.8	15.9
Ghana	-40.8	500.8	45.7	-23.2	7.9	2.9
Kenya	43.9	21.0	82.4	213.0	11.6	-20.7
Malawi	-3.9	6.1	4.2	200.4	7.3	-9.6
Mozambique	14.4	36.9	19.2	13.0	1.0	0.5
Tanzania	260.0	149.7	8.3	8.0	28.2	3.3
Uganda	3.3	39.9	-0.4	7.6	47.7	130.6
Senegal	186.9	-36.1	82.3	1.8	4.3	1.8

Source: Results from authors' model

Table 10 shows a similar set of results for Scenario 3, with percentage changes and dollar values, but this time for real exports. The general pattern of results follows the output results, although a number of the percentage changes are much higher, generally reflecting relatively small initial export flows in that sector. For example, Ugandan beef and sheep exports increase dramatically in percentage terms, but the more than 1 500% increase translates into a dollar increase of just $31 million. On the other hand, a 103% increase in exports of other crops from Ethiopia is equivalent to a more than $1 billion increase in exports from this relatively large exporting sector. Exports from some sectors decline, notably Ethiopian oilseeds and vegetable oil. This contraction is primarily due to oilseed exports, which are projected to decline by $143 million due to the reduction in an initially positive MDG, which served to protect the sector from imports (see Table 5). Reductions in positive MDGs that are sufficient to lead to both export and output expansions are also found in the case of grains for Ghana, fruit and vegetables for Senegal, and other crops for Ghana. In other cases, the relatively small declines are due to the general equilibrium effects of resources moving between sectors, for example we project a small contraction of dairy in Kenya and Malawi, even though no initial MDG was estimated for these countries in this sector.

Table 10: Projected impact on real exports under Scenario 3 (% and US$ million)

	Grains	Vegetables and fruit	Oilseeds and vegetable oil	Other crops	Beef and sheep	Dairy
	Percent					
Burkina Faso	58.8	9.1	24.3	2.7	85.8	8.7
Ethiopia	-21.7	-19.3	-37.5	102.6	84.2	-52.0
Ghana	-13.7	45.8	30.0	-1.5	2.5	2.3
Kenya	6.5	1.2	19.3	8.4	-0.2	-6.1
Malawi	-14.2	-29.4	-12.5	29.3	-52.0	-44.3
Mozambique	5.7	13.7	21.8	2.8	5.0	3.6
Tanzania	135.0	32.9	-5.5	2.4	5.4	16.7
Uganda	0.1	21.5	-0.5	0.7	1542.6	612.9
Senegal	166.9	-25.6	26.7	-0.2	-1.4	-0.9
	US$ million					
Burkina Faso	3.2	5.7	9.8	0.0	4.3	0.1
Ethiopia	-8.4	-77.4	-144.6	1091.0	150.7	-0.9
Ghana	-2.8	253.2	16.5	-30.8	0.1	0.3
Kenya	3.5	3.8	23.8	178.2	0.0	-1.8
Malawi	-10.7	-6.9	-5.4	207.2	-0.1	-1.3
Mozambique	1.8	23.1	16.0	9.2	0.0	0.0
Tanzania	133.3	94.1	-9.0	14.6	3.6	1.4
Uganda	0.0	8.0	-0.6	4.7	30.8	108.4
Senegal	21.7	-27.2	45.7	0.0	-0.1	-0.1

Source: Results from authors' model

5. Conclusions and policy implications

Given the role that the agricultural sector plays in improving food security in SSA countries, governments in the region often intervene directly in the sector, but, in addition, farmers frequently face distortions through non-explicit market distortions and inefficiencies (e.g. lack of good infrastructure, illicit taxes, inappropriate regulatory frameworks, bribes, etc.). In this study, we have quantified the impacts that these prevalent inefficiencies can have, alongside the impacts of more direct market distortions. It is obvious that direct measures are easier to observe, but the non-explicit distortions are just as, or even more, important in policy decision processes in the analysed SSA countries. Therefore, the MAFAP project estimates MDGs for agricultural commodities in selected SSA countries to help quantify such non-explicit distortions and guide the policy-making process with consideration of these. Using the newly available MAFAP dataset to augment the GTAP model allows us to estimate the gains in terms of GDP, welfare and trade that could be achieved through the reduction of these types of non-explicit distortions.

Not surprisingly, our overall results suggest that reducing MDGs, which provide a measure of non-explicit agricultural market distortions and inefficiencies, has the potential to lead to overall positive effects for the SSA region. Therefore, these results emphasise the importance of national policy frameworks considering market inefficiencies that are measured through MDGs, in addition to explicit market, trade and price policies. It also has to be borne in mind that, in many cases, such non-explicit market distortions cancel out the effects of explicit market, trade and price policies implemented by the governments. This is a further reason why they should form a well-considered part of the policy decision process.

We also observed that, while the economic burden of public expenditure in this area is not insignificant, the broad positive macroeconomic effects remain similar, even in our tax-replacement scenario, where we assumed that some of the costs of reducing MDGs are funded by imposing a consumption tax. While there are differences in output and export outcomes between sectors and countries, the particular gainers from this policy reform tend to follow from the extent of current MDGs in these sectors and countries, with the sectors and regions with the greatest MGDs tending to benefit the most.

We acknowledge that the focus of this study, namely non-explicit market distortions and inefficiencies in selected SSA countries, is a sensitive issue and requires the full commitment of the national authorities in order to step forward and tackle them in an efficient way. However, providing an enabling policy environment in order to foster growth in the agricultural sector and to reduce food insecurity is a very important task for the respective governments. It is important to base policy decisions on evidence, and using a sustainable systematic policy-monitoring system in combination with models such as GTAP can contribute useful insights. Our results show the benefits that a reduction of MDGs in SSA countries can have, e.g. through investments in infrastructure and other similar public goods, providing guidance for policy makers in that direction.

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