



European
Commission

JRC TECHNICAL REPORT

in collaboration with
FDRE Policy Studies Institute

COVID-19: socioeconomic impacts and recovery in Ethiopia

Victor Nechifor, Ole Boysen, Emanuele Ferrari,
Kidanemariam Hailu, Mohammed Beshir

2020



This publication is a Technical report by the Joint Research Centre (JRC), the European Commission's science and knowledge service. It aims to provide evidence-based scientific support to the European policymaking process. The scientific output expressed does not imply a policy position of the European Commission. Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use that might be made of this publication. For information on the methodology and quality underlying the data used in this publication for which the source is neither Eurostat nor other Commission services, users should contact the referenced source. The designations employed and the presentation of material on the maps do not imply the expression of any opinion whatsoever on the part of the European Union concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Contact information

Name: Emanuele Ferrari

Address: c/ Inca Garcilaso 3, Edificio Expo, 41092 Seville, Spain

Email: emanuele.ferrari@ec.europa.eu

Tel.: +34 95 44 88461

EU Science Hub

<https://ec.europa.eu/jrc>

JRC122405

EUR 30484 EN

PDF

ISBN 978-92-76-27015-7

ISSN 1831-9424

doi:10.2760/827981

Luxembourg: Publications Office of the European Union, 2020

© European Union, 2020



The reuse policy of the European Commission is implemented by the Commission Decision 2011/833/EU of 12 December 2011 on the reuse of Commission documents (OJ L 330, 14.12.2011, p. 39). Except otherwise noted, the reuse of this document is authorised under the Creative Commons Attribution 4.0 International (CC BY 4.0) licence (<https://creativecommons.org/licenses/by/4.0/>). This means that reuse is allowed provided appropriate credit is given and any changes are indicated. For any use or reproduction of photos or other material that is not owned by the EU, permission must be sought directly from the copyright holders.

All content © European Union, 2020, except cover photo © sdecoret – stock.adobe.com

How to cite this report:

Nechifor V., Boysen O., Ferrari E., Hailu K., Beshir M., *Socioeconomic COVID-19 impacts and recovery in Ethiopia*, EUR 30484 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-27015-7, doi:10.2760/827981, JRC122405.

Contents

- Summary.....2
- 1 Introduction.....3
- 2 Socioeconomic impacts assessment.....5
 - 2.1 Economy-wide modelling of impacts and recovery measures.....5
 - 2.2 Microsimulation poverty analysis6
- 3 COVID-19 impacts and short-term recovery measures7
 - 3.1 COVID-19 impact channels.....7
 - 3.2 Government measures.....7
- 4 Results.....9
 - 4.1 COVID-19 impacts at annualised levels.....9
 - 4.2 Recovery through government measures.....10
 - 4.2.1 Macroeconomic and sector-level effects10
 - 4.2.2 Employment.....12
 - 4.2.3 Household-level effects.....13
 - 4.2.4 Poverty impacts.....15
- 5 Conclusions and policy recommendations.....17
- References.....19
- List of abbreviations and definitions20
- List of figures21
- List of tables.....22
- Annexes23
 - Annex 1. Sectoral and household disaggregation in the JRC DEMETRA model for Ethiopia23
 - Annex 2. Shock values and additional results26

Summary

This technical report assesses the implications of the COVID-19 pandemic for the economic performance and poverty incidence in Ethiopia for 2019/20 and 2020/21. It takes into account the impacts of the pandemic on four channels: a) factor productivity, b) trade costs, c) export demand and tourism, and d) remittances and FDI. Through the inclusion of the Ethiopian government responses of stimulus spending, job protection and business support, the report evaluates the effectiveness of these measures for the economic recovery to pre-COVID-19 pathways.

By using a macroeconomic multi-sectoral model, the study includes results at national (GDP, supply, demand, trade), sectoral (output and prices) and household (welfare) levels. The household food expenditure results are then included as income measures in a poverty analysis module to further characterise the effects of the pandemic on poverty headcount, gap and severity.

In annualised terms, the modelling results show that the COVID-19 impacts could have been significant across all macroeconomic metrics had the government not intervened. The GDP would have decreased from pre-COVID-19 projections by -11.1% in 2019/20 and -6.7% in 2020/21, with severe implications for employment and household welfare. The government response consisting in increased spending (healthcare and food programmes) and salary payments to prevent job losses may have had an important role in improving the macroeconomic outcomes of the pandemic in 2019/20. Nevertheless, much of the aggregate recovery (GDP, employment and welfare) is driven by agriculture as output in most manufacturing, construction and services sectors continue to be affected by productivity shocks and low demand. Therefore, employment and output outside agriculture could still be below the pre-COVID-19 projections even when additional business support measures are included.

Without government intervention, the poverty headcount would have increased by about 5% in total population. The government measures are projected to mitigate that effect to a large extent and to allow national poverty to reach pre-COVID-19 values in 2020/21 or to even fall below in case of an enhanced business stimulus package from the government. Nevertheless, poor urban households continue to be negatively affected and would require more targeted support.

Authors

Nechifor Victor	JRC - Seville
Boysen Ole	JRC - Seville
Ferrari Emanuele	JRC - Seville
Hailu Kidanemariam	FDRE Policy Studies Institute
Beshir Mohammed	FDRE Policy Studies Institute

Note: The implementation of the CGE and microsimulation modelling framework has been entirely performed within JRC premises by Victor Nechifor, Ole Boysen and Emanuele Ferrari. All simulations in this study were finalised in October 2020.

1 Introduction

The COVID-19 pandemic will likely produce one of the deepest global economic recessions in decades with the world economy potentially taking a few years to recover to its pre-2020 levels. Declared as a pandemic by the WHO in mid-March 2020, the economic effects of COVID-19 on the African continent may have been felt sooner than the occurrence of the first cases. The strict lockdown measures taken in China at the beginning of the year, followed by the further restrictions in Europe and the USA, have taken their toll on the international movement of goods and people, with significant impacts on international trade and tourism. There are early indications that global trade has fallen by 5% in the first quarter of 2020 and is set to decline by 20% over the year (UNCTAD, 2020). Furthermore, international passenger flying has been reduced significantly from the middle of March, with the global number of flights expecting to decrease by two-thirds in 2020 compared to the previous year (IATA, 2020a).

Prior to the onset of COVID-19, Ethiopia was one of the Sub-Saharan African nations with remarkable economic growth as the country achieved an average annual GDP growth 10.4% in the last decade. Moreover, the country has been witnessing high investment (both domestic and FDI), rising tax revenue which accounts for nearly 80% of the government expenditure in the last five years, and a reduction in poverty incidence by extending safety net programs to support chronically food insecure people (FDRE MoF, 2020).

However, the country will be challenged by the COVID-19 pandemic since it costs lives, limits movement of people and forces closure or reduction in firms' production capacity. Moreover, the inflationary macroeconomic situation of the country tends to exacerbate welfare impacts of the pandemic especially on those food poor households (reference).

In order to minimize the societal and economic costs of the pandemic, the government has introduced, on the one hand, a number of restrictions/safety measures to limit the spread of the virus and, on the other hand, arrays of economic stimulus packages in the forms of wage subsidies to protect jobs, increasing food and health related emergent costs, tax waivers and direct business supports (FDRE MoF, 2020).

The measures taken by the government to limit spread of the pandemic were related to:

A. Restrictions/safety measures pertaining to movement of people and goods:

- Public Transportation: a) Addis Ababa's light rail operated with 25% seat occupancy; b) Ethio-Djibouti railway operated with 50% seat occupancy; c) all other public transportation (buses, taxis, etc.,) operated with 50% seat occupancy.
- Private Transportation - all vehicles operated with occupancy level 50% of available seats (excluding the driver).
- Movement of goods across borders - all movements across land borders, except for the flow of cargo and essential goods were banned.

B. Measures taken in relation to government services:

- Working hours: a) Federal Government agencies were made to operate at a reduced capacity with significant employees working from home (effective as of March 25, 2020, until further notice); b) working hours for government agencies have been adjusted; c) all federal government agencies were providing services from 07:30 am to 03:30 pm. Addis Ababa City Administration were providing services between 09:30 am to 05:30 pm
- Flights and logistics for inland transfers: a) export manufacturing industries which did not use railway services due to location distances were given a 50% discount on export freight services; b) transport services dedicated for freights from Hawassa to Mojo with a 50% discounted price and 73% discount for manufacturing sector exports using service of ESLSE; c) Ethio-Djibouti Railway transported export materials from industrial parks and export manufacturing industries that come through Mojo dry port to Djibouti free of charge for three months (starting May 1/2020) with a possible extension of an offer for the following 5 months.; d) 50% cost reduction on inland transfer from industrial parks to Mojo railways; e) demurrage cost at the port was lifted until the situation on COVID-19 pandemic improved.
- Dry port services: entrance gate payment was waived for manufacturing export freights passing through Mojo port to Djibouti and a 50% discount of all other charges from their initial prices was applied.
- International flights: Ethiopian Airlines has ceased flight operations to several countries in the interim.

Ongoing surveys show that these restrictions led to significant impacts on business operations, increased the cost of internal trade and altered the demand for certain commodities and services. Moreover, the changes to the international context yielded a lower demand for Ethiopia's top export commodities and services (oilseeds, fruits, flowers, textiles, international aviation). In

addition, with income of the diaspora being impacted by the economic downturn in other countries, remittances to households significantly reduced (World Bank, 2020a).

The Ethiopian government has announced a set of measures to address the healthcare crisis and support the recovery of economic activities by:

- Increasing spending on COVID-19 related costs by 5 billion ETB (140 million USD) and an additional 14.4 billion ETB (400 million USD) on healthcare
- Providing aid to the financial sector through liquidity support to public and private banks
- Preventing job losses in manufacturing, construction and service sectors by covering the salaries of jobs at risks through a support package of 11 billion ETB (305 million USD)
- Providing a 36 billion ETB (1 billion USD) stimulus to businesses to support self-employed, MSMEs and large enterprises
- Increasing spending on food and WASH programmes by 19.5 billion ETB (540 million USD)

Given the complexity of interactions between impacts and their incidence across all sectors of the economy and agents (households, enterprises and government), this study seeks to assess the short-term COVID-19 impacts on the Ethiopian economy using a macroeconomic general equilibrium framework. By taking a multitude of impacts into account, it also evaluates the effectiveness of government measures in the context of reduced international trade and an uncertain landscape for foreign lending and aid.

It then uses the macroeconomic results to delve deeper into the impact of the pandemic on household welfare and poverty. To this end, a microsimulation model based on household survey data is utilized to project the macroeconomic impacts on to the household level, quantifying associated changes in household incomes and poverty.

It should be noted that the analysis focuses on the impacts arising from the COVID-19 pandemic in isolation and does not include other important shocks to Ethiopia. Other institutions have updated their forecast for economic growth in Ethiopia for the coming years by incorporating the multiple contemporaneous constraints on the economy, including the desert locust outbreaks in 2020. Although our GDP deviations from the pre-COVID-19 baseline lead to similar growth rates for 2020 as those forecast in World Bank (2020b) and IMF (2020), the aim of this study is to offer a greater range of details on the impacts of the pandemic on the Ethiopian economy and to identify the socioeconomic areas that continue to be affected even after government intervention. Therefore, the results included should not be treated as a forecast but rather as what-if scenarios for different levels of government intervention for a short-term recovery.

2 Socioeconomic impacts assessment

2.1 Economy-wide modelling of impacts and recovery measures

The study uses the JRC DEMETRA model for Ethiopia¹, a single-country recursive-dynamic open-economy computable general equilibrium model (CGE) which comprises a large number of economic sectors and households. The model results therefore allow for an advanced characterisation of impacts at different levels: sectoral (output and production costs), household (income and consumer demand), regional (households belonging and migrating between different regions) and national (GDP, employment, trade). Important features of the DEMETRA model comprise:

- An assumption of perfect competition i.e. prices and quantities are not subject to market power on the supply or demand side
- A disaggregation of economic activities into individual processes captured as nested constant elasticity of substitution functions which combine factors of production and intermediate goods
- A small open-economy assumption whereby domestic price changes do not impact world prices
- A separation of marketed and subsistence commodities with a consistent accounting of home production for home consumption (HPHC) allowing for the study of semi-subsistence production and consumption processes

The model is calibrated using the 2015/16 Social Accounting Matrix (SAM) for Ethiopia recently developed jointly by Ethiopian Development Research Institute (EDRI)/Police Studies Institute (PSI) (Addis Ababa, Ethiopia) and the European Commission–Joint Research Centre (JRC) (Seville, Spain) and documented in (Mengistu et al., 2019). The SAM comprises annual economic transactions structured around 61 economic activities (11 of which account for households as home producers), 71 marketed commodities (and 23 home commodities) and 28 household groups – see Annex 1 for the SAM structure. Household groups are disaggregated into 11 administrative regions and by the rural, peri-urban and urban division.

For this study, the model simulations are conducted based on the following closure rules:

- Savings-driven investment by which investment adjusts based on fixed saving propensities of households and enterprises
- Endogenous labour supply with full labour mobility across economic sectors
- Fixed government consumption with variable government deficit funded through variable internal borrowing
- Fixed foreign savings and variable exchange rate
- Producer price index (PPI) used as model numeraire (reference price for all other price changes) – the consumer price index (CPI) therefore changes relative to the PPI.

As with other CGE models, the JRC DEMETRA model computes changes to prices and quantities of the captured economic transactions in annual timesteps. Therefore, the model simulations in this study account for changes in exogenous variables (e.g. factor productivity) using annualised values of the COVID-19 impacts. The quantifications in this study reflect short-term adjustments to the economy and are determined through dynamic recursive simulations through which economic performance and welfare changes are determined as deviations from baseline values for the fiscal years 2019/20 and 2020/21.

The baseline for the first fiscal year (2019/20) was established by running the JRC DEMETRA model in a dynamic recursive setup from 2015/16 to 2019/20, followed by a re-estimation of the SAM. For 2020/21, the baseline was constructed using a 6% GDP growth rate as a pre-COVID-19 forecast.

DEMETRA, as all other similar models, is a so-called real model which means that money is used as a means of exchange and monetary policies which could impact on real economic activities are not accounted for. The model allows for a choice of two price normalisation either the consumer price index (CPI) or the producer price index (PPI) which serves as a base to define relative prices. In these types of model, inflation is not accounted and only relative prices matter and also exchange rate is a signal coming from commodity markets and not a financial variable.

¹ DEMETRA is a development of the STAGE_DEV models documented in (Aragie et al., 2017). STAGE_DEV is a variant of STAGE_2 (McDonald, 2015) that incorporates a series of additional behavioural relationships that better account for economic relationships in developing countries, such as the dual role of semi-subsistent agricultural households, a nested consumption function, the endogeneity of the functional distribution of income, domestic migration and factor market segmentation. The recursive dynamic version of DEMETRA is derived from the STAGE_DYN model and STAGE_DEV_DYN models.

2.2 Microsimulation poverty analysis

To further quantify the impacts of the scenarios on household incomes and poverty, the CGE simulation results for the expenditures of the household groups are further utilized to inform a microsimulation model in a top-down fashion. The microsimulation model is based on the household food consumption data from the nationally representative Ethiopia Socioeconomic Survey (ESS) 2015/2016 from the Central Statistics Agency of Ethiopia and the World Bank Living Standards Measurement Study. After cleaning and processing, the derived dataset comprises data for 126 expenditure items of 4954 households representing 96.7 million Ethiopians of which 78.6% and 21.4% are living in rural and urban areas, respectively.

All consumption, including own-produced and received as gifts, are valued at market prices. Consumption away from home is assumed to include a 50% mark-up for services and preparation, thus only two-thirds of the value is counted as food (as done, e.g., by Subramanian and Deaton, 1996). The survey households are linked to the 28 household groups in the SAM which are distinguished by 11 administrative regions again split into rural, peri-urban and urban areas.

Poverty is measured using the Foster-Greer-Thorbecke (Foster, Greer and Thorbecke, 1984) poverty indices, using household food expenditure per adult equivalent (see Dercon and Krishnan (1998) for the per adult equivalent scale) as the income measure. Here, food expenditures are chosen because the survey is not very comprehensive in other household expenditures and food and general poverty are typically closely related. The poverty lines required to determine poverty status are set so that the official 2015/16 Ethiopian food poverty headcount figures of 27.1% in rural and 15.2% in urban areas (FDRE, 2018) are reproduced when applied with the household expenditure dataset.

Finally, for calculating the population indices for poverty headcount, gap and severity from the food expenditure data and the food poverty lines, households are weighted by the ESS survey weights. Note that population and household expenditure data calculated from the ESS differ to some extent from those presented in FDRE (2018) because the latter are based on a different Ethiopian household survey, the Household Income and Consumption Expenditure Survey 2015/16.

Taking advantage of the strong household group disaggregation in the CGE model, the simulated percentage changes of the CGE household groups for prices and quantities are utilized to update each survey household's expenditure. To account for changes in the household's purchasing power, its expenditure is deflated using a food CPI specific to the household which is calculated as an Laspeyres price index using 2019 expenditure quantities as weights.

The results from the procedure to update the SAM to 2019/2020 are used to update the reference poverty figures for 2019/20 according to the above methodology.

3 COVID-19 impacts and short-term recovery measures

3.1 COVID-19 impact channels

The impacts included in this study are differentiated across four channels:

1. **Factor productivity:** sector-specific changes to monthly labour and capital productivity in manufacturing and services sectors due to social distancing protocols (see Table A4 in Annex2). The productivity calculations were based on the reduction in days businesses were operational as resulting from the World Bank phone surveys (Tefera et al., 2020). Productivity impacts were then introduced to reflect the adaptation possibilities of firms differentiated across the two fiscal years. For 2019/20, it was assumed that the pandemic has imposed restrictions for the use of both capital and labour in non-agri sectors. For 2020/21, restrictions continue to be present across the different supply chains preventing firms from becoming fully operational until the middle of the year. This translates into continued capital productivity limitations, however, firms have more flexibility in terms of labour use (no productivity reduction). In agriculture, given that no specific restrictions have been imposed, factor productivity was left unaltered. Nevertheless, agriculture was impacted by changes in the production costs of inputs.
2. **Internal trade:** annualized internal trade margins were increased by 5% to reflect the higher cost of transportation and storage during the last months of 2019/20. (ATPC and ODI, 2020) report a 15% increase in transportation costs for the impacted months. Starting from this value, we determined the effect on trade costs in annual terms.
3. **Export, tourism and international aviation demand:** changes in 2019/2020 export volumes for specific commodities based on reported data in NBE (2020) and CRA (2020) . Given the uncertainty around the evolution of global demand for raw materials in 2020/21, export volumes for the second fiscal year are endogenous in the CGE model, being driven by changes in domestic production costs and the exchange rate, Foreign demand for tourism and international aviation are reduced based on forecasted turnover of international aviation from IATA (2020b). The annualised reduction values are included in Table A5 in the Annex 2. In addition, a reduction in oil import prices of 10% and 20% was applied for 2019/20 and 2020/21 respectively to reflect the significant drop in world oil prices.
4. **Remittances and FDI:** a reduction from baseline values of 5% in household remittances and of 19% in FDI for both fiscal years, with values informed by CRA (2020).

3.2 Government measures

The Ethiopian government announced responses towards a short-term recovery from the COVID-19 impacts are modelled across a number of measures covering public spending measures and support for jobs and businesses. The study does not include guarantees and loan programmes but focuses on on-budget and non-financial measures, namely:

1. An additional government spending of 26.42 billion ETB to cover the additional healthcare costs and to support food security– see Table A6 in Annex 2.
2. An increased support for jobs and businesses:
 - (a) 11 billion ETB to cover salaries in manufacturing, construction and services during 3 months in 2019/20 – see Table A6 in Annex 2 for a breakdown. This job support package was implemented in the DEMETRA model as a labour subsidy differentiated across the three macro-sectors.
 - (b) Business support for MSMEs and large enterprises of 36 billion ETB. This support packages was implemented as an output subsidy to manufacturing and services sectors and distributed as 27 billion ETB in 2019/20 and 9 billion ETB in 2020/21.

The study also includes additional government foreign loans (650 million USD in 2019/20 and 500 million USD in 2020/21) to partially cover the deficit resulting from the increase in government spending and the reduction in government revenues due to the above subsidies. The rest of the government deficit changes are funded through internal borrowing.

An overview of simulations covering both the different impact channels and the recovery measures is presented in **Table 1**. In section 4.1, results will be detailed by impact channel (Factor productivity, Exports, Trade costs and Remittances&FDI) to capture their respective magnitude. The recovery measures described above will be added to the all impacts COVID-19 scenario to estimate their recovery effects at macroeconomic, sectoral and household levels. The increased government spending and the job support package are included in the Government response simulation. Given that it is yet not clear whether the additional

business support was implemented, this measures was included separately on top of the base response package in the Enhanced response simulation.

Most of the results in this study are represented as annualised deviations from pre-COVID baseline values for the two fiscal years 2019/20 and 2020/21. Hence, GDP impacts are reflective of a change in GDP for an economy which was projected to expand at 6% in 2020/21. Also, the price changes reported represent annual averages for the two years, therefore, may not reflect the very short-term price fluctuations observed during the specific months of the pandemic.

Table 1. List of simulations of COVID-19 impacts and government measures. Simulations in bold represent the main simulations in this study.

Simulations	Factor productivity (labour and capital)	Export demand reduction	Increase in internal trade costs	Decrease in remittances	Government spending	Job support package	Business support	Description
Factor productivity	✓							Only labour and capital productivity impacts are considered.
Exports		✓						Only export demand impacts are considered.
Trade Costs			✓					Only internal trade costs changes are considered.
Remittances&FDI				✓				Only remittances and FDI declines are considered.
COVID-19	✓	✓	✓	✓				All COVID-19 impacts are combined.
Government response	✓	✓	✓	✓	✓	✓		All COVID-19 impacts are combined with the Government response of stimulus spending and job support measures.
Enhanced response	✓	✓	✓	✓	✓	✓	✓	In addition to the base Government response package, the supplementary business support package of 36 billion ETB (1 billion USD) is included.

4 Results

4.1 COVID-19 impacts at annualised levels

The simulation results show that the COVID-19 impact channels would have led to a 11.1% GDP decrease relative to the baseline in 2019/20 (**Figure 1a**) with the largest contributors being the drops in factor productivity (-7% GDP impacts), trade costs (-3.3%) and exports (-1.7%). With all impacts combined, aggregate supply and consumer demand would have decreased by 10.6% and 10.3% respectively. General employment would drop by 18.2% in annual terms (**Figure 1b**). Trade would have been also negatively affected through a reduction by 13.9% in aggregate exports demand (including international aviation and tourism) and by 12.1% in aggregate imports.

The reduction in income from the economic contraction would have determined lower overall savings and a consequent reduction in investments by 17.2% at an annualized rate. Also, the reduced economic activity would have led to a decrease in government tax revenues with government income down by 11.9%. The reduction in government income also would have significantly constrained public investment as government surplus² would have shrunk by 36.5%.

Figure 1. 2019/20 macroeconomic impacts (compared to the baseline) of the COVID-19 pandemic by impact channel



The decomposition of the impact channels in **Figures 1a-b** shows that:

- Factor productivity** drops applied to manufacturing and services sectors determine a reduction on the supply side through lower output, but also on the demand side through lower income from labour and capital payments. The resulting contraction of the economy yields a reduction in the consumer price index, lower demand for both domestic and imported commodities. Investment is also impacted by lower revenues of households, enterprises and the government.

² Calculated as the difference between income and non-investment spending

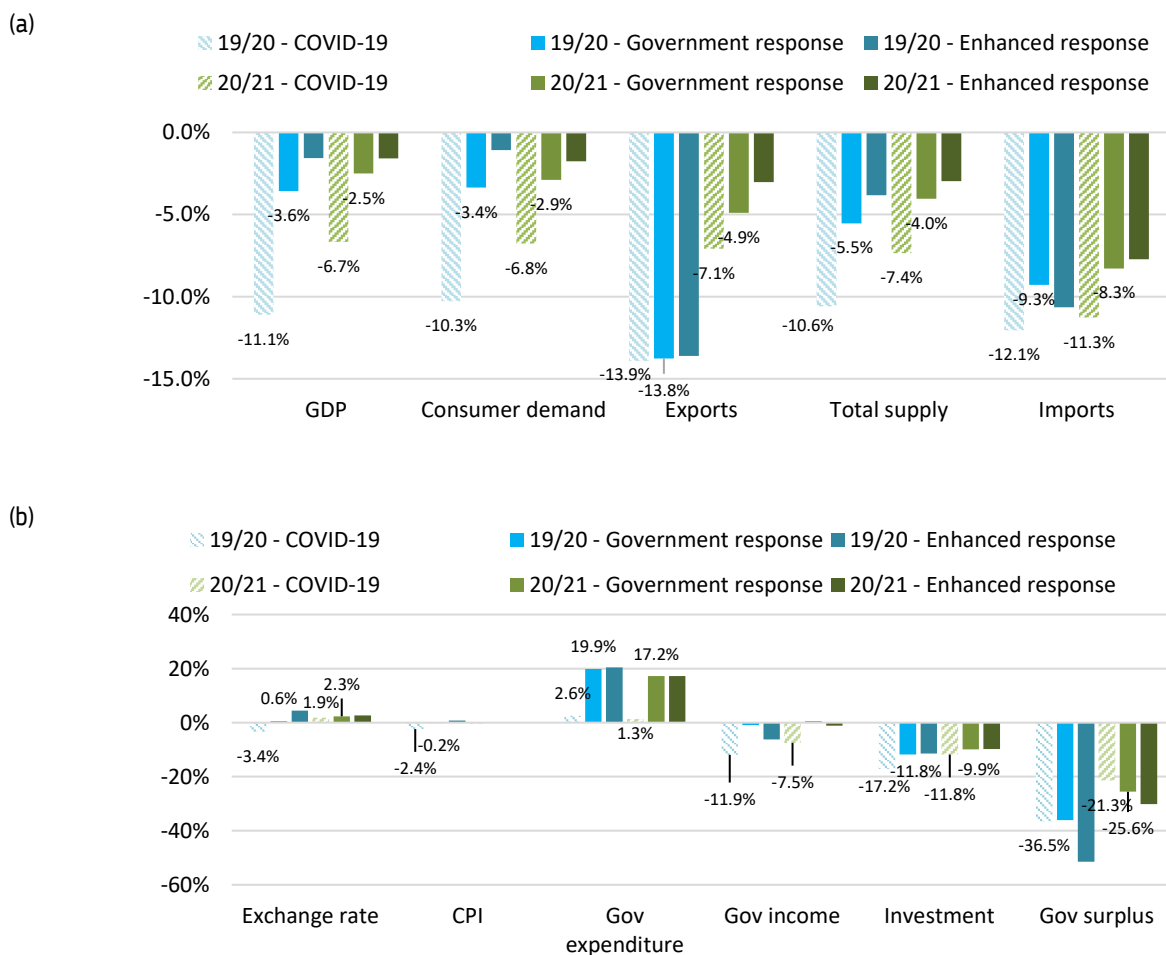
- The increase in **internal trade costs** through higher costs of transportation have a similar effect of a contraction of aggregate economic activity, with a higher negative impact on product competitiveness for exports
- The reduction in **export demand** has a significant effect on the depreciation of the ETB accompanied by adjustment to the trade balances through a decrease in imports. Overall income is also negatively affected. Government deficit increases due to lower domestic output, income and reduced tariff revenues.
- The reduction in **remittances&FDI** has a negative impact over household income and domestic savings. Taken alone, lower remittances and FDI determine a 3.6% depreciation of the ETB with potentially positive impacts on exports. However, this effect is more than counterbalanced when combined with the reduced imports demand in the COVID-19 (All impacts) simulation.

4.2 Recovery through government measures

4.2.1 Macroeconomic and sector-level effects

The government response comprising an increase in public spending and the job support package has a clear positive impact over GDP, activity levels and consumer demand. With these measures, in 2019/20 the GDP impacts of the pandemic decrease to -3.6%, supply to -5.5% and consumer demand to -3.4% - **Figure 2a**. Nevertheless, in 2020/21, GDP is still below the baseline by -2.5%, with the same for supply (-4%) and consumer demand (-3%).

Figure 2. Macroeconomic effects of government measures



These measures lead to an increase in government expenditure by almost 20% in 2019/20 (**Figure 2b**), however, they stimulate economic activity and thus determine a recovery of government income to levels close to the baseline for this fiscal year. Therefore, compared to the simulation without government intervention (All Impacts), the effect of additional spending on the government surplus for investment is neutral. Investments also improve, being driven by a recovery of private savings. With a

boost to income and demand, the government response also a determine a partial recovery if of imports. Therefore, as exports in 2019/20 remain more than 13% below the baseline, the ETB slightly depreciates by 0.6%.

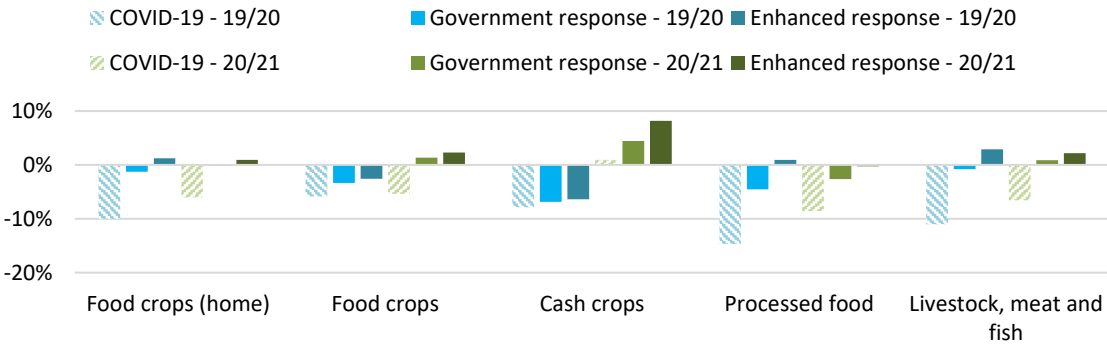
With the additional business support measures (*Enhanced response simulation*), the macroeconomic indicators further improve, with a GDP reduction of only -1.6% for both fiscal years. In 2020/21, the impact of these measures on exports is more sizeable as the competitiveness of domestic enterprises recovers. Exports still fall below the baseline for this fiscal year given that international aviation and tourism continue to be negatively affected by the decrease in global demand. The competitiveness recovery also determines aggregate imports to decrease as demand shifts towards the domestic varieties. The additional support (converted in the simulation as an output subsidy for enterprises) affects the government balances in a negative way as fiscal income decreases by -6.2% and -1.1% in 2019/20 and 2020/21 respectively relative to the baseline values. Nevertheless, despite the government surplus for investment decreasing, investments marginally improve through the recovery of private savings.

Regarding consumer prices, through the positive impacts of measures on income and consumer demand, the CPI remains virtually unchanged in both fiscal years with the base government response, in spite of existing constraints on the supply chains through the factor productivity decreases and trade margins. Only with the additional measures in the *Enhanced response simulation* determine the CPI in 2019/20 to slightly increase over the baseline value (+0.7%).

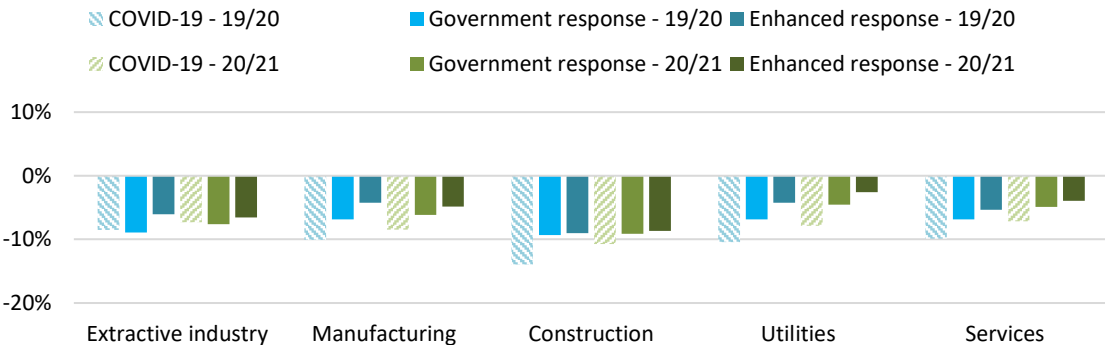
The COVID-19 restrictions could lead to a decrease in economic activities across all sectors, with most sectors reducing output by 5% to 15% (**Figure 3a-b**) with processed foods and construction being the most affected. The sectoral output changes when including the government response confirm the important role of government public spending and job support package in re-launching the economy on the short-term. The effect of government intervention felt more in agriculture where output recovers more. The difference between agricultural and non-agricultural recovery persists even in the second fiscal year. Furthermore, in 2020/21, the output of cash crops could also exceed the pre-COVID-19 baseline levels since government intervention together with a lower exchange rate could improve the competitiveness of Ethiopian commodities on world markets. The business support measures (the *Enhanced response simulation*) have an additional positive effect in 2019/20 on the food, extractive, manufacturing, utilities and service sectors, and less so on construction and cash crops (for these sectors, demand is conditioned investments and exports).

Figure 3. Output recovery by sector

a) Agri-food sectors



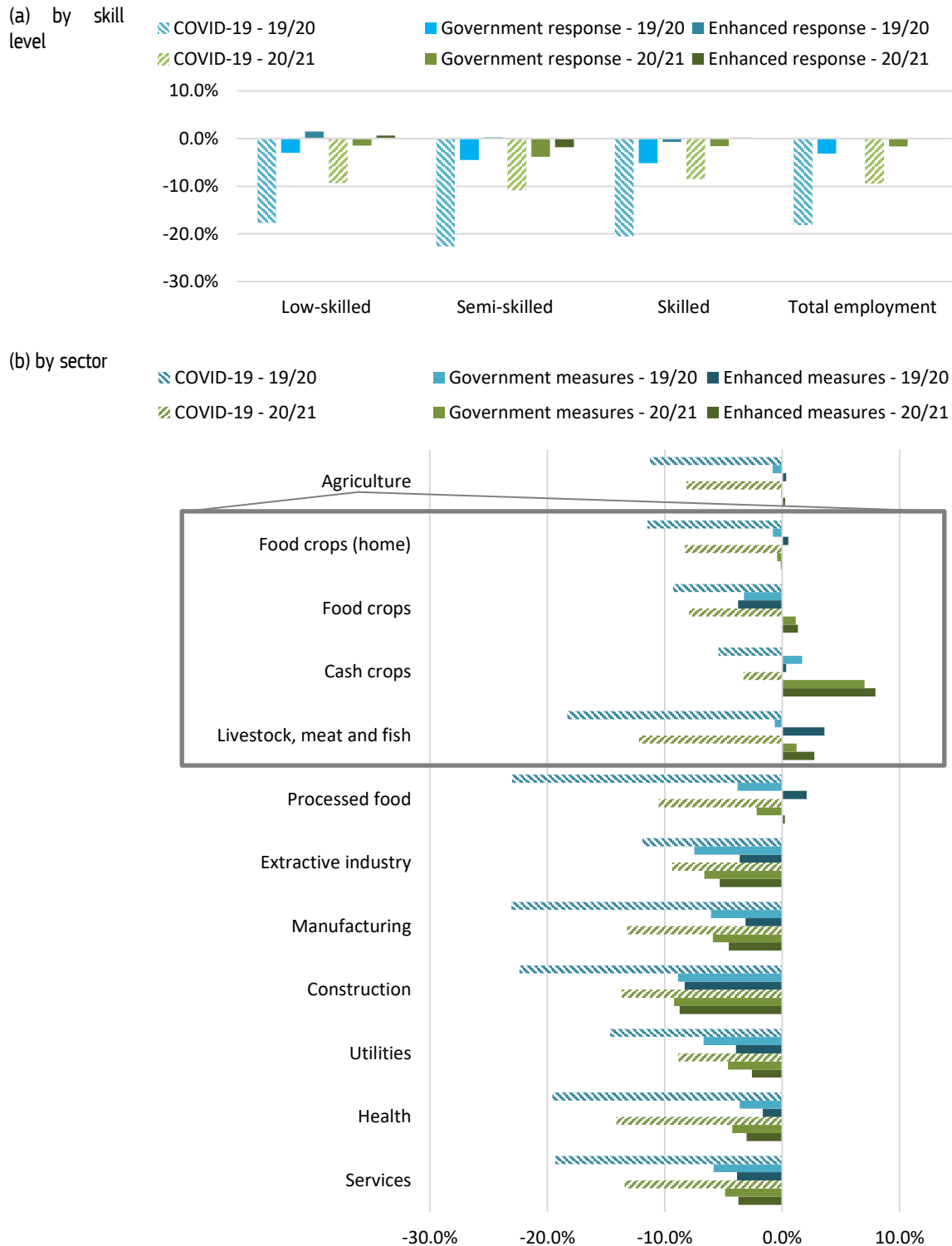
b) Industry, construction and services sectors



4.2.2 Employment

Without government intervention, the combined COVID-19 impact channels would have determined a drop in employment by -18.2% and -9.4% in 2019/20 and 2020/21 respectively, with skilled and semi-skilled labour more affected (**Figure 4a**). These differences between impacts across skill levels are explained by agriculture not being directly affected by the restrictions in terms of factor productivity (labour and capital) –employment in agriculture would have decreased by -11.3% in the absence of government intervention, a smaller decline than the national average (**Figure 4b**).

Figure 4. Employment impacts for 2019/20 and 2020/21



With the base *Government response*, employment significantly recovers across all skill levels, but with the largest improvements on the low-skilled segment. Employment recovers to -3.2% in 2019/20 and to -1.6% in 2020/21 relative to the baseline for the two fiscal years. This recovery is largely driven by the general improvement in income and agricultural demand – employment in agriculture is only -0.8% below the baseline while the employment in manufacturing, construction and service sectors could be -5.8% to -8.9% below the baseline.

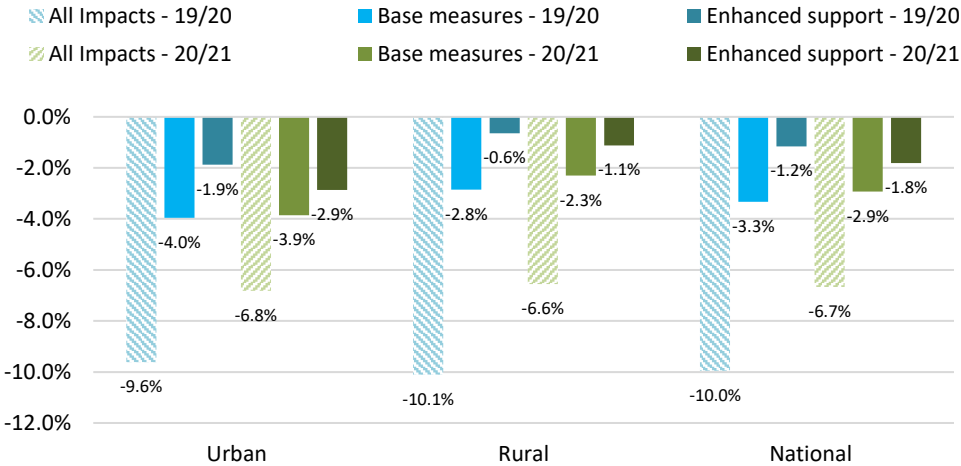
The additional business support measures in the *Enhanced response* simulation indicate a further improvement in employment. Due to the labour intensification in the agricultural and food processing sectors, sectoral employment even exceeds the baseline in the second fiscal year. However, for the rest of the sectors, employment is still -1.7% to -8.9% below baseline values in 2019/20, with construction continuing to face the largest negative impacts.

4.2.3 Household-level effects

At a household level, the combined COVID-19 impact channels lead to a decrease in welfare by -9.8% and -10.1% for urban and rural households respectively³ in 2019/20 (**Figure 5**). The base *Government response* reduces the negative welfare impacts to -3.9% and -2.8% for urban and rural households respectively as income from employment recovers. Government spending on food programmes also has a positive effect on agricultural output and implicitly on rural income. The same income recovery trend whereby rural welfare recovers more is obtained for the second fiscal year.

The *Enhanced response* simulation shows a further improvement in welfare to -0.6% and -1.9% for rural and urban households in 2019/20 respectively. However, the welfare recovery is less significant in 2020/21 when the business support measures are reduced – this is also reflected when comparing the evolution of consumer demand and consumer prices across the two fiscal years.

Figure 5. Household welfare impacts. Welfare changes are calculated as income changes deflated by the price changes in the consumer basket of each household group in the model.



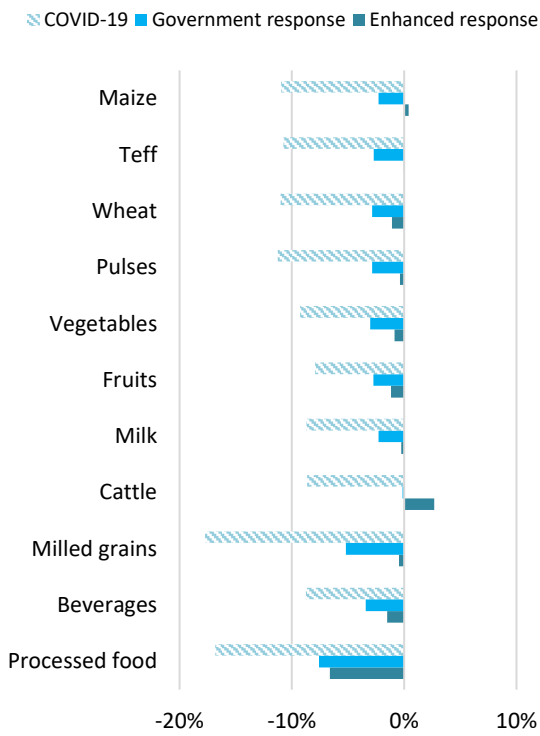
Without government intervention, the lower household income determines the demand for food products to reduce by 7 to 17% across the main food commodities. The lower demand also determines food prices to decrease. With the base response considered, food demand improves most for non-processed commodities, with prices also coming close the baseline values. The almost full recovery is obtained with the additional bussiness support measures – household demand recovers to baseline values, however, prices for most of the main food commodities increase.

With a lower income through the COVID-19 restrictions, households would generally decrease their demand for food commodities (**Figure 6a**). This change would be felt for both market and home-produced commodities, nevertheless, households would continue to rely on home production in high proportions as in the baseline (see Figure A1 in Annex 2). The lower food demand contributes to a general reduction of crop prices (**Figure 6b**). With the base government response included, the resulting increase in real income across household groups determines a recovery of food demand. The demand recovers by three fourths for most food commodities, however, this translates into an increase in market prices for some categories (limited to vegetables and processed food in 2019/20 but extended to wheat, fruits, milled grains and beverages in 2020/21).

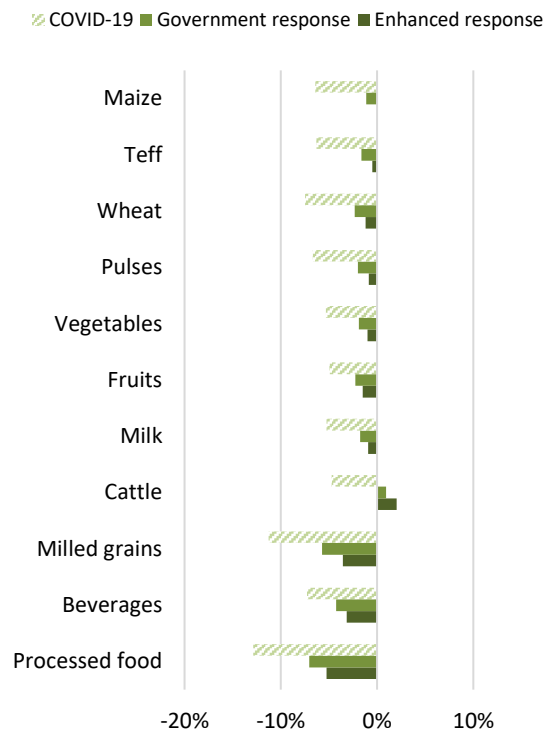
³ The values represent an aggregation of the household groups in the JRC DEMETRA model for Ethiopia.

Figure 6. Food commodities demand and prices

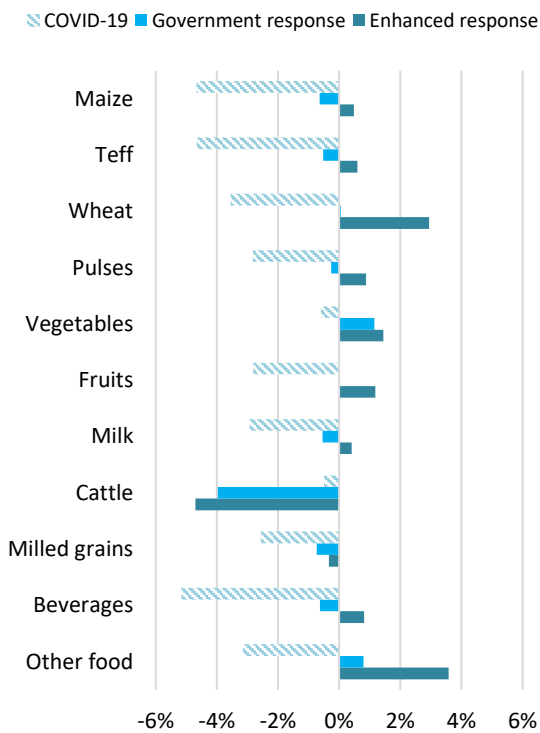
(a) Household demand changes 2019/20



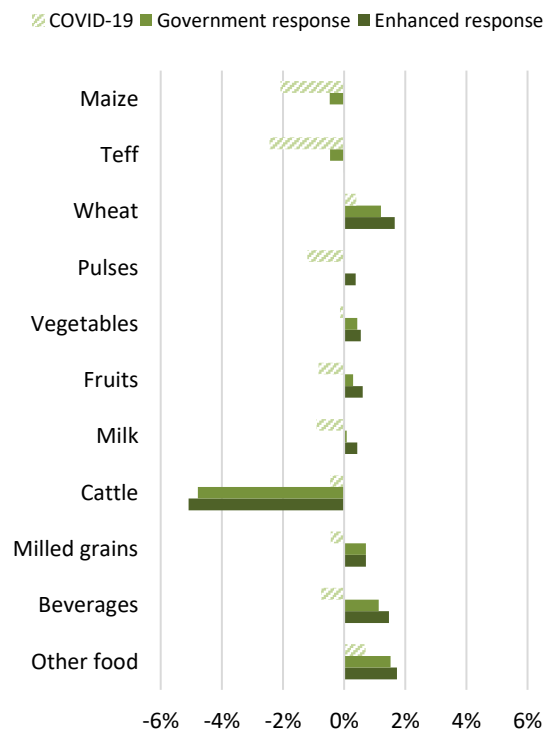
(b) Household demand changes 2020/21



(c) Price changes 2019/20



(d) Price changes 2020/21



4.2.4 Poverty impacts

The CGE results for household food consumption and prices are utilized to project the scenarios' impacts on poverty headcount, gap and severity indices as well as on the average poor individual's CPI as shown in **Figure 7** and **Table 2**. While the food CPI points out that food would get slightly cheaper, without any government intervention, the share of poor individuals in the population (poverty headcount) in 2019/20 would increase from 17.9% to 22.8% (a 28% increase) with the impact in urban being higher (30%) than in rural areas (28%) due to decreasing incomes. Also the average poor individual falls further below the poverty line as indicated by the poverty gap index which would increase by 34% as well as inequality between the poor increases as indicated by the poverty severity index. The figure shows the urban poor to be more strongly affected than the rural. Note that the majority of the poor is living in rural areas.

The *Government response* package appears effective in mitigating the negative effect on the poor to a large extent, more than halving the headcount increase in urban and reducing it to less than a fifth in rural areas compared to no government intervention. In case of an *Enhanced response* package, negative poverty effects could be almost avoided in rural areas whereas some negative effect on the urban poor would remain.

In 2020/21, all poverty indices are projected to be lower than in 2019/20 for all scenarios. Although even with either government package the indices remain higher as in the 2020/21 Baseline results, national poverty decreases below the pre-COVID-19 2019/20 levels, leaving urban levels slightly above. With an *Enhanced response*, also urban poverty would drop below the pre-COVID-19 level.

Figure 7. Percentage changes in food poverty indices and poor's food CPIs in comparison to the budget year's Baseline

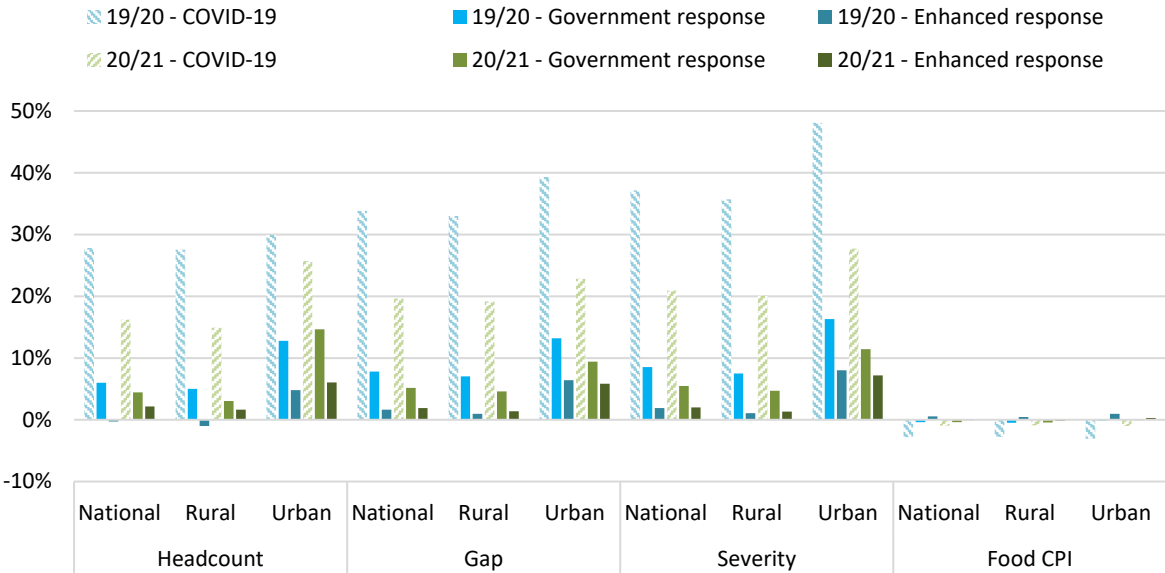


Table 2. Food poverty indices and poor's food CPIs

	19/20				20/21			
	Baseline	COVID-19	Government response	Enhanced response	Baseline	COVID-19	Government response	Enhanced response
National								
Headcount	17.9	22.8	18.9	17.8	17.0	19.7	17.7	17.3
Gap	5.1	6.8	5.5	5.1	4.7	5.7	5.0	4.8
Severity	2.2	3.0	2.3	2.2	2.0	2.4	2.1	2.1
Food CPI	100.0	97.2	99.6	100.5	100.0	99.1	99.6	99.9
Rural								
Headcount	19.8	25.3	20.8	19.6	19.0	21.8	19.5	19.3
Gap	5.6	7.5	6.0	5.7	5.3	6.3	5.5	5.4
Severity	2.4	3.3	2.6	2.4	2.3	2.7	2.4	2.3
Food CPI	100.0	97.2	99.5	100.4	100.0	99.1	99.6	99.8
Urban								
Headcount	10.6	13.8	12.0	11.2	9.7	12.2	11.1	10.3
Gap	3.0	4.2	3.4	3.2	2.8	3.4	3.0	2.9
Severity	1.2	1.7	1.4	1.3	1.1	1.4	1.2	1.1
Food CPI	100.0	96.9	99.9	101.0	100.0	99.0	100.0	100.3

5 Conclusions and policy recommendations

The macroeconomic simulations in this study highlight that:

- The COVID-19 lockdown impacts could have been significant across all macroeconomic metrics had the government not intervened – a GDP decrease of -11.1% in 2019/20 and -6.7% in 2020/21 from pre-COVID-19 projections..
- The government base response consisting in increased spending (healthcare and food programmes) and salary payments to prevent job losses may have had an important role in improving the macroeconomic outcomes of the pandemic in 2019/20 reducing the negative GDP impacts compared to the simulated baseline to -3.6% implying an effective growth rate of about 2.2% for the year. Nevertheless, much of the aggregate recovery (GDP, employment and welfare) is driven by agriculture.
- The economy in the fiscal year of 2020/21 could be impacted by lower investments in the previous period and also by continued supply-chain impacts determining business to operate at less than 100% of the time. Medium-term adjustments to the lower capital investments could come from labour intensification across economic activities.
- Employment and output in manufacturing and services sectors could still be below the pre-COVID-19 projections even when additional business support measures are included.
- Construction continues to be impacted by lower investment as government surplus for investment projects is reduced. The recovery of the construction sector would thus be dependent on the government capacity to either improve FDI or to borrow more from abroad. The recovery of the sector would also engender supply-chain effects with more positive outcomes for the rest of the economy.
- Without government intervention, the poverty headcount would have strongly increased by about 5 percentage points. But the support package is projected to mitigate that effect to a large extent and to allow poverty to drop to pre-COVID-19 levels in 2020/21 or to even fall below in case of an *Enhanced response* package.

Based on the findings, we suggest the following recommendations:

- Overall, the government should implement the various economic stimulus measures announced at the start of the COVID-19 spread in the country. Without the implementation of the proposed economic stimulus, the economy would suffer a significant reduction in growth in the 2020/21 fiscal year.
- With all the support packages, employment remains below the pre-COVID-19 projections. The government should protect jobs and create new ones. Focus should be given to the manufacturing and services sectors.
- With the easing of the COVID-19 restrictions since September 2020, firms already started to open businesses across the country. However, binding challenges will exist on the ground in relation to regaining production capacity prior to COVID-19 levels. Even those firms which may potentially overcome their supply side constraints and adjust their production capacity will face shortage of demand for their products since recovery of employment and income will not be spontaneous. Moreover, there are trends of secondary waves of the pandemic across US and Europe which is bad news for the slightly recovering international trade. As a result, actions and policies aimed at reducing the impact of the pandemic on manufacturing firms and service sector should resolve both supply side constraints and shortage of demand.
- The construction sector which accounts for a significant share (about 20%) of the country's GDP continues to suffer from lower investment. Thus, the government needs to stimulate construction activities in the country. This may require the government to balance investment projects towards the sector and to provide targeted bank loans to the same.
- In addition to fully implementing the planned interventions as presented in the *Enhanced response* simulation, the government has to maintain a reliable supply of electricity for firms since this is one of the biggest obstacles to businesses in the country (World Bank, 2016). Lack of adequate finance will remain the other major problem by firms so the role of government and banks will be paramount to reduce such shortage of funds. In line with this, the already existing shortage of foreign currency will be intensified due to lower exports and FDI. In order to improve the balance of payments, priority to access hard currency should be given to firms that import inputs to produce exportable output and substitute further imports. To further stimulate exports, the search for additional markets especially in those countries which geographical proximate with Ethiopia (in Africa & Middle East) should be intensified because, if secured, trading costs will be reduced. Thus, this re-orientation to new markets could offset the falling export revenue following the second wave of COVID-19 restrictions in Europe, one of the major destinations of exports and supplier of imports of the country.

- The government should continue expanding the social protection support packages program such as the food program to the poor. With the introduction of such assistance the national poverty drops. Particular attention should be given to urban households as they are more likely to be negatively affected compared to rural households.

References

- Aragie, Emerta., Mainar Causapé, Alfredo., Dudu, Hasan., Ferrari, Emanuele., Thierfelder, Karen., McDonald, Scott., European Commission. Joint Research Centre., 2017. STAGE_DEV a variant of the STAGE model to analyse developing countries. Publications Office of the European Union, Seville, Spain.
- ATPC, ODI, 2020. Africa trade and Covid-19: The supply chain dimension (No. 586), Working paper. UNECA Africa Trade Policy Centre, Addis Ababa, Ethiopia.
- CRA, 2020. Quarterly Macroeconomic Review. Second Quarter 2020, Macro Research Ethiopia. Cepheus Research & Analytics.
- Dercon, S. and Krishnan, P., 1998. Changes in poverty in rural Ethiopia 1989-1995: Measurement, robustness tests and decomposition. CSAE Working Paper Series WPS/98-7. Centre for the Study of African Economies, University of Oxford, UK.
- FDRE, 2018. Poverty and economic growth in Ethiopia 1995/96-2015/16. Planning; Development Commission, Federal Democratic Republic of Ethiopia, Addis Ababa, Ethiopia.
- FDRE MoF, 2020. COVID19: Economic impact responses assessment and policy. Federal Democratic Republic of Ethiopia, Ministry of Finance, Addis Ababa, Ethiopia.
- Foster, J., Greer, J., Thorbecke, E., 1984. A class of decomposable poverty measures. *Econometrica* 53(3), 761-766.
- IATA, 2020a. Downgrade for global air travel outlook - 29 September 2020. Chief Economist, International Air Transport Association, Montreal, Canada.
- IATA, 2020b. Economic Performance of the Airline Industry, 2020 Mid-Year Report. International Air Transport Association, Montreal, Canada.
- IMF, 2020. World Economic Outlook - October 2020. Washington, D.C.
- McDonald, S., 2015. A Standard Applied General Equilibrium Model: Technical Documentation. STAGE Version 2.
- Mengistu, A., Woldeyes, F., Dessie, E., Ayalew, Z., Yeshineh, A., Mainar Causapé, A., Ferrari, E., 2019. Ethiopia Social Accounting Matrix 2015/16 (No. EUR 29902 EN). Publications Office of the European Union, Luxembourg.
- NBE, 2020. Quarterly Bulletin. Third Quarter 2019/20, Fiscal Year Series. National Bank of Ethiopia, Addis Ababa, Ethiopia.
- Subramanian, S., Deaton, A., 1996. The demand for food and calories. *Journal of Political Economy* 104(1), 133-162.
- Tefera, G., Bundervoet, T., Wieser, C., 2020. How Ethiopian Firms are Adapting to the Pandemic? : A Brief Look at the Evidence from HFPS-F (Vol. 2) : Database (English) (No. 7), How Ethiopian Firms are Adapting to the Pandemic? : A Brief Look at the Evidence from HFPS-F (Vol. 2) : Database (English). World Bank, Washington, D.C.
- UNCTAD, 2020. Global Trade Update June 2020. United Nations Conference on Trade and Development, Geneva, Switzerland.
- World Bank, 2020a. COVID-19 Crisis Through a Migration Lens. World Bank, Washington, D.C.
- World Bank, 2020b. The Macro Poverty Outlook for Sub-Saharan Africa. International Bank for Reconstruction and Development / The World Bank, Washington, D.C.
- World Bank, 2016. World Bank Enterprise Surveys. Ethiopia. World Bank, Washington, D.C.

List of abbreviations and definitions

CGE	Computable General Equilibrium
CPI	Consumer Price Index
ESLSE	Ethiopian Shipping and Logistics Service Enterprise
ESS	Ethiopian Socioeconomic Survey
ETB	Ethiopian Birr
FDI	Foreign Direct Investment
FDRE	Federal Democratic Republic of Ethiopia
GDP	Gross Domestic Product
SAM	Social Accounting Matrix
WASH	Water, Sanitation and Hygiene

List of figures

Figure 1. 2019/20 macroeconomic impacts (compared to the baseline) of the COVID-19 pandemic by impact channel..... 9

Figure 2. Macroeconomic effects of government measures10

Figure 3. Output recovery by sector11

Figure 4. Employment impacts for 2019/20 and 2020/2112

Figure 5. Household welfare impacts13

Figure 6. Food commodities demand and prices14

Figure 7. Percentage changes in food poverty indices and poor's food CPIs in comparison to the budget year's Baseline15

Figure A1. 2019/20 Household demand of food commodities by home production and market sources29

List of tables

Table 1. List of simulations of COVID-19 impacts and government measures. Simulations in bold represent the main simulations in this study..... 8

Table 2. Food poverty indices and poor’s food CPIs.....16

Table A1. Economic sectors in the Ethiopia 2015/2016 SAM23

Table A2. Marketed commodities in the Ethiopia 2015/2016 SAM24

Table A3. Household grouping in the Ethiopia 2015/2016 SAM25

Table A4. Changes to labour productivity across sectors26

Table A5. Changes to commodity and service exports.....27

Table A6. Additional government expenditure measures included in the analysis (in billion ETB)28

Annexes

Annex 1. Sectoral and household disaggregation in the JRC DEMETRA model for Ethiopia

Table A1. Economic sectors in the Ethiopia 2015/2016 SAM

Economic sectors		
Addis Ababa (hh as producers)	Other livestock	Metal products
Afar (hh as producers)	Forestry	Other manufacturing
Ambara (hh as producers)	Fishing	Electrical equipment
Benshagul Gumuz (hh as producers)	Mining	Vehicles
Dire Dawa (hh as producers)	Dairy products	Medical equipment
Gambelia (hh as producers)	Grain milling	Other manufacturing
Harari (hh as producers)	Sugar	Electricity
Oromia (hh as producers)	Other processed foods	Water supply
SNNP (hh as producers)	Beverages	Construction
Somalie (hh as producers)	Tobacco	Trading services
Tigray (hh as producers)	Textile fibres	Hospitality
Food crops	Finishing of textiles	Transport services
Cash crops	Wearing apparel	Communication
Coffee	Leather products	Financial intermediation
Other crops	Wood and wood products	Public administration
Flowers	Paper and paper products	Education
Cattle	Chemicals	Health and social work
Goats	Pharmaceuticals	Real estate
Sheep	Mineral products	Business services
Camels	Cement	
Poultry	Iron and steel	

Table A2. Marketed commodities in the Ethiopia 2015/2016 SAM

Commodities		
Teff	Manure	Mineral products
Barley	Milk	Cement
Wheat	Cotton	Metals
Maize	Forestry	Metal products
Sorghum	Fishing	Vehicles
Pulses	Mining products	Electrical equipment
Vegetables	Vegetable products	Machinery
Oil seeds	Dairy products	Other manufacturing
Sugarcane	Sugar	Electricity
Fruits	Grain milling	Water supply
Tea	Food crops	Construction
Chat	Beverages	Trading services
Coffee	Tobacco	Hospitality
Enset	Manufactured tea	Transport services
Other crops	Manufactured tobacco	Communication
Animal feed	Linted cotton	Financial intermediation
Flowers	Wearing apparel	Business services
Cattle	Leather products	Public administration
Sheep	Wood and wood products	Education
Goat	Paper products	Health and social work
Camel	Petroleum products	Recreation and other services
Poultry	Chemicals	Real estate
Meat products	Pharmaceuticals	

Table A3. Household grouping in the Ethiopia 2015/2016 SAM

Household groups		
Addis Ababa Urban	Dire Dawa Rural	SNNP Rural
Afar Urban	Gambelia Urban	SNNP Peri-urban
Afar Rural	Gambelia Rural	Somalie Urban
Afar Peri-urban	Gambelia Peri-urban	Somalie Rural
Ambara Urban	Harari Urban	Somalie Peri-urban
Ambara Rural	Harari Rural	Tigray Urban
Ambara Peri-urban	Oromia Urban	Tigray Rural
Benshagul Gumuz Rural	Oromia Rural	Tigray Peri-urban
Benshagul Gumuz Peri-urban	Oromia Peri-urban	
Dire Dawa Urban	SNNP Urban	

Annex 2. Shock values and additional results

Table A4. Changes to labour productivity across sectors

Sector	2019/20		2020/21
	Labour	Capital	Capital
Mining	-3.35%	-3.35%	-3.47%
Dairy products	-3.35%	-3.35%	-3.47%
Grain milling	-3.35%	-3.35%	-3.47%
Sugar	-3.35%	-3.35%	-3.47%
Other processed foods	-3.35%	-3.35%	-3.47%
Beverages	-3.35%	-3.35%	-3.47%
Tobacco	-3.35%	-3.35%	-3.47%
Textile fibres	-3.35%	-3.35%	-3.47%
Textiles	-3.35%	-3.35%	-3.47%
Wearing apparel	-3.35%	-3.35%	-3.47%
Leather products	-3.35%	-3.35%	-3.47%
Wood and wood products	-3.35%	-3.35%	-3.47%
Paper and paper products	-3.35%	-3.35%	-3.47%
Chemicals	-3.35%	-3.35%	-3.47%
Mineral products	-3.35%	-3.35%	-3.47%
Cement	-3.35%	-3.35%	-3.47%
Iron and steel	-3.35%	-3.35%	-3.47%
Metal products	-3.35%	-3.35%	-3.47%
Other manufacturing	-3.35%	-3.35%	-3.47%
Electrical equipment	-3.35%	-3.35%	-3.47%
Vehicles	-3.35%	-3.35%	-3.47%
Other manufacturing	-3.35%	-3.35%	-3.47%
Construction	-3.21%	-3.21%	0.00%
Communication	-3.21%	-3.21%	-3.29%
Financial intermediation	-3.21%	-3.21%	-3.29%
Public administration	-3.21%	-3.21%	-3.29%
Education	-6.25%	-6.25%	0.00%
Real estate	-3.21%	-3.21%	-3.29%

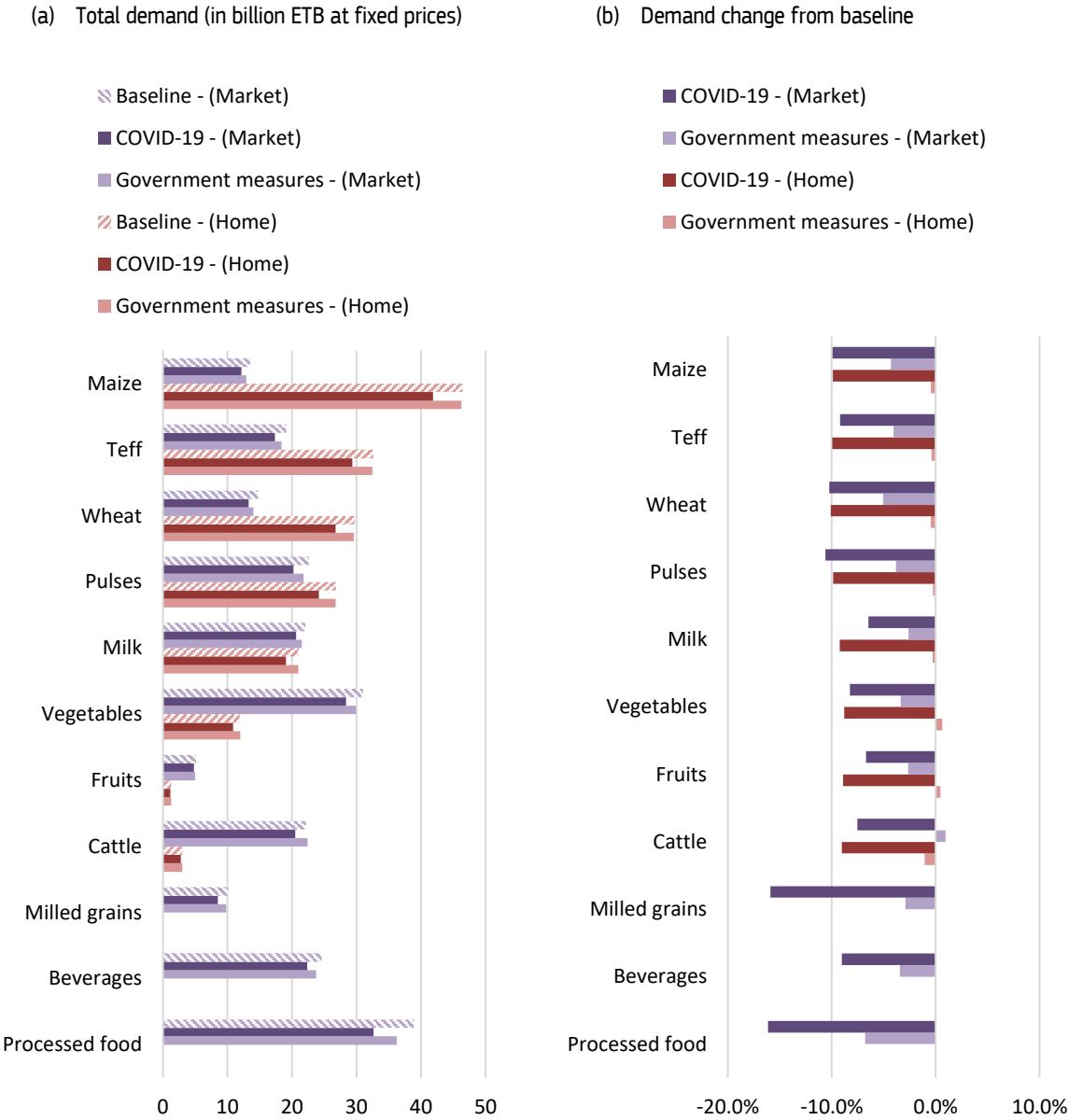
Table A5. Changes to commodity and service exports

Commodity	2019/20	2020/21
Oil seeds	-2.8%	endogenous
Coffee	0%	endogenous
Flowers	-10.8%	endogenous
Textiles	-11.7%	endogenous
Leather products	-22.1%	endogenous
Pulses	-2.4%	endogenous
Fruits	-32.2%	endogenous
Meat	-12.6%	endogenous
Live animals	-4.6%	endogenous
Sugars	-5.2%	endogenous
Processed food	-10.6%	endogenous
Beverages	-10.6%	endogenous
Tobacco	-10.6%	endogenous
Manufactured tea	-10.6%	endogenous
Manufactured tobacco	-10.6%	endogenous
Linted cotton	-10.6%	endogenous
Wearing apparel	-10.6%	endogenous
Wood and wood products	-22.1%	endogenous
Paper products	-10.6%	endogenous
Transport (aviation)	-25%	-12.5%
Hospitality (tourism)	-29%	-25%

Table A6. Additional government expenditure measures included in the analysis (in billion ETB)

Area	Government response	Enhanced response	2019/20	2020/21
Healthcare	✓	✓	9.77	9.77
Food programmes	✓	✓	10.92	10.92
Shelter	X	✓	4.72	4.72
Logistics	X	✓	1.01	1.01
Total spending	✓	✓	26.42	26.42
Job protection	✓	✓	11.80	0.00
Manufacturing (including IP)			2.28	
Construction			7.23	
Services			1.48	
Business support		✓	27.00	9.00

Figure A1. 2019/20 Household demand of food commodities by home production and market sources



GETTING IN TOUCH WITH THE EU

In person

All over the European Union there are hundreds of Europe Direct information centres. You can find the address of the centre nearest you at: https://europa.eu/european-union/contact_en

On the phone or by email

Europe Direct is a service that answers your questions about the European Union. You can contact this service:

- by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),
- at the following standard number: +32 22999696, or
- by electronic mail via: https://europa.eu/european-union/contact_en

FINDING INFORMATION ABOUT THE EU

Online

Information about the European Union in all the official languages of the EU is available on the Europa website at: https://europa.eu/european-union/index_en

EU publications

You can download or order free and priced EU publications from EU Bookshop at: <https://publications.europa.eu/en/publications>. Multiple copies of free publications may be obtained by contacting Europe Direct or your local information centre (see https://europa.eu/european-union/contact_en).

The European Commission's science and knowledge service

Joint Research Centre

JRC Mission

As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.



EU Science Hub
ec.europa.eu/jrc



@EU_ScienceHub



EU Science Hub - Joint Research Centre



EU Science, Research and Innovation



EU Science Hub



Publications Office
of the European Union

doi:10.2760/827981

ISBN 978-92-76-27015-7