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Could free trade alleviate effects of climate change?

A worldwide analysis with emphasis on Morocco and Turkey

Ismail Ouraich,[1] Hasan Dudu,[2] Wallace E. Tyner,[1] and Erol Cakmak[3]

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Abstract: This paper examines the interaction of globalization through trade liberalization and climate change, globally with a special focus on Morocco and Turkey. We use the GTAP model, which is a global general equilibrium model, to investigate trade liberalization welfare impacts under climate change, and its ability to provide mitigation and/or adaptation to potential losses. Our hypothesis was that trade liberalization would at least partially offset potential welfare losses induced by negative productivity shocks on agriculture. Our findings suggest that the world as a whole benefits the more trade is liberalized. For instance, under an unrealistic multilateral trade liberalization scenario, average net global welfare increases by +US$76,676 million. Hence, initial average welfare loss under climate change, which reached -US$31,775 million, is totally offset. Nonetheless, as we move away from complete trade liberalization to limited trade liberalization at the regional and sector levels, the gains realized are minimal and offset only marginally climate-induced welfare losses. At the regional level, most regions under trade liberalization do not experience large enough welfare gains to offset welfare losses triggered by negative productivity impacts in agriculture. The exceptions are countries/regions which are projected to benefit from climate change. For Morocco, tariff elimination under all scenarios on average induces additional welfare loss compared with the climate change only scenario. Despite the gains in allocative efficiency accruing from trade liberalization, the latter are generally low and are offset by the substantial negative contribution of the terms of trade and investment savings effects. For Turkey, trade liberalization induces net welfare gains under all scenarios. Nonetheless, these gains are not large enough to offset totally the initial loss under climate change. These results are primarily driven by the combined effect of allocative efficiency and terms of trade effects.

Keywords: climate change, adaptation, uncertainty, CGE model, trade liberalization
JEL classification: F18, O13, O57, Q17

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[1]Purdue University, West Lafayette, Department of Agricultural Economics; [2]European Comission Joint Research Center, Institute for Prospective Technological Studies; [3]TED University Ankara, Department of Economics; corresponding author: iouraich@purdue.edu

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UNU-WIDER, Katajanokanlaituri 6 B, 00160 Helsinki, Finland, wider.unu.edu

1 Introduction

A significant effort has been devoted by scientists from various disciplines to shed light on the causes and effects of climate change in recent years (Tol 2010). Although there is still controversy about the details (Idso and Singer 2009), it is widely accepted that climate change has already started to occur, and the impacts will increase through the 21st century (Agrawala and Fankhauser 2008; Parry et al. 2007; Stern 2006). There are a wide range of social and physical effects that are linked to climate change in the literature, and the most significant effects are expected to be increasing temperatures accompanied by declining precipitation plus increasing frequency of climatic extremes. Hence, agricultural production, which is among the most climate-dependent economic activities, is likely to be the most vulnerable sector (Fankhauser 2005; Rosegrant et al. 2008). Various methods are employed to translate the physical effects to economic shocks. The most popular way is introducing climate change shocks through the agricultural sector as yield or water requirement shocks. Although there is no consensus among the conclusions of these studies, some general results can be derived. The results suggest an average negative welfare effect between 1 to 2 percent of gross domestic (GDP) at the global level (Calzadilla et al. 2010; Tol 2012). Nonetheless, aggregate impacts are generally considered as weak due to the adjustment effects of economic agents and markets in response to climate-induced shocks (Bosello et al. 2010). However, effects are non-homogenous over space, time, sectors, and social groups. Country level analysis suggest more significant effects especially in the Middle East (Sowers and Weinthal 2010; World Bank 2010), Africa (Arndt et al. 2012a, 2012b; Pauw, Thurlow and van Seventer 2010; Thurlow, Zhu, and Diao 2012), and South Asia (Thurlow, Dorosh, and Yu 2012).

Among the growth levers in the economic landscape for developing countries, international trade is argued to offer a potential for adaptation in the face of climate change. This is achieved through the enabling channels of technological spill-overs and enhanced access to capital and infrastructure investments and production specialization. Trade has the potential to alleviate the climate-induced scarcity burden (especially in the agricultural sector) by bridging the differences between demand and supply conditions globally. Nonetheless, it can also increase climate-induced vulnerability in certain regions which specialize in the production of certain products in which they have a comparative advantage, while relying on imports to meet their demands for other commodities and services. Trade liberalization is reported to have welfare-improving effects (Calzadilla, Rehdanz, and Tol 2011; Chang, Chen, and McCarl 2012; Laborde 2011; Reilly and Hohmann 1993). However these effects are generally insufficient to compensate the adverse effects of climate change (Hertel and Randhir 2000; Reilly and Hohmann 1993). Welfare gains from trade liberalization depend primarily on the elimination of trade barriers such as tariffs and quotas, and subsidies. The effects are not uniform and depend on the geographic location (Calzadilla et al. 2010; Reilly and Hohmann 1993) and vulnerability of the region to climate change (Reilly and Hohmann 1993), and poor people are expected to be adversely affected more from the changes (Laborde 2011).

The objective of this paper is to analyse the climate change and trade linkages, and evaluate the potential of trade liberalization (i.e. tariff elimination) as a means of adaptation in the context of developing countries. Our focus is on Morocco and Turkey as case studies, where we use the GTAP model to investigate trade liberalization scenarios' welfare impacts under climate change. In Section 2, we present our methodological approach for developing the range of global yield forecasts and data sources. Section 3 discusses the results for the world and the regional patterns in welfare impacts.

Section 4 focuses on the Moroccan and Turkish cases, Section 5 summarizes our key findings and conclusions.

2 Methodological approach, scenarios, and data discussion

2.1 Modelling framework: GTAP Model

To estimate the impacts of climate-induced agricultural productivity shocks on the economy and the linkages with international trade, we use the Global Trade Analysis Project (GTAP) general equilibrium global trade model and its accompanying database. The GTAP model is a multi-commodity, multi-region computable general equilibrium model (Hertel 1997). In the standard GTAP model, we assume markets are perfectly competitive and exhibit constant returns to scale. Consumers, as represented by the private household, maximize utility where consumption is modeled via a non-homothetic constant difference of elasticity implicit expenditure function. Producers are assumed to maximize profits subject to a nested constant elasticity of substitution production function which bundles primary factors and intermediate inputs to produce final outputs. For the purpose of our analysis, a standard neo-classical closure is assumed where producers earn zero-profits, the regional household is on its budget constraint, and global investment equals global savings, with equilibrium imposed in all markets. World price of a given commodity is determined through the global trade balance.

We make use of the GTAP database version 7.0 which provides a disaggregation of agricultural production and harvested area by agro-ecological zones[1] (AEZ) by using the Food and Agriculture Organization (FAO) data on production, harvested area and price, available by country and 159 FAO crop categories. The GTAP database version 7.0 has been aggregated in order to accommodate the needs of the analysis. The new aggregation collapses the dimensions of the GTAP database into 16 regions, 15 sectors, and five factor endowments.

The objective of the analysis is to shed light on the potential impacts of trade policy as an adaptation tool in the face of climate change. Therefore, we will attempt to analyse the potential adaptive impacts of selected trade policy liberalization scenarios, especially for the agricultural sector. In particular, the analysis will focus on the macroeconomic and welfare linkages of trade liberalization and climate change impacts in terms of trade (TOT) flows and production impacts globally and more specifically in Morocco and Turkey. We conduct the analysis in a comparative static mode where projected yield shocks by 2050 are introduced into the model as productivity shocks to the technology parameters in the model. Table 1 summarizes the selected simulation scenarios. In order to investigate the effects of trade liberalization, we calculate the net effect of key variables by comparing the results from the climate change only scenario with the results from the climate change plus trade liberalization scenarios (Table 1 in the Appendix).

[1] The AEZ structure in the GTAP model is based on the SAGE (The Center for Sustainability and the Global Environment) database, which was developed by aggregating the IIASA/FAO GAEZ data into six categories identified by the length of growing period (LPG). In addition to the LGP break-down, the world is subdivided into three climatic zones, namely: tropical, temperate, and boreal.

2.2 Discussion of data sources for climate-induced yield shocks

Given the objective of the study, we needed to develop a global dataset that takes into consideration the inherent uncertainty in terms of regional distribution of impacts and the heterogeneous nature of their magnitude across climate scenarios. We have identified two major sources for the yield impact data: IFPRI Food Security CASE Maps database (IFPRI 2010) and the Integrated Model to Assess the Global Environment (IMAGE) Version 2.2. Combining the two databases, we create a comprehensive set of projected yield change estimates that provides estimates of productivity shocks on the basis of the regional and sector aggregation adopted in the analysis.

The IFPRI food security CASE maps database

The IFPRI database provides projected yield impacts globally for six crops (rice, wheat, maize, cassava, groundnut, and soybean) under a wide range of scenarios based on simulations from the IMPACT model by 5-year increments until 2050 (Nelson et al. 2010).The results are provided for three overall scenarios (pessimistic, baseline, and optimistic) that capture the dynamics of economic growth based on assumptions about per capita GPD growth and population growth (Table 2).

Table 2: GDP and population growth scenarios in IFPRI database

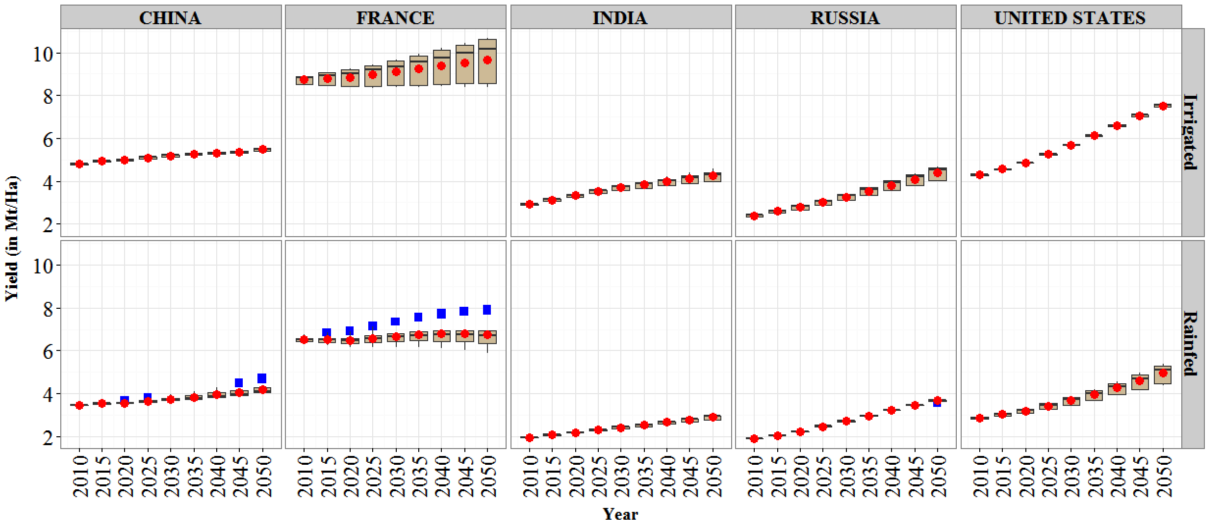
Category	Pessimistic	Baseline	Optimistic
GDP, constant 2000 US$	Lowest of the four GDP growth rate scenarios from the Millennium Ecosystem Assessment GDP scenarios (Millenium Ecosystem Assessment 2005) and the rate used in the baseline (next column)	Based on rates from World Bank EACC study (Margulis et al. 2010), updated for Sub-Saharan African and South Asian countries	Highest of the four GDP growth rates from the Millennium Ecosystem Assessment GDP scenarios and the rate used is the baseline (previous column)
Population	UN high variant, 2008 revision	UN medium variant, 2008 revision	UN low variant, 2008 revision

Source: IFPRI (2010).

The yield impacts are estimated via the Decision Support System for Agrotechnology Transfer (DSSAT) model version 4.5 using two Intergovernmental Panel on Climate Change (IPCC) climate scenarios that project future greenhouse gas emission (A1B and B1) and two global circulation models (GCM) for the climate (called CSIRO and MIROC), the combination of which represent two futures: a dry and relatively cool future under the combination CSIRO A1B and B1, and a wet and warmer future under the combination MIROC A1B and B1.

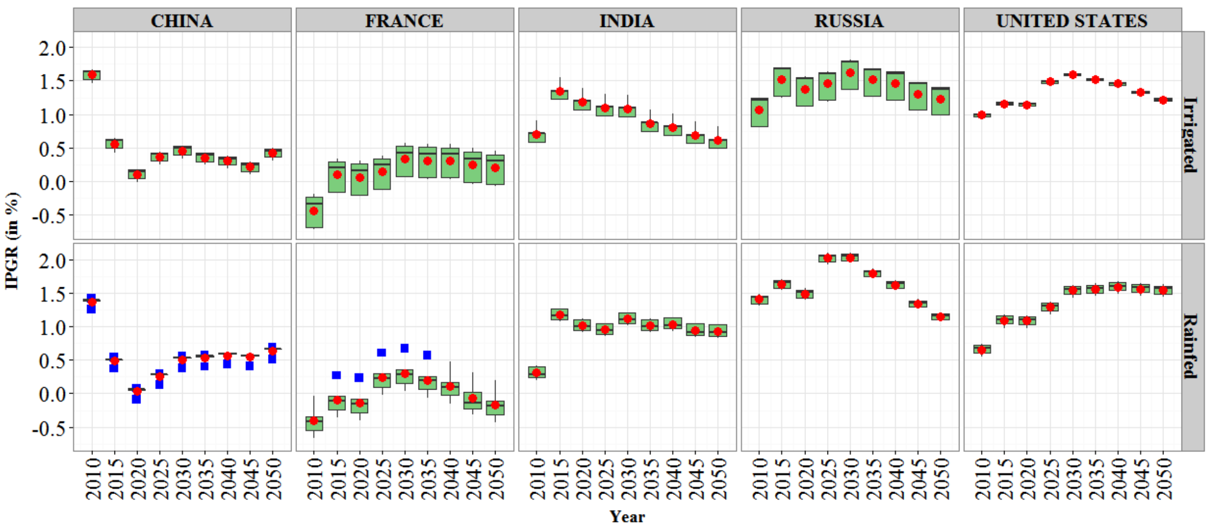
Hence, combining the scenarios capturing the projected per capita GDP growth and population growth, the SRES scenarios and the GCM climate models, results in 15 potential future pathways that encompass a wide range of plausible outcomes in terms of projected yields. Yield estimates from the IMPACT model are dynamically produced under each of the 15 pathways for irrigated and rainfed systems, and incorporate assumptions about exogenous yield growth (i.e. the intrinsic productivity growth rates, IPRs) and exogenous area changes (i.e. the intrinsic area growth rates, IARs). Figures 1a and 1b summarize a sample of the data on yield and IPR for wheat in the top five producing regions.

Figure 1a: Evolution of distribution across scenarios of yield for irrigated and rainfed wheat in the top five producing countries of the IFPRI database



Source: Authors' adaptation (using data from IFPRI 2010).

Figure 1b: Evolution of distribution across scenarios of intrinsic productivity growth rates for irrigated and rainfed wheat in the top five producing countries of the IFPRI database



Source: Authors' adaptation (using data from IFPRI 2010).

To isolate the effect of climate change on yield, we combine the yield and IPR data generated by the IMPACT model. As documented in Nelson et al. (2010), the IMPACT model captures the effects of climate change through the alteration of crop area and yield, represented by Equation (1) and Equation (2) as follows:

$$YC_{tni} = \beta_{tni} \times (PS_{tni})^{\gamma_{iin}} \times \prod_k (PF_{tni})^{\gamma_{ikn}} \times (1 + gy_{tni}) - \Delta YC_{tni}(WAT_{tni})^2 \quad (1)$$

$$AC_{tni} = \alpha_{tni} \times (PS_{tni})^{\varepsilon_{iin}} \times \prod_{j \neq i} \left(PS_{tnj}\right)^{\varepsilon_{ijn}} \times (1 + ga_{tni}) - \Delta AC_{tni}(WAT_{tni}) \quad (2)$$

The key parameters of interest are gy_{tni} and ga_{tni}. They represent the intrinsic productivity and area growths rates respectively (IPRs and IARs) and enter the model as shift parameters.

For the purpose of isolating the climate change impacts, we ignore the effects on area. From Equation (1) we assume that the price effects are insignificant, and that effects on yields pertain only to the climate change impacts and the productivity enhancement associated with the IPRs. The IPRs (or gy_{tni}) represent assumptions about yield productivity enhancement that are exogenous to the model. Estimates are based on factors such as investment in agricultural productivity by the public and private sectors, technology dissemination by research and extension, infrastructure investments, etc. (IFPRI 2010).

In private Email communications with the primary author(s) of the IFPRI publication (Nelson et al. 2010) on 18 March 2013, Dr. Nelson stated that reported yield in the data mainly captures the climate change impacts and the exogenous non-climate productivity effects associated with the IPRs. In other words, the price effect components in Equation (2) are assumed to be insignificant, hence we ignore them. Thus, and given the availability of data on the IPRs, we can isolate the impacts of climate change by assuming the following:

$$Y_{p+1} = Y_p\left(1 + CC_p + IPR_p\right)^5 \quad (3)$$

with CC_p the climate change impact associated with period p; $IPR_p$the exogenous non-climate productivity shift parameter for period p; Y_p is reported yield at start of period p; and Y_{p+1} reported yield at start of period $p + 1$. Therefore, the climate change impact for period p is expressed as follows:

$$CC_p = \left\{\left[\left(\frac{Y_{p+1}}{Y_p}\right)^{1/5} - IPR_p\right] - 1\right\} \times 100 \quad (4)$$

We should note that CC_p, as defined in Equation (4) represents the annual percent change in yield due to climate change in period p in the IFPRI database, which is based on a five-year increment until 2050. Thus, the aggregate period-specific climate change effect CC_p^{agg} is obtained as follows:

$$CC_p^{agg} = \left(1 + CC_p\right)^5 \quad (5)$$

Using Equation (5), we obtain climate change impacts for each crop and each period under irrigated and rainfed systems. Given that the base GTAP model does not differentiate between irrigated and

[2] β_{tni} - yield intercept for year t, determined by yield in previous year; PS_{tni} - output price in year t; PF_{tni} - input price in year t; γ - input and output price price elasticities.

rainfed production at the AEZ level, we calculate a production-weighted average of climate change impact using available data on irrigated and rainfed production.

The IMAGE yield database

The IMAGE database provides yield impacts globally for 11 crop categories under 10 SRES climate scenarios, and covering 17 regions/countries until 2100 by five year increments (Table 3).

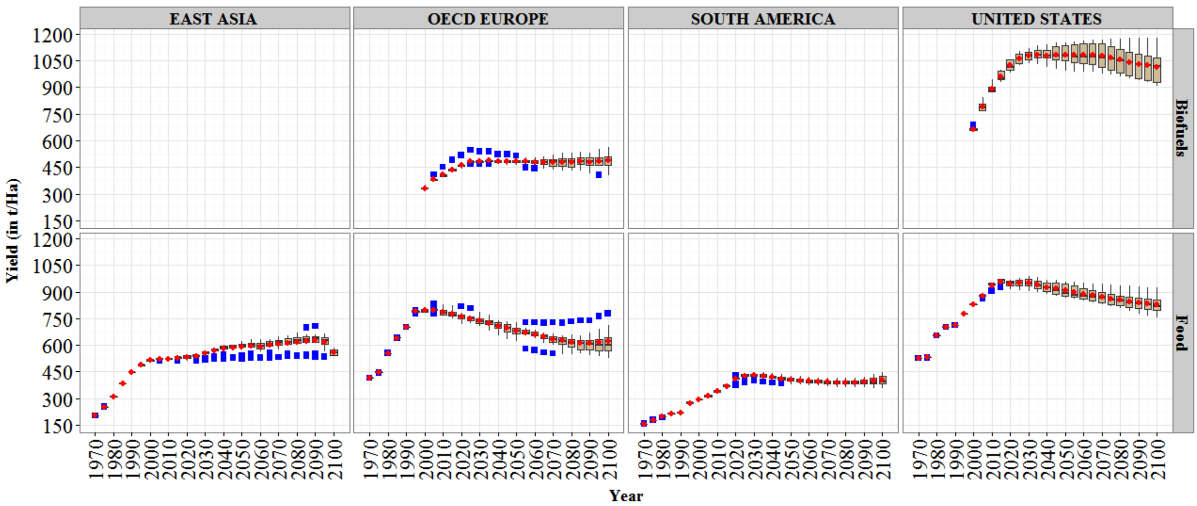
Table 3: Description of IMAGE database dimensions

Element	Description
Scenarios	A1B, A1F, A1F_high, A1F_low, A1T, A2, B1, B1_high, B1_low, B2
Variables	Yield, management factor, production, area
Crops	Maize_f, maize_b, oil crops, pulses, rice, roots and tubers, temperate cereals, tropical cereals, non-woody biofuels, woody biofuels, sugar cane
Regions	Canada, Central America, East Asia, Eastern Africa, Eastern Europe, Former USSR, Japan, Middle East, Northern Africa, Oceania, OECD Europe, South America, South Asia, South East Asia, Southern Africa, USA, Western Africa

Source: Authors' adaptation (using data from IMAGE 2.2[3])

The projected yield impacts are generated via the terrestrial modules in the IMAGE framework (the terrestrial vegetation model and the land cover model), which are coupled to the extended GTAP Model (LEITAP), by using input data such as CO_2 concentration, cloudiness, temperature, and precipitation as projected under each SRES climate scenario. A detailed description can be found in Hoogwijk et al. (2005). Figures 2a and 2b present sample data on reported yields and management factor (MF) for the four major producing regions in the IMAGE database.

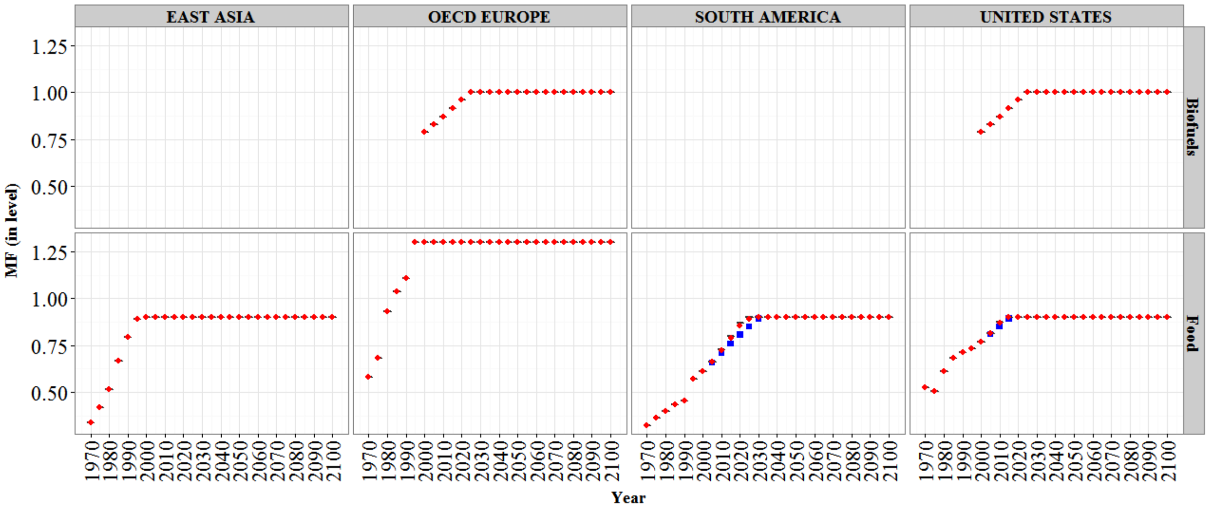
Figure 2a: Evolution of the distribution across scenarios of yield data for maize in the top four producing regions in the IMAGE database



Source: Authors' adaptation (data: IMAGE 2.2, 2001)

[3] The IMAGE model is documented in detail in Alcamo et al. (1998) and by the IMAGE team (2001).

Figure 2b: Evolution of the distribution across scenarios of management factors data for maize in the top four producing regions in the IMAGE database



Source: Authors' adaptation (data: IMAGE 2.2, 2001)

The yield data in the IMAGE database represent projections of yield estimates, which include the climate change impacts and the potential technology-driven yield enhancement captured by the MFs. Thus, isolating the climate change impacts on yield is trivial since the latter can be inferred as follows:

$$Y_t^{CC} = \frac{Y_t^{reported}}{MF_t} \tag{6}$$

where Y_t^{CC} the climate change yield in period t, $Y_t^{reported}$ the reported yield in period t, and MF_t the MF in period t. For the analysis, we use only the food crop category which include six crops; namely, maize, oil crops, pulses, rice, roots and tubers, temperate cereals, and tropical cereals.

Harmonization assumptions and procedure for IFPRI and IMAGE data

As previously mentioned, we use the IFPRI and IMAGE databases as our primary sources to develop a new database for climate-induced yield projections. Nonetheless, there exist substantial differences in the dimensions in both databases in terms of regional and crop coverage, and therefore we need a procedure to harmonize the two sets of estimates.

In terms of regional aggregation, the final version represents a merging of the two databases that assumes the regional aggregation adapted from the GTAP database version 7. Table 4 (Appendix) summarizes the final regional aggregation that the analysis assumes for the simulations using the GTAP model. As we notice, the GTAP database version 7.0 includes 113 countries/regions. We adopt a regional structure based on 16 regions by aggregating the initial 113 countries/regions within appropriate regional blocs. Given that a special focus of the study is to analyse impacts on Morocco and Turkey, we include the latter as separate regions.

The regional coverage in the IFPRI database encompasses 114 countries/regions and in IMAGE database 17 regional blocs. Harmonizing the regional disaggregation in IFPRI and IMAGE data with the adopted regional structure in the GTAP model is straightforward. For IFPRI, estimates of projected yield impacts are computed for each of the 113 countries/regions as previously discussed. To obtain estimates at the GTAP region level, we compute a production weighted average of the IFPRI estimates based on the regional matching defined in Table 5 (Appendix). We adopt a similar approach to obtain estimates of projected yields from the IMAGE data based on the regional matching defined in Table 6 (Appendix). As with the IFPRI data, when a GTAP region is matched with more than one region in the IMAGE data, a production-weighted average yield estimate is calculated. When a GTAP region is not explicitly matched with a region in the IMAGE data, we assume that the yield impact for the GTAP region is the same as the impact for the region in which it belongs within the IMAGE regional aggregation. For example, Morocco, Turkey, and Brazil are not modeled separately in the IMAGE data. But data on yield impacts for North Africa, the Middle East, and South America is available. Therefore, we assume that the yield impacts for Morocco, Turkey, and Brazil equal the yield impacts in North Africa, the Middle East, and South America, respectively, given that those countries are part of the regional bloc.

In terms of sector coverage in the GTAP model, Table 7 (Appendix) summarizes the aggregation adopted which includes seven crop sectors. The yield projections developed through the IFPRI data cover six crop categories; namely, rice, wheat, maize, cassava, groundnut, and soybean. For IMAGE, the crop coverage includes 11 crops by distinguishing between food crops and biofuel crops. As previously mentioned, only the food crop category is used in the analysis, which includes six crops: maize, oil crops, pulses, rice, roots and tubers, temperate cereals, and tropical cereals. Table 8 (Appendix) summarizes the matching assumptions between the GTAP crop sectors and the IFPRI and IMAGE crops, which is based on IFPRI's crop matching methodology (IFPRI 2010).[4] Whenever one GTAP crop is matched with more than one crop category in IFPRI and IMAGE data, a simple average is calculated to represent the final impact associated with the GTAP crop.

In terms of projected yield scenarios, the IFPRI database provides a range of future pathways of yield impacts which represent the combination of three overall growth scenarios x 2 SRES scenarios x 2 GCM models, which capture the impact of climate change. In addition, a third set of yield impacts is calculated using current climate conditions. The latter is considered a 'no climate change' scenario, whereby it projects potential yield impacts assuming current climate conditions prevailing under each global growth scenario. Thus, we generate 15 potential pathways of yield impacts. The IMAGE database provides 11 pathways of projected yield impacts (Table 3). Therefore, merging the two databases, we have 26 scenarios of projected yield impacts, of which 23 represent deviation from current climate under climate change and three represent current climate prevailing in the future.

Given the high dimensionality characterizing the simulation scenarios, we further condense the data for yield projections in each database given the potential overlap that exists among the scenarios

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[4] 'Millet, sorghum, sugarcane, and maize all use the C4 pathway and are assumed to follow the DSSAT results for maize in the same geographic regions. The remainder of the crops uses the C3 pathway. The climate effects for the C3 crops not directly modelled in DSSAT follows the average from wheat, rice, soy, and groundnut from the same geographic region, with the following two exceptions. The IMPACT commodities of "other grains" and dryland legumes are directly mapped to the DSSAT results for wheat and groundnuts, respectively (IFPRI 2010: 99)'.

included. Figures 3a and 3b summarize the kernel distribution estimation of projected yield impacts for all regions and all crops by GCM in the IFPRI data. Overall, we notice that projected yield impacts under each GCM overlap significantly. Therefore, we first average across GCM for each crop and each region. Second, we average across growth scenarios. As a result, we reduce the dimension of projected yield impacts in the IFPRI database to two scenarios, A1B and B1. We adopt a similar approach for the IMAGE database where we collapse the number of scenarios from 11 to 7. This is achieved by averaging the yield impacts for the scenarios A1B, A1B_Low and A1B_High and B1, B1_Low and B1_High.

The final step in merging the data from IFPRI and IMAGE datasets relates to sorting the issue of SRES overlap. In both databases, observations for projected yield impacts exist for all crops under the A1B and B1 scenarios. Nonetheless, comparing the average across crops, we notice that the impacts from the IMAGE database are lower compared to IFPRI on average (Table 9).

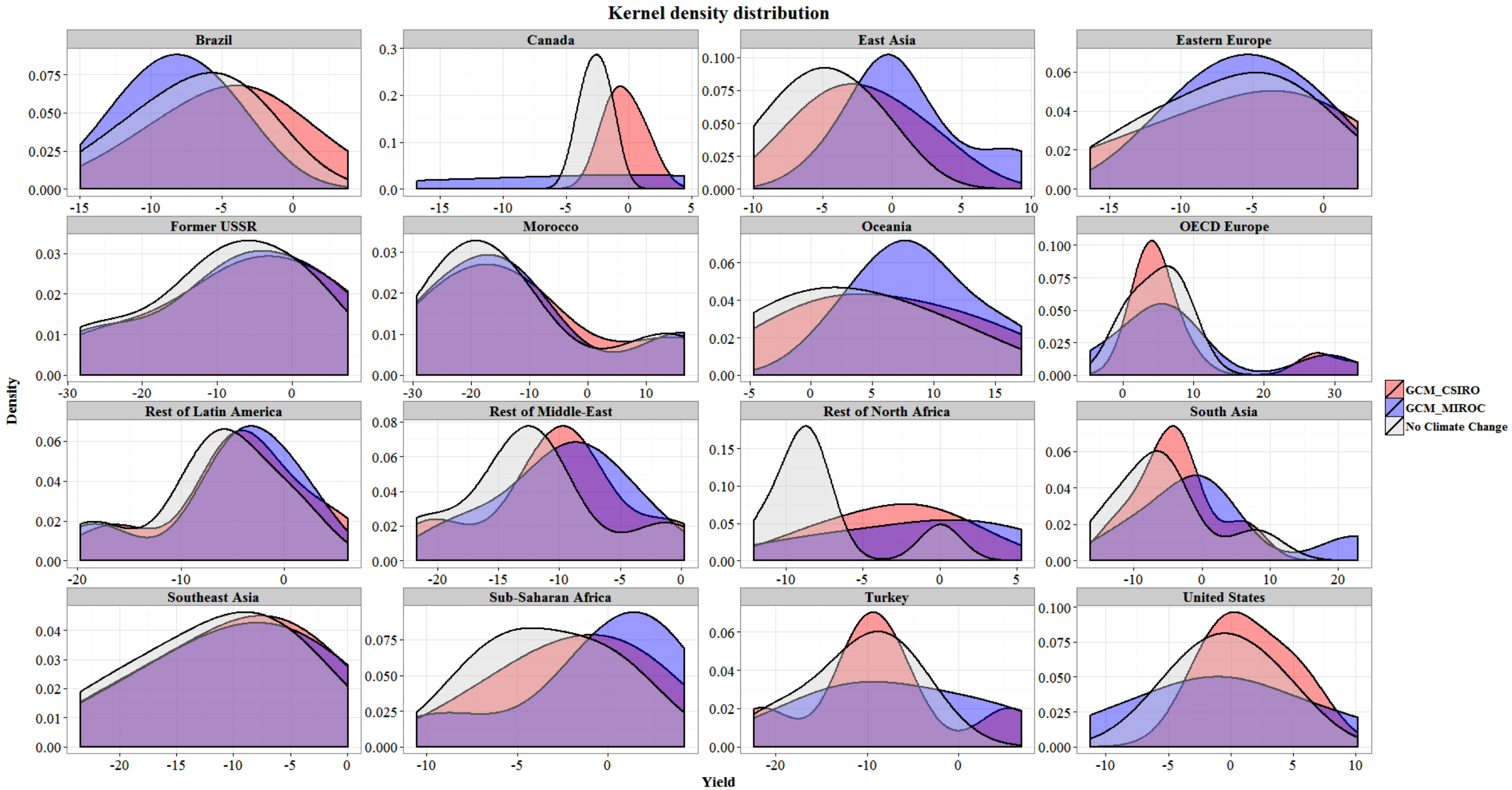
Table 9: Average yield impact in IFPRI and IMAGE (in % change)

	A1B	B1
IFPRI	-4	-4
IMAGE	-2	0

Source: Authors' calculations.

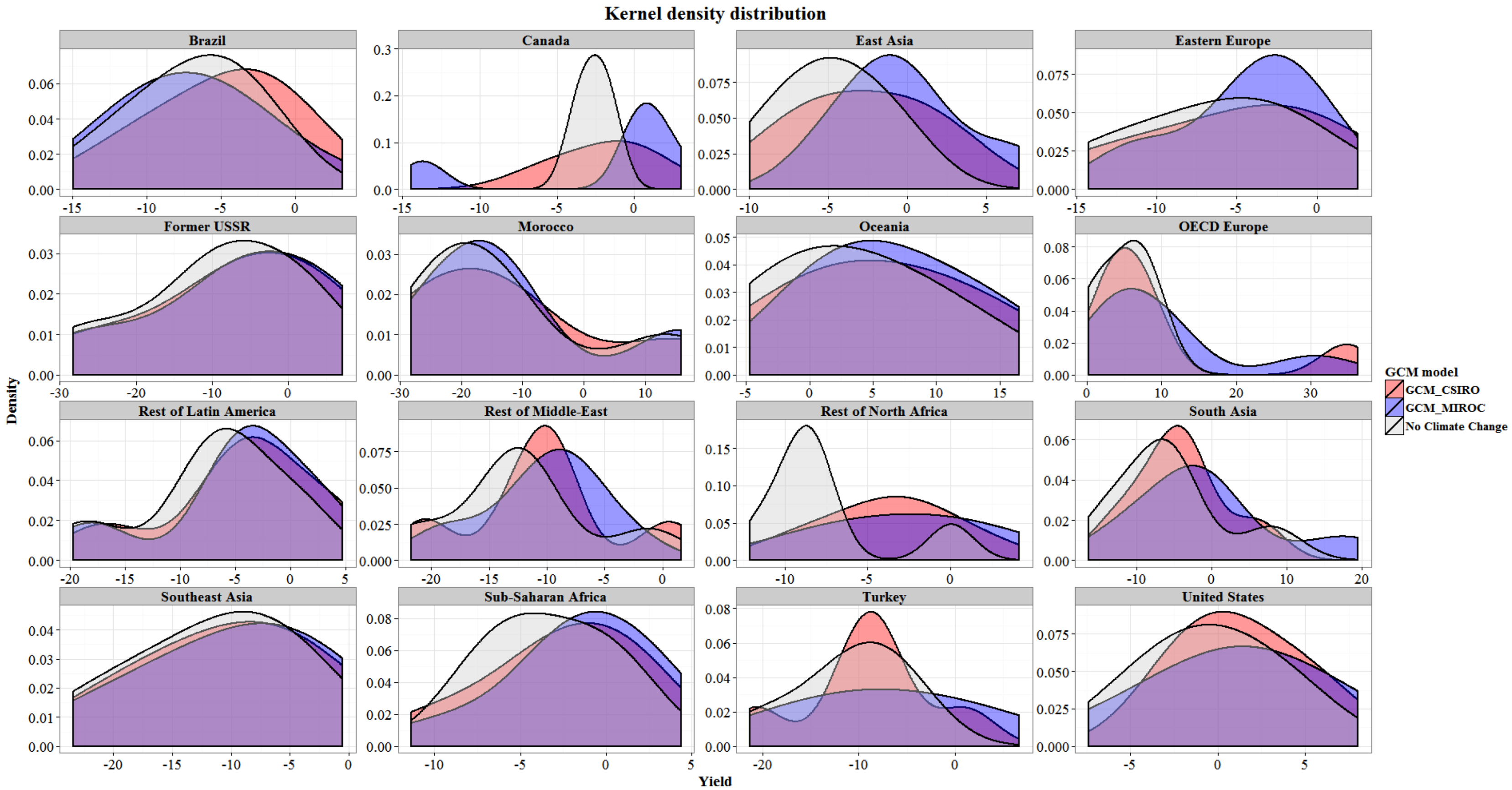
Thus, we include the A1B and B1 scenarios from IMAGE data in the final projected yield database as A1BLow and B1Low.

Figure 3a: Kernel density distribution across growth scenarios of projected yield impacts by GCM for all regions in IFPRI data under SRES A1B



Source: Authors' adaptation (using data from IFPRI 2010).

Figure 3b: Kernel density distribution across growth scenarios of projected yield impacts by GCM for all regions in IFPRI data under SRES B1



Source: Authors' adaptation (using data from IFPRI 2010).

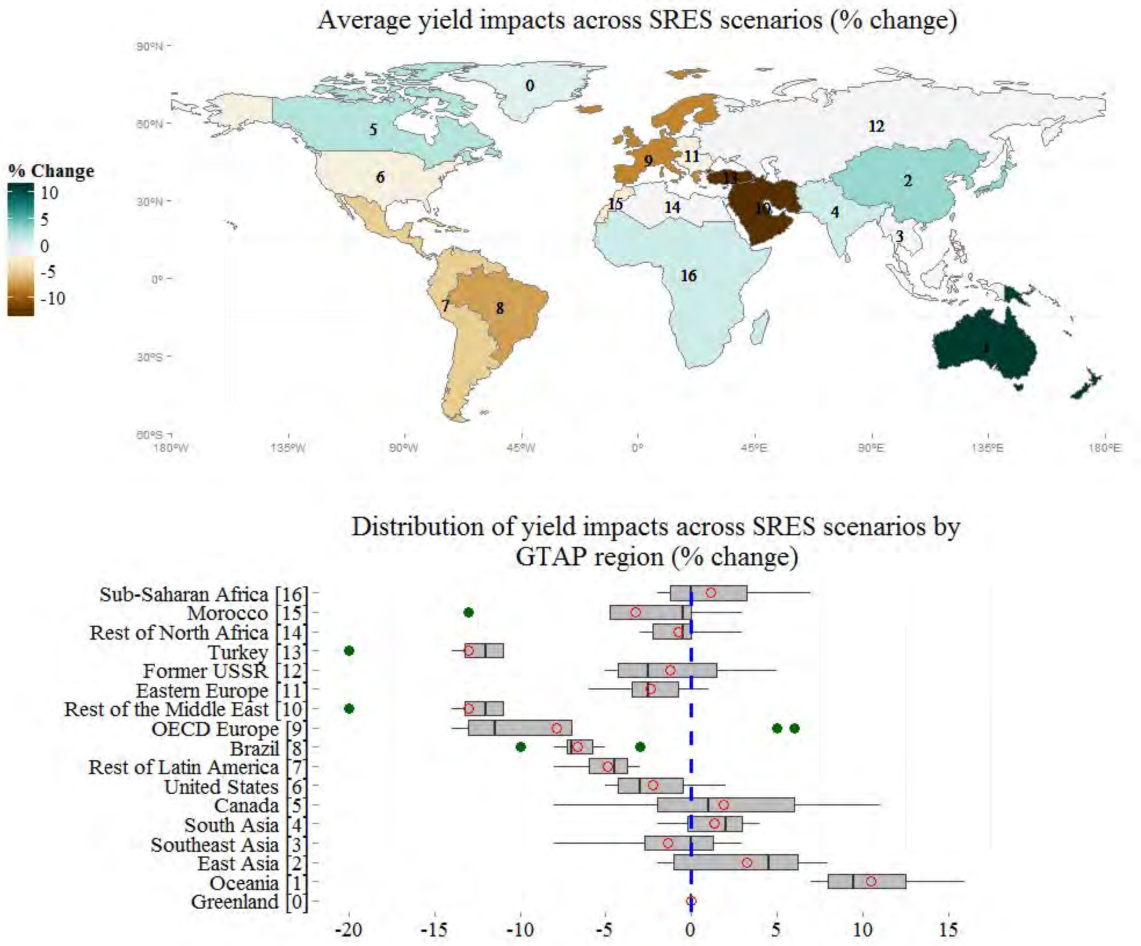
2.3 The new yield impact database: A descriptive analysis

The nature of production systems (irrigated vs. rainfed), location and photosynthetic typology of crops[5] (i.e. C3 vs. C4 plants) are among the main factors that contribute to the heterogeneous climate-induced productivity impacts on yields. Figure 4a captures the heterogeneity dimension characterizing climate change impacts globally in our database. Overall, Turkey, the Rest of Middle East, Brazil, the Rest of Latin America, and OECD Europe display the largest negative impacts on average agricultural productivity across all crops, respectively -13 per cent, -13 per cent, -7 per cent, -5 per cent, and -8 per cent. The United States, Morocco, the Rest of North Africa, Eastern Europe, the Former USSR and Southeast Asia experience slight negative impacts, whereby Canada, South Asia, East Asia, Oceania, and Sub-Saharan Africa (SSA) benefit slightly.

Focusing on averages can be misleading when analysing climate change and international trade linkages. Indeed, the distribution of projected yield impacts across rsegions and crops, and in combination with the volume of trade flows and their origins, plays a significant role in determining the final global impact. For example, impacts on rice yield range from -1 per cent to +6 per cent in East Asia, -6 per cent to +5 per cent in Southeast Asia, -3 per cent to +6 per cent in South Asia and +1 per cent to +10 per cent in the United States (Figure 4b in the Appendix). These regions respectively represent 21 per cent, 29 per cent, 39 per cent, and 1 per cent of total rice harvested area and 32 per cent, 28 per cent, 31 per cent, and 2 per cent of total rice production globally. Therefore, we might conclude that climate change impacts on rice yield in the Asian regions are the driving factor that impacts trade flows globally. Nonetheless, the latter is not determined solely by the geographical distribution of biophysical impact on yields in top producing regions, but as well by the geographical distribution of the trade flows, their volumes, and origins. In our case, despite the insignificant size of the US rice production globally, it plays a bigger role in international trade compared to East Asia which is the major rice producer. Indeed, US rice exports represent 11 per cent of global rice exports compared to 6 per cent for East Asia. Therefore, to account for this dimension when modeling the effect of climate change on agriculture globally is paramount to understand the dynamics at play and the resulting impacts on prices and welfare.

[5] So-called C3 plants use CO_2 less efficiently than C4 plants, so C3 plants such as rice and wheat are more sensitive to higher concentrations of CO_2 than C4 plants like maize and sugarcane. However, when nitrogen is limiting, the CO_2 fertilization effect is dramatically reduced. So the actual benefits in farmer fields of CO_2 fertilization remain uncertain (Nelson et al. 2010).

Figure 4a: Distribution of average yield impacts across all crops by region[6]



Source: Authors' adaptation (using data from IFPRI 2010 and IMAGE 2.2, 2001)

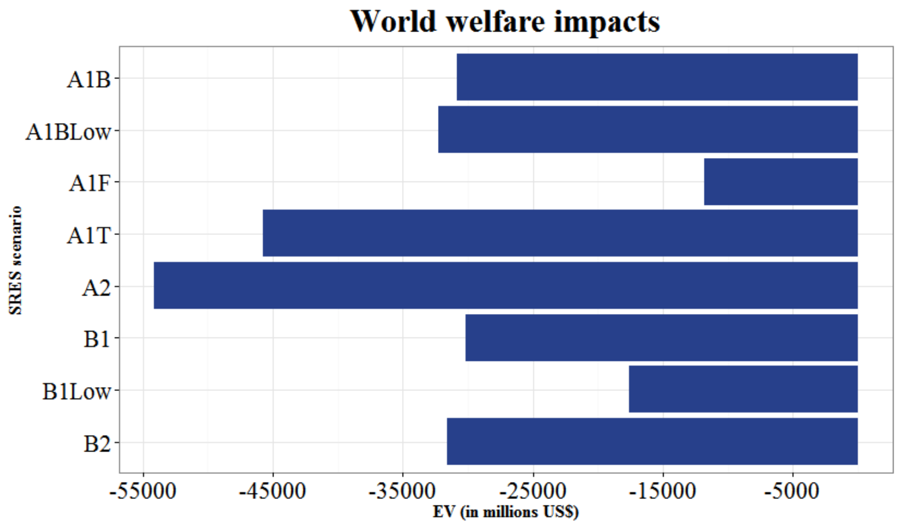
[6] Results are presented in boxplots using the 'ggplot2' package in R. The lower and upper borders of the boxplot represent respectively the 25th and 75th percentiles of the distribution of yield projections. The upper (lower) whisker extends from the boxplot upper (lower) border to the highest (lowest) value that is within 1.5*IQR of the border, where IQR stands for inter-quartile range defined as the distance between the 25th and 75th percentiles. The black lines inside the boxplot refer to the median of the distribution. Data beyond the end of the whiskers are outliers and are plotted as points. For a detailed discussion, refer to McGill, Tukey, and Larsen (1978).

3 Climate change and trade liberalization: An ex ante and ex post analysis of global welfare and macroeconomic impacts

3.1 Welfare and macroeconomic impact of climate change

As previously discussed, climate-induced yield impacts depict significant variability across climate scenarios regions. On average, the world experiences a negative welfare impact with a welfare loss of -US$31,762 million (Table 10 in the Appendix). Nonetheless, the distribution across climates scenarios suggests a substantial variability in welfare impacts, and ranges between a minimum of -US$11,784 million under SRES A1F to a maximum of -US$54,138 million under SRES A2 (Figure 5). This is expected given that productivity losses globally under SRES A2 are larger compared to SRES A1F where average yield losses across crops are -3.7 per cent and -0.2 per cent, respectively.

Figure 5: World welfare impacts by SRES scenario under climate change only (in US$ millions)



Source: Simulation results.

The effects that drive the observed welfare impacts globally most under the climate change only scenario are the allocative efficiency and technical efficiency effects,[7] with the latter providing the bulk of the impact (Table 10).

Geographical distribution of impacts on welfare and product GDP suggests a strong correlation with the distribution of projected yield changes across crop sectors (Figure 6 in the Appendix). Climate-induced impacts on welfare and GDP (+ or -) depend on the sign of projected yield impact and its magnitude. Indeed, the larger the yield impact the larger the effect of welfare and GDP. Nonetheless, the final effect depends crucially on which crop sectors are most affected by climate change and their relative shares in agricultural output and exports within each region.

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[7] Allocative efficiency (EV) is the change in EV due to the reallocation of economic resources. Technical efficiency is the change in EV due to the change in production technology (i.e. yields in our case).

Table 10: Decomposition of welfare impacts of climate change by effect for the world (in US$ millions)

	Allocative efficiency	Technical efficiency	TOT	Investment savings
A1B	-4,462.35	-26,423.52	2.25	0.67
A1BLow	-4,336.40	-27,953.71	-1.72	-0.30
A1F	-977.94	-10,806.87	-0.06	0.05
A1T	-5,898.39	-39,867.45	-3.61	-0.25
A2	-7,475.46	-46,662.10	-0.75	0.61
B1	-4,120.62	-26,050.43	1.96	0.80
B1Low	-1,279.00	-16,326.30	-1.92	0.07
B2	-4,054.56	-27,503.18	-0.52	0.54
Average	-4,075.59	-27,699.19	-0.55	0.27

Source: Simulation results.

On average, welfare impacts in Oceania, East Asia, South Asia and SSA are positive owing to positive average projected yield impacts respectively +3 per cent, +1 per cent, and +1 per cent. East Asia registers the largest average welfare gain with +US$7,926 million and SSA the lowest average gain with +US$754 million. Positive allocative efficiency and technical efficiency effects are the main drivers of the observed results, except for South Asia where allocative efficiency effects are negative. Nonetheless, the latter are largely offset by the technical efficiency effects. The TOT and investment savings effects are not significant to alter the final result. For the remaining regions, negative climate-induced productivity shocks induce welfare losses with the largest loss occurring in OECD Europe (-US$20,908 million) and the lowest in Canada (-US$83 million). As is the case for the positively impacted regions, allocative efficiency and technical efficiency effects are significantly larger than the TOT and investment savings effects. The former are negative for most regions; hence, the negative aggregate effect on welfare (Table 11).

Table 11: Decomposition of average welfare impacts by effects and by region under climate change only (in US$ millions)

GTAP region	Allocative efficiency	Technical efficiency	TOT	Investment savings	Equivalent variation
Oceania	106	2,086	147	62	2,401
East Asia	415	8,166	-794	139	7,926
Southeast Asia	-78	-788	90	76	-700
South Asia	-190	1,585	200	41	1,636
Canada	-112	-183	213	-2	-83
United States	-548	-3,497	1,462	-543	-3,126
Rest of Latin America	-826	-4,763	1,053	-3	-4,540
Brazil	-307	-3,229	796	171	-2,570
OECD Europe	-1,965	-16,642	-2,321	20	-20,908
Rest of the Middle East	-173	-4,161	-610	113	-4,832
Eastern Europe	-365	-801	45	-79	-1,200
Former USSR	-121	-2,277	-271	63	-2,607
Turkey	-4	-3,581	207	-51	-3,428
Rest of North Africa	11	231	-363	11	-110
Morocco	78	-427	-33	-5	-387
SSA	4	584	179	-14	754

Source: Simulation results.

In terms of impacts on GDP, we notice that negative impacts are associated with regions experiencing projected yield declines, and vice versa (Table 12 in the Appendix). In addition, the sign and magnitude of impacts for most regions are driven by the impacts on the consumption component in GDP, which accounts for more than 55 per cent of total GDP in most regions. In general, regions depicting high climate-induced productivity shocks (+ or -) and where agriculture accounts for a relatively large share of GDP, display the largest effects on the latter. For instance, the effects on GDP vary from a maximum loss of -1.5 per cent for Morocco under SRES A1B to a maximum gain of +1.2 per cent in SSA under SRES A1F (Figure 6 in the Appendix). These results are expected given that crop production accounts for 6.6 per cent and 7.2 per cent of total output in Morocco and SSA, respectively.

In general, climate-induced yield impacts' implications in terms of welfare and macroeconomic impacts depend on a multitude of factors that jointly determine losers and winners. The distribution of yield impacts and their magnitude across scenarios, and of domestic production and international trade flows, both at the regional and sector levels, are key determinants of the obtained results. Therefore, when investigating the potential of trade liberalization as an adaptation measure in the face of climate change, analysing the interaction among these factors is crucial to understanding the results.

3.2 Trade liberalization under climate change: Welfare and economy-wide impacts

In theory, the more international trade is liberalized at the global and sector levels the higher the welfare gains, and the more efficient is smoothing of adverse shock such as climate-induced productivity shocks. For the world on average, our hypothesis is robustly verified only under the trade liberalization scenario CCMULTI, which corresponds to a 100 per cent tariff removal for all regions and all sectors under climate change. We notice that global welfare under climate change only is negative and reaches -US$31,775 million. With a multilateral tariff elimination as in scenario CCMULTI, the welfare results on average are positive and reach +US$44,901 million. Therefore, the net effect of trade liberalization amounts to a welfare gain of +US$76,676 million, which totally mitigates the initial welfare loss due to climate change (Table 13 in the Appendix). For the rest of the scenarios, liberalizing trade does not deliver in terms of mitigation of the climate-induced impacts. This is verified when investigating the distribution of welfare impacts. Indeed, only under multilateral trade liberalization (CCMULTI), the welfare distribution fully changes from negative to positive for the world (Figure 7 in the Appendix). For the rest of the trade liberalization scenarios, mitigation of climate change impacts is not realized given the unchanged nature in the distribution of welfare results which remained mostly negative. Only the agricultural multilateral trade liberalization (CCAGMULTI) provides a partial offset of climate-induced welfare impacts.

In terms of the decomposition of the welfare impacts for the world, allocative efficiency and technical efficiency effects drive most of the observed results (Table 14).

Table 14: Decomposition of average welfare impacts for the world by effects (in US$ millions)

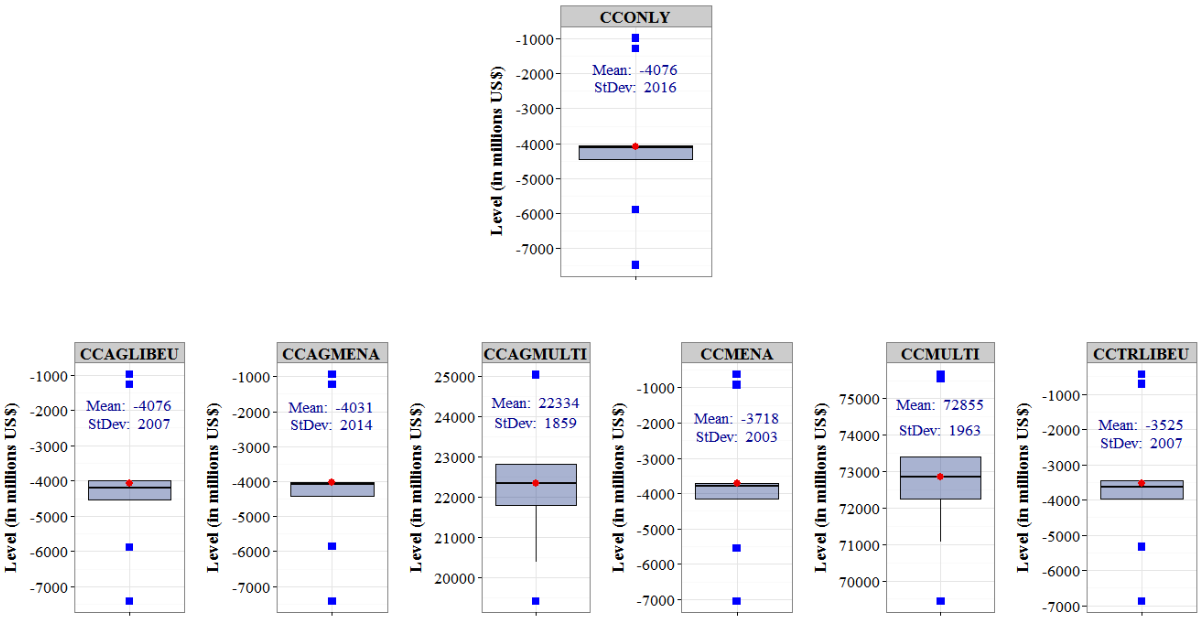
Scenario	Allocative efficiency	Technical efficiency	TOT	Investment savings
	Climate change only			
CCONLY	-4,075.59	-27,699.19	-0.55	0.27
	Climate change and trade liberalization			
CCAGLIBEU	-4,076.47	-27,684.05	-1.61	0.19
CCAGMENA	-4,030.87	-27,709.61	-0.43	0.27
CCAGMULTI	22,334.47	-27,111.75	-16.23	-0.20
CCMENA	-3,718.04	-27,740.84	-42.65	-4.30
CCMULTI	72,854.81	-27,332.46	-671.40	50.42
CCTRLIBEU	-3,524.84	-27,693.09	-5.48	-0.63
	Trade liberalization net			
AGLIBEU	-0.88	15.14	-1.06	-0.08
AGMENA	44.72	-10.42	0.12	0.00
AGMULTI	26,410.06	587.44	-15.68	-0.47
MENA	357.55	-41.65	-42.10	-4.58

MULTI	76,930.39	366.73	-670.85	50.14
TRLIBEU	550.75	6.10	-4.93	-0.90

Source: Simulation results.

Nonetheless, and compared with the climate change only scenario, there is little change in terms of technical efficiency effects as the latter mainly captures the impacts of climate-induced productivity shocks, which do not change under the different trade liberalization scenarios. Most of the change due to tariff elimination under the trade liberalization scenarios is captured by the observed change in allocative efficiency effects. The TOT and investment savings effects are insignificant for all scenarios. Trade liberalization offsets some of the negative climate-induced productivity impacts, but only marginally as suggested by the reduction in the negative contribution of technical efficiency effects. Upon investigating the distribution of the results, we notice that only under the CCAGMULTI and CCMULTI scenarios that the climate-induced negative impacts on allocative efficiency are robustly mitigated across climate scenarios (Figure 8).

Figure 8: Comparative analysis for the distribution of allocative efficiency results for the world under climate change with and without trade liberalization by scenario



Source: Simulation results.

Yet, it is only under the full multilateral trade liberalization scenario CCMULTI that the allocative efficiency gains are large enough to offset the negative impact of climate change as captured by the technical efficiency effects. Under all the Free Trade Agreement (FTA) scenarios (i.e. CCAGMENA, CCAGLIBEU, CCMENA, CCTRLIBEU), allocative efficiency is negative with the largest loss occurring under the CCAGLIBEU trade liberalization scenario (-US$4,076 million) (Table 15 in the Appendix). To further highlight the driving forces behind the negative allocative efficiency results, we investigate the decomposition by tax instruments (Table 16). We notice that private and intermediate consumption represent the bulk of the impacts globally. Furthermore, and when considering the regional disaggregation, we notice that OECD Europe's results capture the highest impacts.

Table 16: Decomposition of average allocative efficiency effects by tax instrument under climate change only and the CCAGLIBEU scenario (in US$ millions)

GTAP region	Climate change only							Net impact trade liberalization						
	contax	govtax	inputtax	mtax	pfacttax	prodtax	xtax	contax	govtax	inputtax	mtax	pfacttax	prodtax	xtax
Aggregate														
World	-2,985.04	-151.97	-856.96	357.72	-635.04	136.21	59.50	24.22	1.86	-1.24	25.74	-23.49	-24.73	-3.15
By region														
Oceania	126.54	1.00	-12.54	54.10	-13.45	-32.64	-16.82	-0.80	-0.01	0.31	-0.77	0.17	0.46	0.17
East Asia	167.58	0.08	87.82	-249.23	196.02	153.01	60.10	0.91	0.00	0.67	2.43	2.32	2.73	-2.22
Southeast Asia	-20.00	-0.01	-4.67	-35.04	-0.11	-17.30	-1.16	0.19	0.00	0.12	-0.83	-0.01	0.38	-0.08
South Asia	36.04	0.04	-19.61	-116.89	-0.69	-74.30	-14.42	0.00	0.00	0.78	-1.19	-0.03	2.08	0.22
Canada	-21.49	0.00	-6.30	1.24	-68.59	-16.78	0.26	-0.97	0.00	0.63	-0.86	3.13	0.65	-0.03
United States	-145.23	0.00	-80.23	-70.85	-180.43	-67.20	-4.54	0.43	0.00	2.24	-2.77	6.32	4.74	0.44
Rest of Latin America	-360.31	-19.33	-93.21	-46.48	-51.63	-255.59	0.18	0.33	-0.15	0.61	-0.89	0.33	12.39	-0.06
Brazil	-221.98	0.00	-54.03	-34.37	-13.47	11.84	5.21	-0.17	0.00	1.47	-1.48	0.16	2.37	0.17
OECD Europe	-2,137.80	-129.95	-496.20	562.49	-324.57	551.08	10.32	14.97	1.47	-0.41	25.00	-31.03	-39.40	-1.17
Rest of the Middle East	-37.70	-1.05	-21.07	14.95	1.89	-134.93	4.44	0.06	0.00	0.07	-2.24	-0.03	0.45	0.00
Eastern Europe	-115.97	-3.34	-81.50	1.59	-119.59	-45.87	-0.75	3.42	0.21	-3.08	9.27	-5.85	-5.14	-0.11
Former USSR	-172.61	-0.29	-73.84	52.41	-37.50	76.35	34.20	0.60	-0.01	2.57	-3.35	0.54	-2.73	-0.35
Turkey	-103.33	-0.77	10.36	70.56	-24.55	38.53	5.42	4.99	0.37	-7.44	-2.25	0.54	-7.06	-0.65
Rest of North Africa	-0.09	0.02	0.15	7.30	-0.96	7.25	-2.88	0.00	0.00	0.00	-0.94	-0.01	-0.03	0.18
Morocco	-0.01	0.00	0.00	79.15	0.00	-1.53	-0.03	-0.01	0.00	-0.01	5.04	0.00	2.64	0.11
SSA	21.31	1.64	-12.10	66.76	2.59	-55.71	-20.03	0.25	-0.01	0.25	1.58	-0.03	0.74	0.23

Source: Simulation results.

Given that private and intermediate consumption are the primary factors influencing the allocative efficiency results, we investigate the percent change dynamics for domestic and imports sales, decomposed by sectors in OECD Europe for households and firms (Table 17).

Table 17: Decomposition of impacts on domestic and imports sales by commodity in OECD Europe under climate change only and the CCAGLIBEU trade liberalization scenario (in % change)

Commodities	Climate change only				Net impact trade liberalization			
	Domestic sales		Import sales		Domestic sales		Import sales	
	Private	Firms	Private	Firms	Private	Firms	Private	Firms
Paddy rice	-13.80	-14.82	24.50	17.65	13.10	14.28	-18.84	-14.53
Wheat	8.37	5.51	30.92	25.50	-7.73	-4.99	-23.04	-19.71
Coarse grains	12.79	13.02	13.79	14.48	-11.34	-11.54	-12.09	-12.63
Vegetables, fruits, and nuts	6.11	7.15	9.00	10.04	-5.85	-6.80	-8.20	-9.11
Oilseeds	2.20	2.60	6.94	7.17	-2.18	-2.58	-6.43	-6.65
Sugar cane, suger beet	10.99	10.74	24.65	24.30	-9.86	-9.67	-19.68	-19.46
Other crops nested	3.40	4.16	8.69	9.55	-3.29	-4.00	-7.87	-8.60
Meat, livestock, raw milk	0.12	0.50	-0.07	0.40	-0.11	-0.49	0.10	-0.37
Forest, fish and minerals	-0.26	-0.09	-0.26	-0.06	0.27	0.09	0.26	0.05
Vegetable oils and fats	0.49	1.23	-0.40	0.41	-0.51	-1.26	0.44	-0.39
Other processed food	-0.01	0.39	-0.04	0.34	0.01	-0.39	0.06	-0.33
Textile and apparel	-0.20	-0.04	-0.28	-0.12	0.19	0.01	0.31	0.12
Manufactures	-0.23	-0.05	-0.30	-0.12	0.23	0.05	0.31	0.12
Utilities and construction	-0.25	-0.19	-0.27	-0.19	0.26	0.19	0.28	0.20
Transportation and services	-0.26	-0.12	-0.29	-0.16	0.26	0.12	0.30	0.17

Source: Simulation results.

We notice that for most crop and processed food commodities, consumption in value terms increases for both domestic production and imports under climate change; whereas it falls marginally for the non-food sectors. These results can be explained by investigating the price change dynamics, and its effect on the arbitrage in terms of substitution between domestic output and imports. At the domestic level, negative productivity shocks induce prices to increase for the food sectors. As a result, the demand for domestic food output decreases. For the non-food commodities, despite the marginal decrease in prices, demand shrinks but marginally. Given that prices for domestic output increases more compared to imports, an arbitrage occurs whereby the demand for imports increases quite significantly in order to replace lost consumption in the domestic output. This is clearly depicted by the magnitude of the percent change in import quantities which outweighs the per cent change in demand for domestic output. This dynamic unfolds both for private and intermediate demands under climate change only scenario. Nonetheless, resorting to imports to replace lost domestic consumption, despite relatively lower imports prices, is constrained given that import prices do increase as well. In turns, the allocation of resources across sectors becomes less efficient due to increasing costs as captured by the climate-induced price dynamics in domestic and import markets. When trade is liberalized under the CCAGLIBEU scenario, import prices decline, but only marginally. Indeed, we notice that the deflationary impact of multilateral tariff elimination on import prices does not offset the price increase observed under the climate change only scenario. As a result, the import demand expands further but marginally. Prices for domestic output increase slightly due to increased intermediate demand in exporting sectors, which benefit from favourable TOT due to the tariff elimination. For private households, trade liberalization alleviates the cost burden of substituting away from domestic goods through deflationary impacts on imports prices, albeit marginal (Table 18 in the Appendix). Nonetheless, the gains in efficiency in resource allocation brought about by a reduction in the cost of substitution from domestic goods to imports due to tariff elimination are not large enough to offset the initial loss under climate change only. Arguably, the limited scope of the trade liberalization scenario at the sector and regional level as defined for the CCAGLIBEU scenario does not have a significant impact on initial equilibrium conditions. This is clearly depicted by the magnitude of the net impact of tariff elimination under the latter scenario, which are insignificant compared to the price dynamic unfolding under climate change only.

On average at the regional level, and depending on the scope of the trade liberalization scenario, we can group the countries/regions based on the results in three groups (Table 13 in the Appendix):

- Group 1: countries/regions that benefit under climate change and gain under trade liberalization scenarios, but not all;
- Group 2: countries/regions that loose under climate change and benefit under trade liberalization scenarios, but not all;
- Group 3: countries/regions that loose under climate change and further loose under all trade liberalization scenarios.

In Group 1, Oceania, East Asia, South Asia, and SSA all benefit under climate change from positive projected yields on average. With trade liberalization, these regions further realize additional welfare gains. Nonetheless, not all regions gain under all scenarios. For instance, Oceania, East Asia, and SSA realize additional gains under the multilateral trade liberalization (CCMULTI), but not South Asia which displays a much lower welfare result compared to the climate change only scenario. In contrast, and under the agricultural multilateral trade liberalization (CCAGMULTI), Oceania's welfare results are lower compared with the climate change only scenario; whereas East Asia, South Asia, and SSA all benefit from higher welfare gains. The remaining countries/regions mostly fall within Group 2, which also include Turkey. Morocco is the only country that displays larger welfare losses compared with the climate change only scenario (Figure 9 in the Appendix).

For all regions, and given the exogenously-induced technical efficiency impacts due to climate change which remain mostly unchanged when introducing tariff elimination, the final welfare impacts are mainly driven by the combined effects of allocative efficiency, TOT, and investment savings (Table 15 in the Appendix).

For regions in Group 1 the contribution of allocative efficiency is positive for all, but only under the full and agricultural multilateral trade liberalization scenarios. For South Asia and SSA, allocative efficiency contributes negatively to welfare in four and two scenarios out of the six trade liberalization scenarios respectively.[8] Depending on the scenario, the TOT can contribute positively and

[8] In principle, negative allocative efficiency effects are counterintuitive in terms of theoretical expectations which suggest a positive contribution due to tariff elimination. Kabir and Salim (2011) investigate the issue of negative contribution of allocative efficiency to aggregate welfare stemming from regional trade liberalization scenarios. Their analysis focused on the BIMSTEC FTA, which combines seven geographically contiguous South and Southeast Asian countries: Bangladesh, Bhutan, India, Myanmar, Nepal, Sri Lanka, and Thailand. They argue that the negative contribution of allocative efficiency

significantly to aggregate welfare. For instance, East Asia and Oceania benefit from relatively large TOT under the CCMULTI scenario; they contribute negatively in South Asia and SSA. A reversal occurs under the CCAGMULTI scenario whereby South Asia and SSA benefit, and vice versa for East Asia. The savings-investment effects contribute positively to aggregate welfare for most regions and under most tariff elimination scenarios.

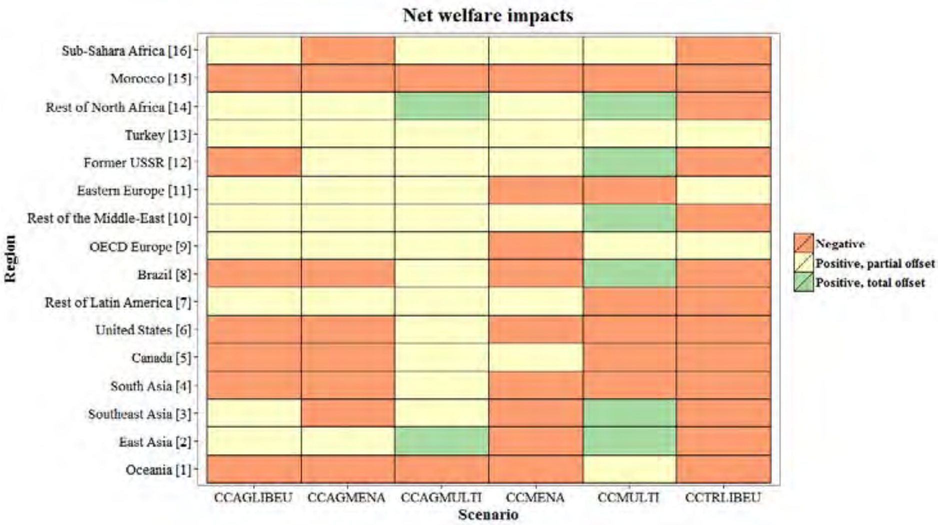
For countries/regions in Group 2, the allocative efficiency effects in general are positive and relatively large under the multilateral trade liberalization scenarios, except for the United States and Canada under the CCAGMULTI scenario. On the other hand, TOT effects are mostly negative under the full multilateral trade liberalization scenario. As we move from a multilateral to a regional scenario in terms of tariffs elimination, we notice that the TOT effect contributes positively for some regions, but not all. For example, under the CCMENA scenario, the United States, Canada, the Rest of the Middle East, and Turkey display positive TOT effects; whereas it remains negative for the rest of the regions in the group under the same scenario.

For Morocco in Group 3, the results suggest that only allocative efficiency effects contribute positively to aggregate welfare under the different trade liberalization scenarios, except under the full FTA in MENA (CCMENA). The gains can be significant, especially under the broader tariffs elimination regimes (e.g. CCMULTI). In addition, the negative climate-induced technical efficiency effects are lower compared to the climate change only scenario, which suggests minor gains. Nonetheless, the latter remain mostly negative and combined with the negative contribution from investment savings, and the significant TOT effects, the final result is a welfare loss under all trade liberalization scenarios.

Overall and based on the net welfare impacts of trade liberalization (Table 13 in the Appendix), the ability of trade liberalization to offset (enhance) the climate-induced yield losses (gains), varies from one country/region to the other. Given that we model six trade liberalization scenarios for 16 countries/regions, we generate 96 case figures of welfare results for each climate scenario. On average, the general trend in the results across regions and trade scenarios suggests net welfare losses in 47 per cent of the cases. Positive net welfare results account for 53 per cent of the cases, with cases of partial offset of initial welfare loss representing 45 per cent of the cases and total offset cases 8 per cent. When investigating the distribution across climate scenarios, we do not observe significant changes compared to the average (Figure 10 and 11).

effects can be explained by 'the magnitude and interaction of the pre-existing sector subsidies with the quantity change in imports and exports after the removal of import duties within the bloc. The sign of the effect would depend on whether the quantity change in exports that receive domestic subsidies surpasses the effect in quantity change in imports due to the removal of tariff liberalization' (Kabir and Salim 2011).

Figure 10: Distribution of average net welfare impact for all regions by category



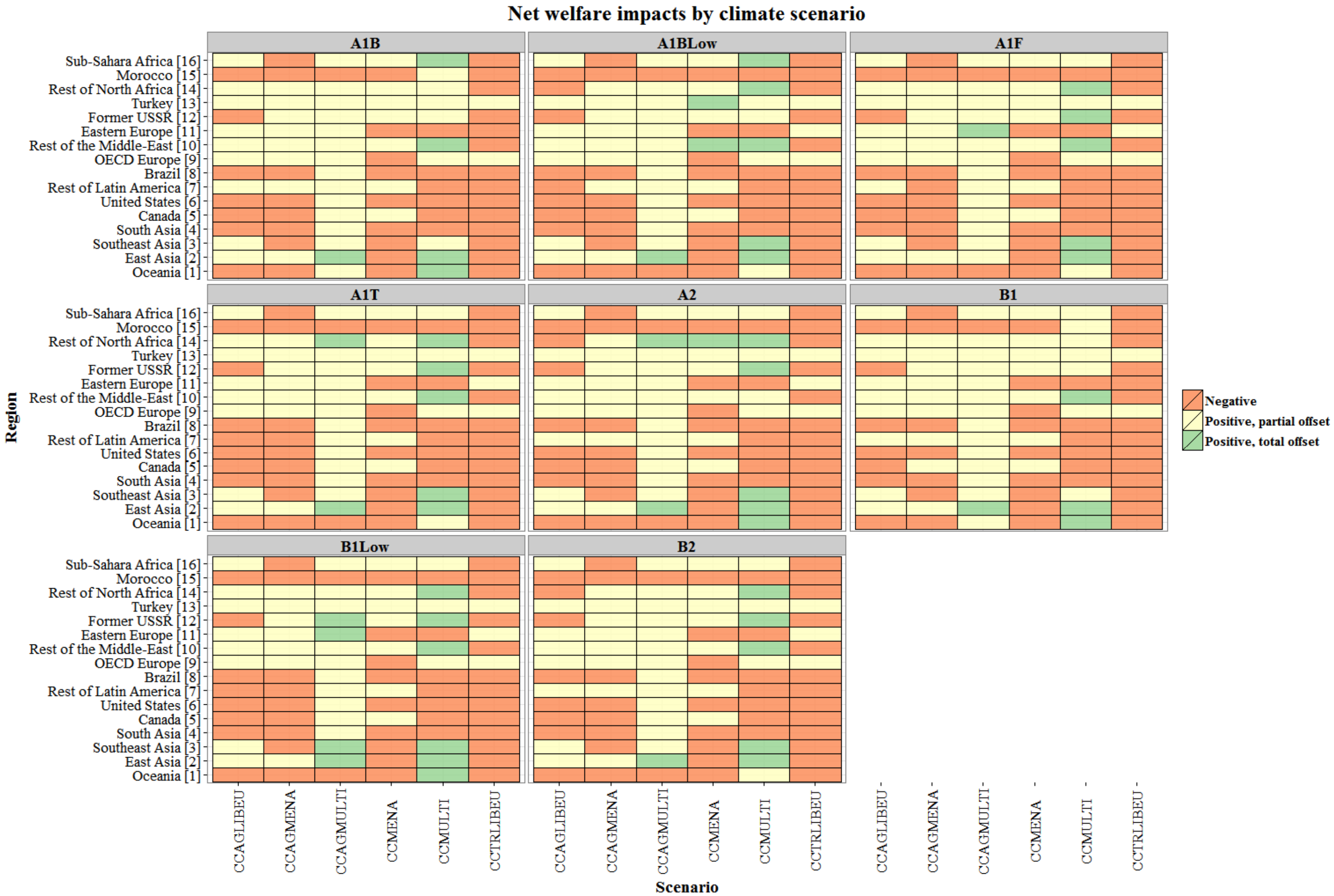
Source: Simulation results.

4 Impacts of trade liberalization under climate change: A comparison between Morocco and Turkey

4.1 Analysis of aggregate welfare and macroeconomic impacts

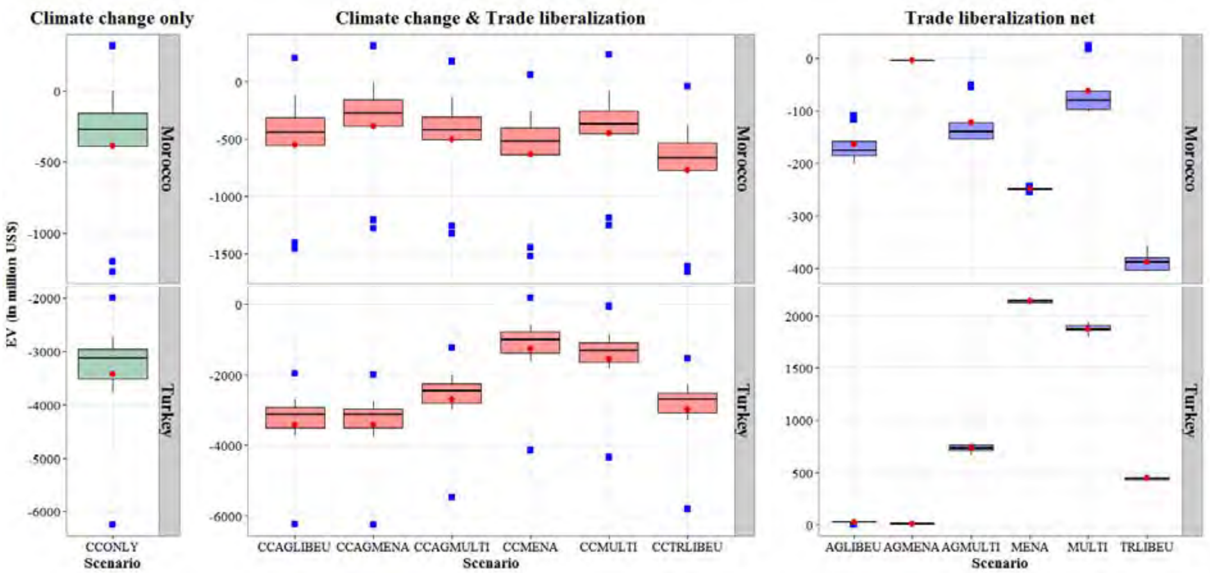
As previously argued, Morocco on average does not benefit from trade liberalization ex post climate change; whereas the contrary is observed for Turkey. In terms of net welfare contribution, Moroccan tariff elimination induces further losses with the lowest occurring under the agricultural FTA in MENA and the highest under the full FTA with OECD Europe. In Turkey, trade liberalization seems to have a positive impact on aggregate welfare. There are positive net welfare contributions under all scenarios, with the highest occurring under a full FTA in MENA and the lowest under an agricultural FTA in MENA. Nonetheless, the net gains are not large so as to totally offset the initial welfare loss induced by negative productivity shocks in agriculture under climate change (Figure 12).

Figure 11: Distribution of net welfare impacts by climate scenario and by category



Source: Simulation results.

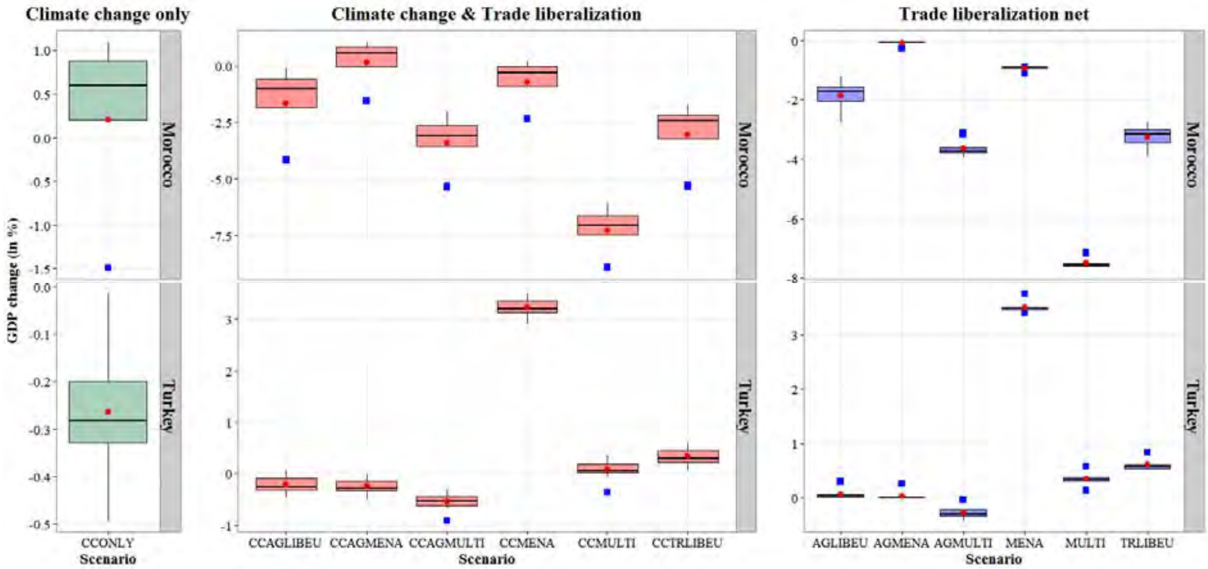
Figure 12: Distribution of welfare impacts for Morocco and Turkey by scenario



Source: Simulation results.

In terms of impacts on GDP, the latter mimic the observed results for aggregate welfare. For Morocco, the results suggest a significant negative impact on GDP, and especially under the full and agricultural multilateral trade liberalization scenarios. Overall, the net contribution of trade liberalization on GDP is negative under all scenarios, with highest under the full multilateral trade liberalization (-8 per cent) and the lowest under the agricultural FTA with MENA (-0.3 per cent). In Turkey, the results suggest a mixed picture. On average, impacts on GDP are positive only under trade liberalization scenarios spanning all sectors. For the agricultural trade liberalization scenarios, impacts are mostly negative but not significantly. The highest GDP gain occurs under the full FTA with MENA where the latter reaches +4 per cent; whereas the lowest gain is +0.6 per cent under the full multilateral trade liberalization scenario (Figure 13).

Figure 13: Distribution of GDP impacts for Morocco and Turkey by scenario



Source: Simulation results.

When we investigate the decomposition of the welfare impacts, we notice that on average the interaction between the allocative efficiency and TOT effects is the main determinant of the net welfare position in Morocco and Turkey. For the former, we notice that trade liberalization induces positive net allocative efficiency effects under all scenarios, except the under the full FTA with MENA. On the other hand, TOT and investment savings are generally negative, with the former significantly larger. Under most scenarios, the TOT losses outweigh the gains in allocative efficiency effects, except under the full multilateral trade liberalization scenario where net allocative efficiency gains are +US$ 1,254 million, and net TOT losses are -US$1,212 million. Nonetheless, the net contribution of investment savings effects under this scenario is negative and reaches -US$188 million, thus causing an aggregate welfare loss despite the small net gain in terms of technical efficiency. For Turkey, on average, the net TOT and allocative efficiency effects contribute positively to aggregate welfare. For instance, net gains from allocative efficiency and TOT effects under the full multilateral trade liberalization scenario reach +US$908 million and +US$906 million. Even in the case where we observe a divergence between the two effects, it is usually the case that one or the other is large enough to offset any potential net loss. This occurs for example under the full FTA with MENA where the net gains from TOT effects amount to +US$2,198 million and the net losses from allocative efficiency are -US$328 million. But generally for Turkey, trade liberalization entails net welfare gains, though not large enough to totally offset the initial loss of welfare under climate change (Figure 14).

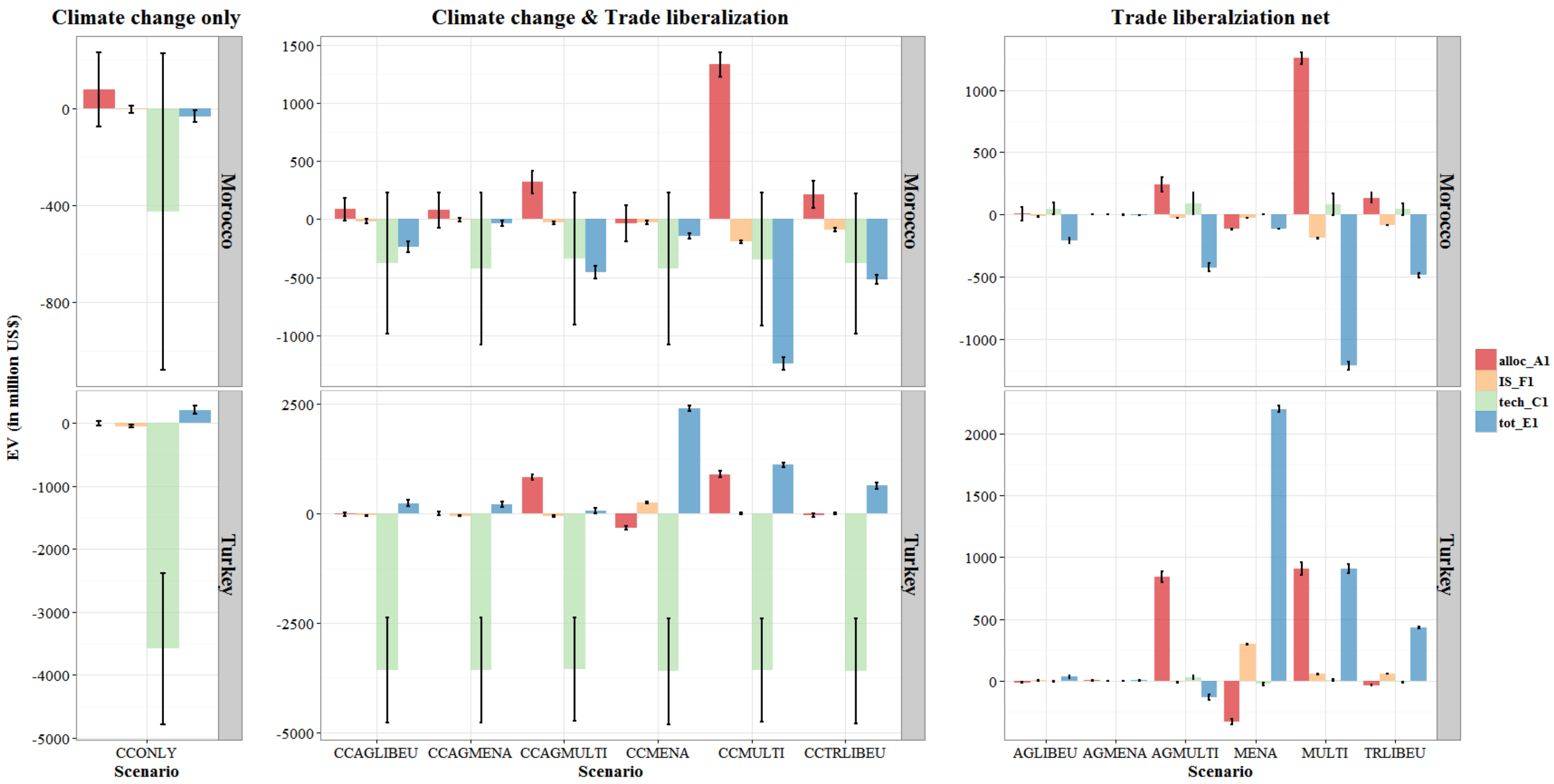
In terms of net impacts on GDP components, Morocco consumption and government spending declines under most scenarios, with consumption decreasing more compared to government spending. Aggregate exports and imports display significant increases, especially under the full multilateral trade scenario and the full FTA with OECD Europe. Under the non-agricultural trade liberalization scenarios, imports increase more than exports, and vice versa for the agricultural trade liberalization scenario. For aggregate investment, they decrease under the agricultural trade liberalization scenarios and vice versa under the non-agricultural trade scenarios. Given the disproportionate share of consumption and government spending in Moroccan GDP, the negative impacts associated with the latter dominate the final effect, which is the negative overall impact on GDP discussed earlier. In Turkey, the impact of trade liberalization is generally positive for all GDP components. For example, all GDP components increase by more than 3 per cent under the full FTA with MENA. Overall, trade liberalization induces an expansionary surge in terms of aggregate GDP in Turkey, whereas the contrary occurs in Morocco where the economy in general experiences a general contraction (Figure 15). The explanation and discussion of the latter conclusion is furthered in the next section.

4.2 Sector impacts: trade, prices, and production

Trade: imports and exports

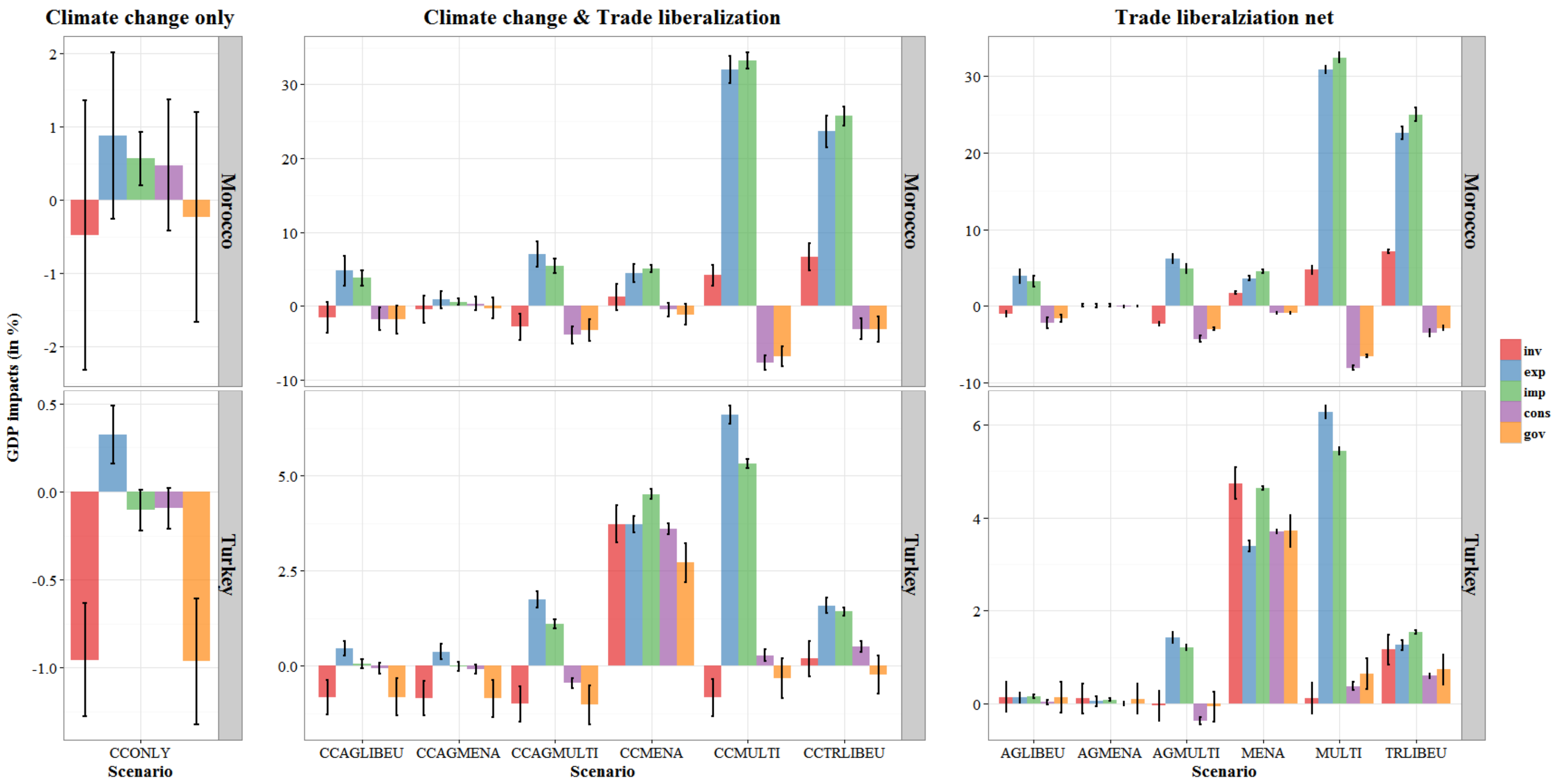
In the aftermath of tariff elimination, the immediate impact is a decline in world prices, therefore affecting the relative price of exports and imports, which in turn affect the consumption and production patterns domestically. For Morocco, the net effect of trade liberalization under climate change on export price and quantity index is different. Under all scenarios, aggregate export price indexes decrease significantly, especially under the full multilateral trade liberalization scenario (-6 per cent). As for the quantity index, the latter suggests a positive evolution, which can be significant reaching +39 per cent under the full multilateral scenario. On the imports side, Moroccan imports exhibit a similar surge to exports. Nonetheless, this occurs in a context of increasing import prices. By contrast, Turkey on the export side benefits from increasing prices and quantities as suggested by the net impact on aggregate export price and quantity indices which is mainly positive under most scenarios. Moreover, Turkish imports are increasing and in a context of decreasing prices. These results are robust across scenarios (Figure 16).

Figure 14: Decomposition of aggregate average welfare impacts by effect in Morocco and Turkey



Source: Simulation results.

Figure 15: Decomposition of gross domestic product average impacts by category in Morocco and Turkey



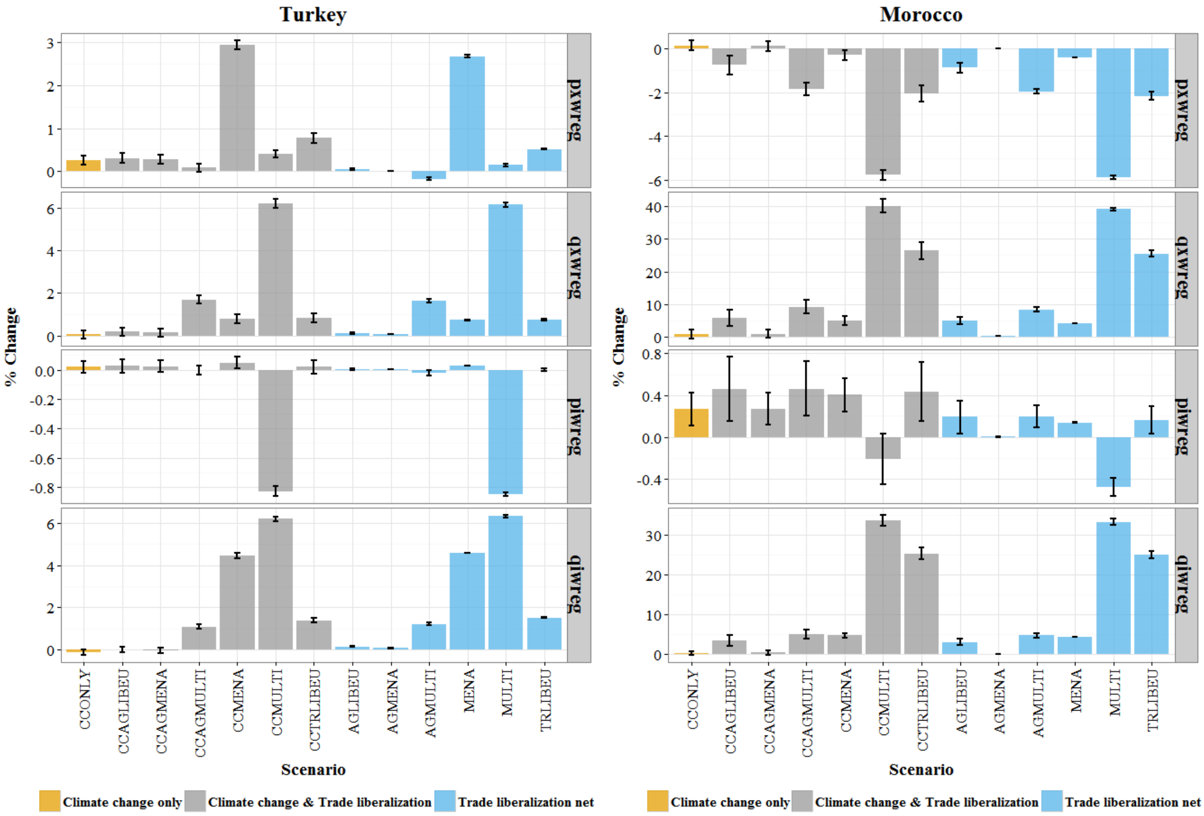
Source: Simulation results.

These results help explain the welfare impacts resulting from the TOT effects in both countries. As argued previously, the contribution on the TOT to net aggregate welfare in Morocco was found to be consistently negative under most scenarios. This comes as no surprise given that Moroccan exports, despite increasing in quantitative terms on aggregate, do not benefit from increasing export prices. As for imports, the latter increase substantially and in a context of increasing prices. Thus, the combination of devalued exports and costly imports generate negative TOT effects. A reverse dynamic is observed in the Turkish case, where Turkish exports increase with increasing prices, and imports becoming cheaper under most scenarios. This helps explain the positive contribution to welfare generated through the TOT.

At the sector level, for Turkey import prices for crop commodities tend to increase under most scenarios. The rest of the sectors depict decreasing import prices in general, especially under the full multilateral trade liberalization scenario. Imports quantities on the other hand display substantial increases most notably under the full and agricultural multilateral trade scenarios, and the full FTA with MENA. For instance, net imports for crop commodities on average increase by more than 60 per cent except for coarse grains and oilseeds under the full multilateral trade liberalization scenario (Table 19 in the Appendix). In terms of exports, the net price impacts induced by trade liberalization is generally positive and for most sectors, except under the CCAGMULTI scenario (Table 20 in the Appendix). Under the latter, exports prices mostly decrease, whereas exports quantities increase; thus, and coupled with an import dynamic where prices and quantities increase, it results in a negative contribution to welfare through the TOT effects as discussed earlier. Overall, Turkey seems to benefit from relatively cheap imports, which in turn stimulate production domestically. At the same time, prices on the export side increase, which boosts exports.

For Morocco, import prices increase under most scenarios, especially for crop commodities. For the latter, a small decrease in prices occurs under the full and agricultural FTA scenarios with MENA, but remains negligible. In terms of quantities, the general trend suggests substantial increases, most notably for the crop commodities (Table 19 in the Appendix). In terms of exports, despite increasing volumes, the latter occur in a context of decreasing prices under the CCMULTI and CCAGMULTI scenarios (Table 20 in the Appendix). The large percent change observed in trade volumes for Morocco is driven by the initial high import tariff structure in place. Therefore, a complete removal of tariffs, as in the CCMULTI scenario, translates into a substantial shock to relative prices at the sector level, especially for crops and food commodities. Overall, Morocco does not benefit from its exports despite the substantial increase in exported quantities. The latter is due to the impacts of trade liberalization on export prices, which cause them to decrease under most cases. In addition, the dependency on imports as suggested by the substantial increase in demand and in a context of increasing prices results in an overall negative contribution to welfare accruing from the TOT.

Figure 16: Average percent change in exports and imports price and quantity indices



Source: Simulation results.

Domestic demand and production

The contradictory effect of climate change on productivity induces price hikes domestically, and especially for the crop commodities in both Morocco and Turkey. In general, these price hikes in domestic markets are larger than the price increases of imported commodities. Therefore, we observe an increase in the final demand for imports which are relatively cheaper than domestic production from private households and government. In terms of intermediate demand generated by firms, a similar dynamic plays out especially for crop commodities. Generally, we notice that firms' demand for imported intermediate inputs increases in both countries at the expense of domestic intermediate inputs, particularly for crop intermediates. Intermediate input prices in the non-agricultural sectors increase only marginally compared with the agricultural sectors, and even decline for certain sectors. As a result, we notice a general reallocation of domestic and intermediate inputs from the climatically unconstrained non-agricultural sectors to the crop and food processing sectors. A similar dynamic occurs for final household and government expenditure demand for domestic and imported commodities (Appendix Table 21).

Eliminating tariffs under all scenarios induces significant fluctuations in final and intermediate demands for domestic and imported commodities through price differentials. In Morocco, aggregate output sales by destination display significant impacts. The share of domestic markets experiences a significant decline in all sectors especially under the multilateral trade scenario. On the other hand, the share of export markets displays a substantial appreciation. The largest impacts occur for crop and food processing sectors. The decline in demand for domestic output stems from the decrease in demand from households, government and firms. As previously argued, tariff elimination induces a substantial price decline for imports, which in turn deflate prices for domestic output. Nonetheless, the disproportionate decrease in import prices compared to domestic prices induces the different agents to substitute away from domestic output to imports which are relatively cheaper. For instance, the substantial fall in wheat production under the 'MULTI' scenario is a direct result of falling market prices, which are driven by increased import-supply following tariff elimination. Indeed, demand for domestic wheat from private households, government and firms decreases by -54 per cent, -44 per cent and -45 per cent respectively; whereas their demand for imported wheat increase by +23 per cent, +11 per cent and +46 per cent. This comes as no surprise given that import prices for wheat decline by -35 per cent compared with -7 per cent for domestic prices. A similar dynamic unfolds for most of the crop and food processing commodities sectors under the 'MULTI' scenario. These sectors are heavily protected in Morocco, and therefore tariff elimination exposes the less competitive domestic sector to international competition (Tables 21-25 in the Appendix).

For Turkey, a similar trend is observed for aggregate output sales. The share of domestic markets in output sales declines for most sectors and especially under the multilateral trade scenario. Nonetheless, the magnitude of change is smaller than the Moroccan case. On the other hand, the share of export markets displays a substantial appreciation which is significantly higher than the Moroccan case. The impacts for some sectors can be large. For instance, the share of livestock and rice production allocated to export markets increase by +3,003 per cent and +1.192 per cent. But these changes are not meaningful as most of these changes are from a base near zero. The decline observed in demand for domestic output stems from the decrease in demand from households, government and firms. As previously argued, tariff elimination induces a substantial price decline for imports, which in turn deflate prices for domestic output. But these effects are less pronounced than in Morocco. The effects of trade liberalization on Turkey are mainly through imported intermediate input use. Although effects on sectors may differ, Turkish imports generally increase to supply the increasing intermediate input demand by the export sectors. Use of agricultural inputs increases especially for intermediate use in food, manufacturing, livestock and vegetable oil production as the exports of these commodities increases (Tables 21-25 in the Appendix).

5 Conclusions

Globally, the main conclusions of the analysis suggest that:

- Trade liberalization in most cases offsets only partially the negative impact associated with climate change on agriculture;
- Total offset of negative welfare impacts associated with climate change occurs only under special scenario cases, which are from an implementation perspective highly improbable to materialize.
- At the regional level, and depending on the scope of the trade liberalization, we notice that, regions benefitting from positive climate-induced productivity shocks on agriculture benefit the most under trade liberalization;

- Regions experiencing negative climate shocks to agricultural yields benefit only marginally from trade liberalization, and under specific tariff elimination scenarios, the net impact is negative.

For Morocco, the analysis suggests that:

- Tariff elimination under all scenarios on average induces additional welfare loss compared with the climate change only scenario;
- Trade liberalization induces net gains in allocative efficiency, but the latter are generally offset by the substantial negative contribution of the TOT and investment savings effects;
- Exports tend to increase substantially, but in a context of significantly decreasing prices; whereas imports show significant increases in a contest of increasing prices, especially for crop and food commodities.

In Turkey, we notice that:

- Trade liberalization induces net welfare gains under all scenarios;
- The magnitude of the gains are not large enough to offset the totality of the initial loss under climate change;
- The combined effect of positive net allocative efficiency and TOT effects drive most of the results;.
- Exporting sectors in Turkey seem to benefit substantially from free trade given increasing export prices and quantities, and especially for crop and food commodities (e.g. oilseeds and other crops);
- Imports increase substantially, driven primarily by intermediate demand and low import prices;
- For the rest of the sectors, the trend in traded volumes is generally increasing for both exports and imports, due to increasing export prices and declining import prices.

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Appendix, remaining tables and figures

Table 1: Definition of simulation scenarios

Scenario	Description
CConly	Climate change only
CCMULTI	CConly + Global tariff elimination on all commodities
CCAGMULTI	CConly + Global tariff elimination on all agricultural commodities
CCTRLIBEU	CConly + Tariff elimination on all commodities between OECD Europe + Eastern Europe and Morocco, and OECD Europe + Eastern Europe and Turkey
CCAGLIBEU	CConly + Tariff elimination on all agricultural commodities between OECD Europe + Eastern Europe and Morocco, and OECD Europe + Eastern Europe and Turkey
CCMENA	CConly + Tariff elimination on all commodities among all MENA regions
CCAGMENA	CConly + Tariff elimination on all agricultural commodities among all MENA regions

Source: Authors' definition.

Table 4: Description of the GTAP regional aggregation adopted in the analysis

Region code	Description	GTAP countries/regions
Oceania	Oceania	Australia, New Zealand, Rest of Oceania
EAsia	East Asia	China, Hong Kong, Japan, Korea, Taiwan, Rest of East Asia
SEAsia	Southeast Asia	Cambodia, Indonesia, Lao People's Democratic Republic, Myanmar, Malaysia, Philippines, Singapore, Thailand, Viet Nam, Rest of Southeast Asia
SAsia	South Asia	Bangladesh, India, Pakistan, Sri Lanka, Rest of South Asia
CAN	Canada	Canada
USA	United States of America	United States
XLatAmer	Rest of Latin America	Mexico, Rest of North America, Argentina, Bolivia, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela, Rest of South America, Costa Rica, Guatemala, Nicaragua, Panama, Rest of Central America
BRA	Brazil	Brazil
OecdEU	OECD Europe	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Spain, Sweden, United Kingdom, Switzerland, Norway, Rest of EFTA
XMidEast	Rest of Middle East	Cyprus, Iran Islamic Republic of, Rest of Western Asia
EastEU	Eastern Europe	Czech Republic, Hungary, Poland, Slovakia, Slovenia, Albania, Bulgaria, Croatia, Romania, Rest of Eastern Europe, Rest of Europe
FrmUSSR	Former USSR	Estonia, Latvia, Lithuania, Belarus, Russian Federation, Ukraine, Kazakhstan, Kyrgyztan, Rest of Former Soviet Union, Armenia, Azerbaijan, Georgia
TUR	Turkey	Turkey
XNAfrica	Rest of North Africa	Egypt, Tunisia, Rest of North Africa
MAR	Morocco	Morocco
SSA	SSA	Nigeria, Senegal, Rest of Western Africa, Central Africa, South Central Africa, Ethiopia, Madagascar, Malawi, Mauritius, Mozambique, Tanzania, Uganda, Zambia, Zimbabwe, Rest of Eastern Africa, Botswana, South Africa, Rest of South African Customs

Source: Authors' adaptation (Data: GTAP database version 7.0[9])

[9] Narayanan and. Walmsle (2008).

Table 5: Regional matching between the GTAP and IFPRI regions

GTAP region		IFPRI region	
Code	Description	Code	Description
EastEU	Eastern Europe	ADR	Adriatic
OecdEU	OECD Europe	AEU	Alpine Europe
SAsia	South Asia	AFG	Afghanistan
XNAfrica	Rest of North Africa	ALG	Algeria
SSA	SSA	ANG	Angola
XLatAmer	Rest of Latin America	ARG	Argentina
Oceania	Oceania	AUS	Australia
OecdEU	OECD Europe	BAL	Baltic
SAsia	South Asia	BAN	Bangladesh
OecdEU	OECD Europe	BEL	Belgium
SSA	SSA	BEN	Benin
SAsia	South Asia	BHU	Bhutan
SSA	SSA	BOT	Botswana
BRA	Brazil	BRA	Brazil
OecdEU	OECD Europe	BRI	Britain British Isles
SSA	SSA	BUF	Burkina Faso
SSA	SSA	BUR	Burundi
SSA	SSA	CAM	Cameroon
CAN	Canada	CAN	Canada
SSA	SSA	CAR	Central African Republic
FrmUSSR	Former USSR	CAU	Caucus
XLatAmer	Rest of Latin America	CCA	Caribbean
EastEU	Eastern Europe	CEU	Central Europe
SSA	SSA	CHA	Chad
XLatAmer	Rest of Latin America	CHL	Chile
EAsia	East Asia	CHN	China
XLatAmer	Rest of Latin America	COL	Colombia
SSA	SSA	CON	Congo
XLatAmer	Rest of Latin America	CSA	Central South America
XMidEast	Rest of Middle East	CYP	Cyprus
SSA	SSA	DJI	Djibouti
SSA	SSA	DRC	Democratic Republic of Congo
XLatAmer	Rest of Latin America	ECU	Ecuador
XNAfrica	Rest of North Africa	EGY	Egypt
SSA	SSA	EQG	Equatorial Guinea
SSA	SSA	ERI	Eritrea
SSA	SSA	ETH	Ethiopia
OecdEU	OECD Europe	FRA	France
SSA	SSA	GAB	Gabon
SSA	SSA	GAM	Gambia
OecdEU	OECD Europe	GER	Germany
SSA	SSA	GHA	Ghana
SSA	SSA	GUB	Guinea Bissau
SSA	SSA	GUI	Guinea
XMidEast	Rest of Middle East	GUL	Gulf States
OecdEU	OECD Europe	IBE	Iberia
SAsia	South Asia	IND	India
SEAsia	Southeast Asia	INO	Indonesia
XMidEast	Rest of Middle East	IRN	Iran
XMidEast	Rest of Middle East	IRQ	Iraq
XMidEast	Rest of Middle East	ISR	Israel
OecdEU	OECD Europe	ITA	Italy
SSA	SSA	IVC	Ivory Coast
EAsia	East Asia	JAP	Japan
XMidEast	Rest of Middle East	JOR	Jordan
FrmUSSR	Former USSR	KAZ	Kazakhstan

SSA	SSA	KEN	Kenya
FrmUSSR	Former USSR	KYR	Kyrgyzstan
XNAfrica	Rest of North Africa	LBY	Libya
XMidEast	Rest of Middle East	LEB	Lebanon
SSA	SSA	LES	Lesotho
SSA	SSA	LIB	Liberia
SSA	SSA	MAD	Madagascar
SSA	SSA	MAL	Mali
SSA	SSA	MAU	Mauritania
XLatAmer	Rest of Latin America	MEX	Mexico
SSA	SSA	MLW	Malawi
SEAsia	Southeast Asia	MLY	Malaysia
EAsia	East Asia	MON	Mongolia
MOR	Morocco	MOR	Morocco
SSA	SSA	MOZ	Mozambique
SEAsia	Southeast Asia	MYN	Myanmar
SSA	SSA	NAM	Namibia
SAsia	South Asia	NEP	Nepal
OecdEU	OECD Europe	NET	Netherlands
SSA	SSA	NIA	Nigeria
SSA	SSA	NIG	Niger
EAsia	East Asia	NOK	North Korea
XLatAmer	Rest of Latin America	NSA	Northern South America
Oceania	Oceania	NZE	New Zealand
SAsia	South Asia	PAK	Pakistan
XLatAmer	Rest of Latin America	PER	Peru
SEAsia	Southeast Asia	PHI	Philippines
Oceania	Oceania	PNG	Papua New Guinea
EastEU	Eastern Europe	POL	Poland
FrmUSSR	Former USSR	RUS	Russia
SSA	SSA	RWA	Rwanda
SSA	SSA	SAF	South
OecdEU	OECD Europe	SCA	Scandinavia
SEAsia	Southeast Asia	SEA	SE Asia
SSA	SSA	SEN	Senegal
SEAsia	Southeast Asia	SIN	Singapore
EAsia	East Asia	SKO	South Korea
SSA	SSA	SLE	Sierra Leone
SSA	SSA	SOM	Somalia
SAsia	South Asia	SRL	Sri Lanka
SSA	SSA	SUD	Sudan
SSA	SSA	SWA	Swaziland
XMidEast	Rest of Middle East	SYR	Syria
FrmUSSR	Former USSR	TAJ	Tajikistan
SSA	SSA	TAN	Tanzania
SEAsia	Southeast Asia	THA	Thailand
FrmUSSR	Former USSR	TKM	Turkmenistan
TKY	Turkey	TKY	Turkey
SSA	SSA	TOG	Togo
XNAfrica	Rest of North Africa	TUN	Tunisia
SSA	SSA	UGA	Uganda
FrmUSSR	Former USSR	UKR	Ukraine
UNS	United States	UNS	United States
XLatAmer	Rest of Latin America	URU	Uruguay
FrmUSSR	Former USSR	UZB	Uzbekistan
SEAsia	Southeast Asia	VIE	Vietnam
SSA	SSA	ZAM	Zambia
SSA	SSA	ZIM	Zimbabwe

Source: Authors' adaptation (Data: GTAP database version 7 and IFPRI 2010).

Table 6: Regional matching between the GTAP and IMAGE regions

GTAP region	IMAGE region
Oceania	Oceania
East Asia	East Asia, Japan
Southeast Asia	Southeast Asia
South Asia	South Asia
Canada	Canada
United States of America	USA
Rest of Latin America	Central America, South America
Brazil	South America
OECD Europe	OECD Europe
Rest of Middle East	Middle East
Eastern Europe	Eastern Europe
Former USSR	Former USSR
Turkey	Middle East
Rest of North Africa	Northern Africa
Morocco	Northern Africa
SSA	Eastern Africa, Southern Africa, Western Africa

Source: Authors' adaptation (Data: GTAP database version 7 and IMAGE 2.2, 2001).

Table 7: GTAP sector aggregation in the model

GTAP New sector		GTAP Old sector	
Code	Description	Code	Description
pdr	Paddy rice	pdr	Paddy rice
wht	Wheat	wht	Wheat
gro	Cereal grains nec	gro	Cereal grains nec
VegtFrut	Vegetables, fruit, nuts	v_f	Vegetables, fruit, nuts
osd	Oil seeds	osd	Oil seeds
c_b	Sugar cane, sugar beet	c_b	Sugar cane, sugar beet
OthCrop	Other crops	pfb	Plant-based fibers
		ocr	Crops nec
MtLkMlk	Meat, livestock, raw milk	ctl	Cattle, sheep, goats, horses
		oap	Animal products nec
		rmk	Raw milk
		wol	Wool, silk-worm cocoons
		cmt	Meat: cattle, sheep, goats, horse
		omt	Meat products nec
Extract	Forest, fish, minerals	frs	Forestry
		fsh	Fishing
		coa	Coal
		oil	Oil
		gas	Gas
		omn	Minerals nec
VegtOil	Vegetable oils and fats	vol	Vegetable oils and fats
XPrFood	Other processed food	mil	Dairy products
		pcr	Processed rice
		sgr	Sugar
		ofd	Food products nec
		b_t	Beverages and tobacco products
TextApp	Textile and apparel	tex	Textiles
		wap	Wearing apparel
		lea	Leather products
Mnfctrs	Manufactures	lum	Wood products
		ppp	Paper products, publishing
		p_c	Petroleum, coal products
		crp	Chemical, rubber, plastic prods
		nmm	Mineral products nec

		i_s	Ferrous metals
		nfm	Metals nec
		fmp	Metal products
		mvh	Motor vehicles and parts
		otn	Transport equipment nec
		ele	Electronic equipment
		ome	Machinery and equipment nec
		omf	Manufactures nec
		ely	Electricity
UtilCons	Utilities and construction	gdt	Gas manufacture, distribution
		wtr	Water
		cns	Construction
		trd	Trade
		otp	Transport nec
		wtp	Sea transport
		atp	Air transport
		cmn	Communication
Svces	Transportation and services	ofi	Financial services nec
		isr	Insurance
		obs	Business services nec
		ros	Recreation and other services
		osg	Pub. admin/defence/health/educat
		dwe	Dwellings

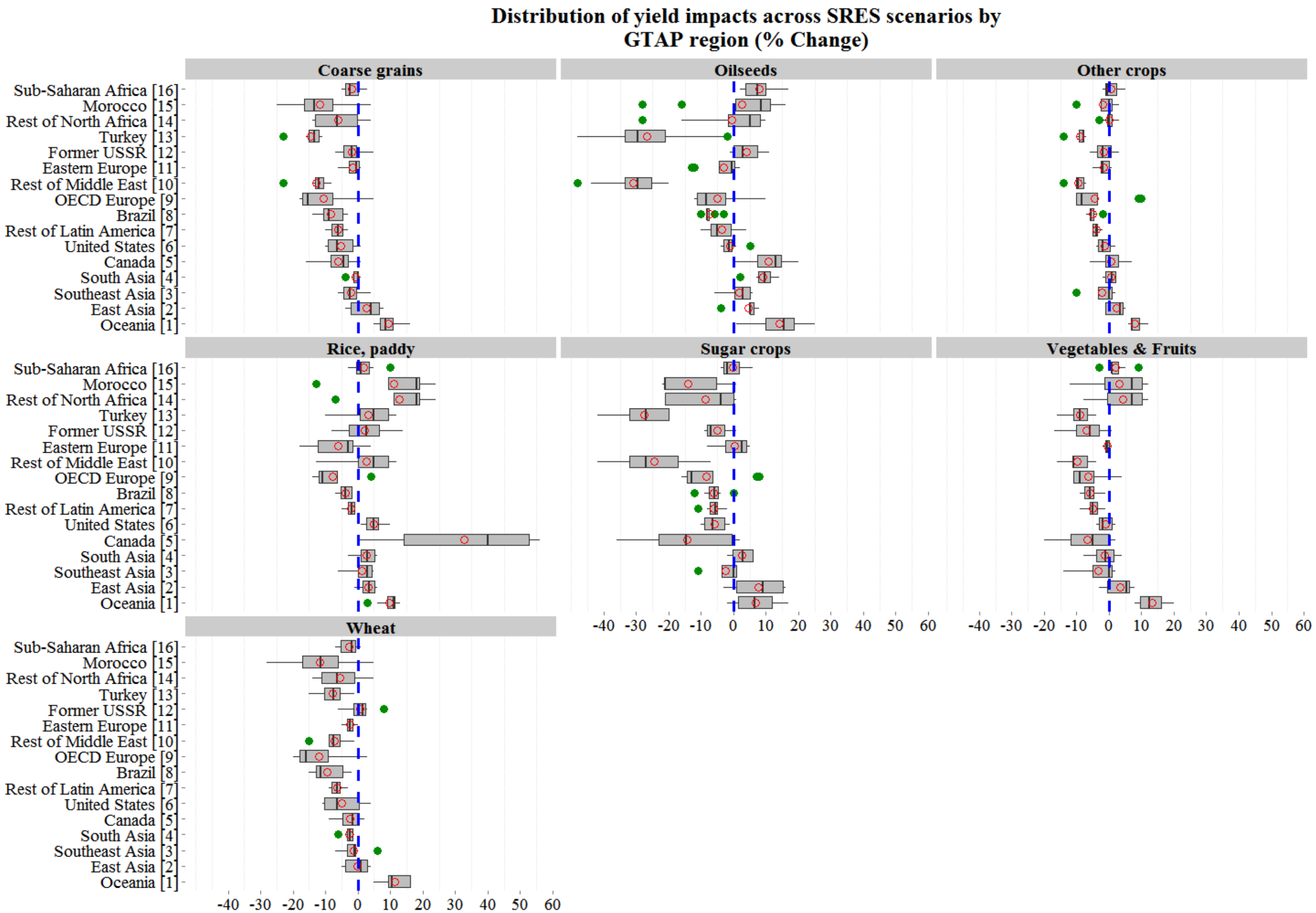
Source: Authors' adaptation (Data: GTAP database version 7.0).

Table 8: Summary of crop matching between GTAP, IFRPI and IMAGE crops

GTAP crops	Matching crops in: IFPRI	IMAGE
Paddy rice	Rice	Rice
Wheat	Wheat	Temperate cereals, tropical cereals
Cereal grains nec	Wheat, maize	Temperate cereals, tropical cereals, Maize
Vegetables, fruit, nuts	Rice, groundnuts	Roots and tubers, pulses
Oil seeds	Soybeans	Oil crops
Sugar cane, sugar beet	Maize	Maize
Other crops	Rice, wheat, cassava, soybeans, groundnuts, maize	Rice, temperate cereals, tropical cereals, maize, oil crops, roots and tubers, pulses

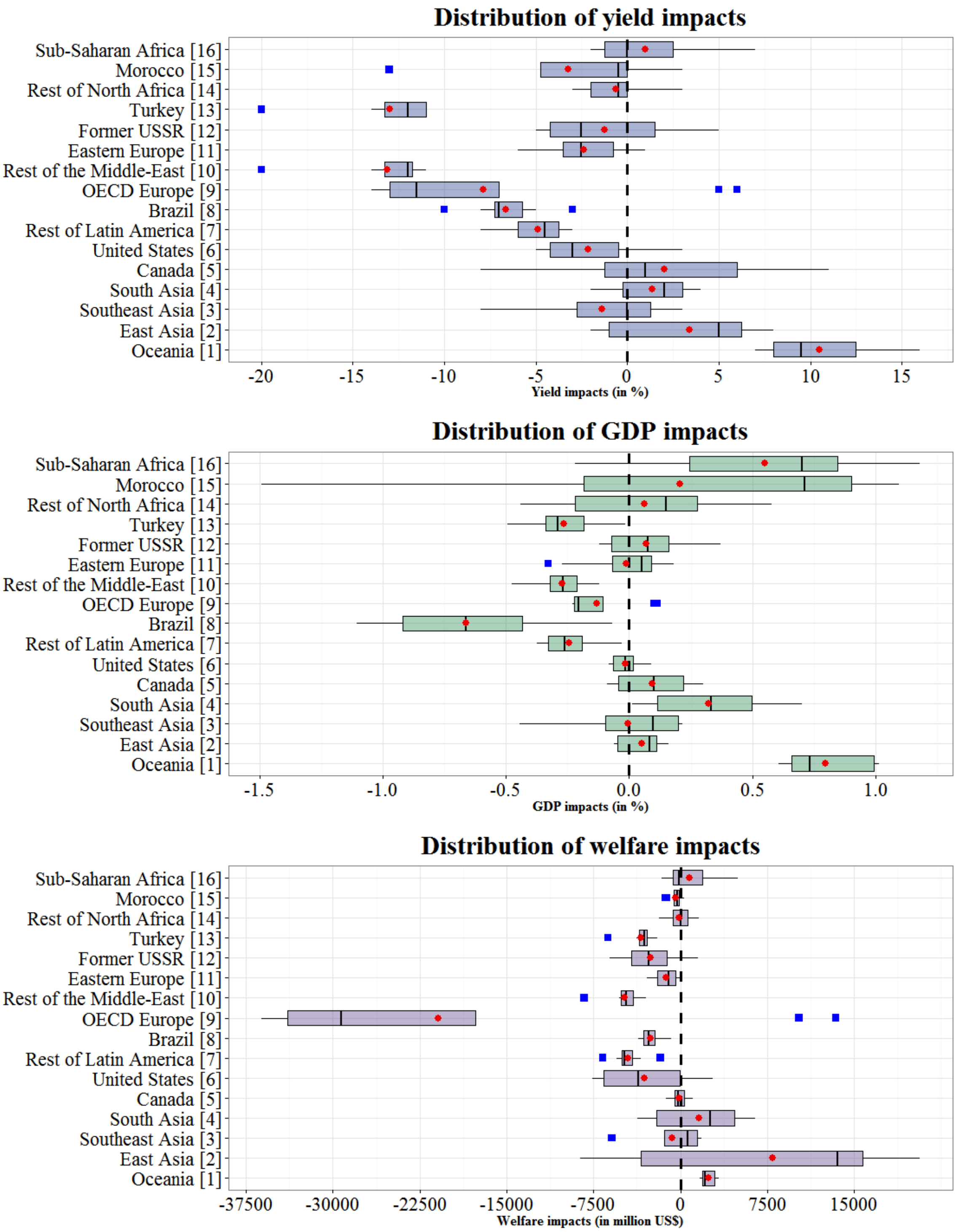
Source: Authors' adaptation (Data: GTAP database version 7, IFPRI 2010 and IMAGE 2.2 2001).

Figure 4b: Distribution of projected yield impacts across climate scenarios by crop and by region



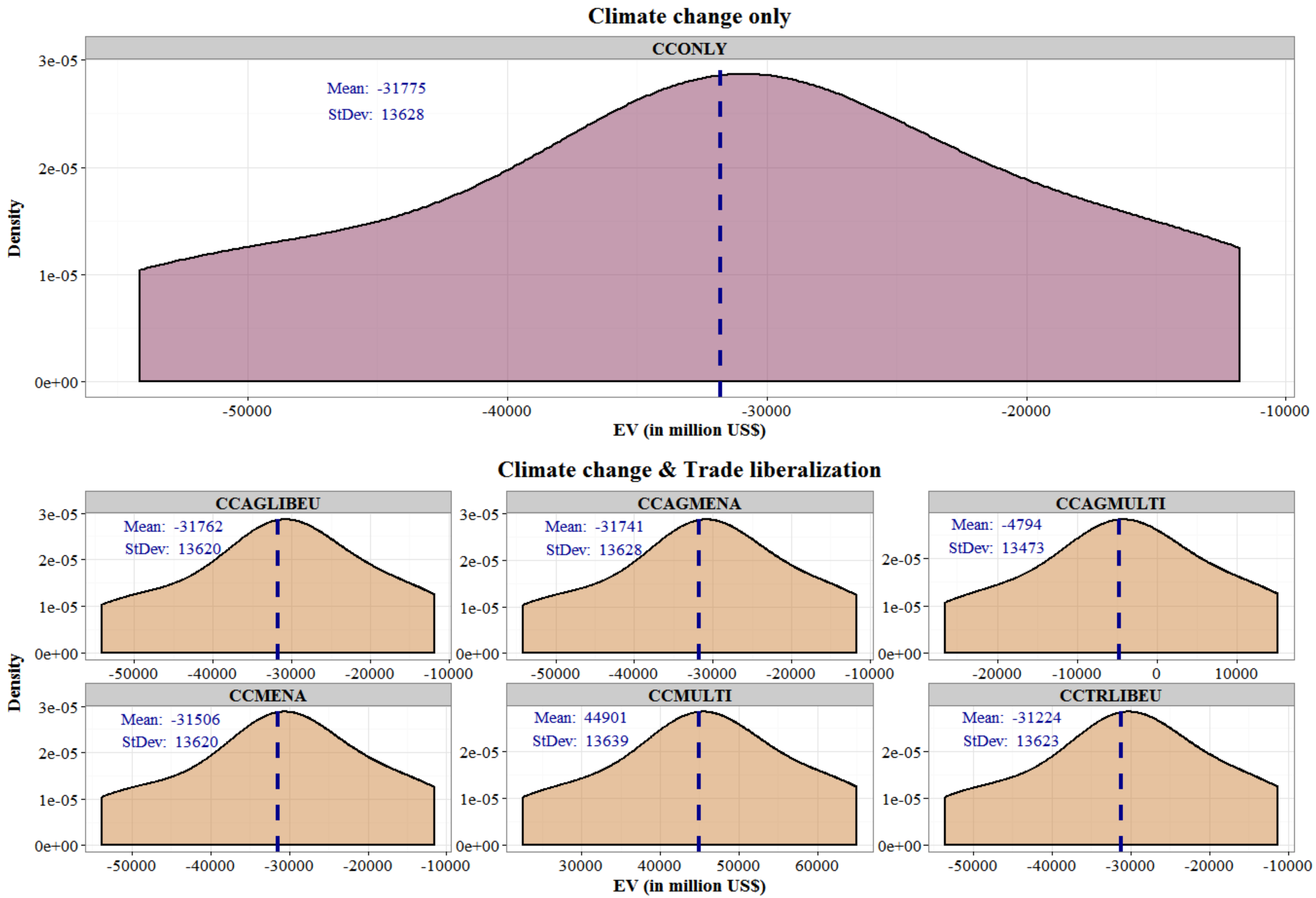
Source: Authors' adaptation (using data from IFPRI 2010 and IMAGE 2.2, 2001).

Figure 6: Regional distribution of climate-induced projected yield, and impacts on welfare and gross domestic product



Source: Simulation results.

Figure 7: Distribution of welfare impacts under climate change only, and climate change and trade liberalization for the World region



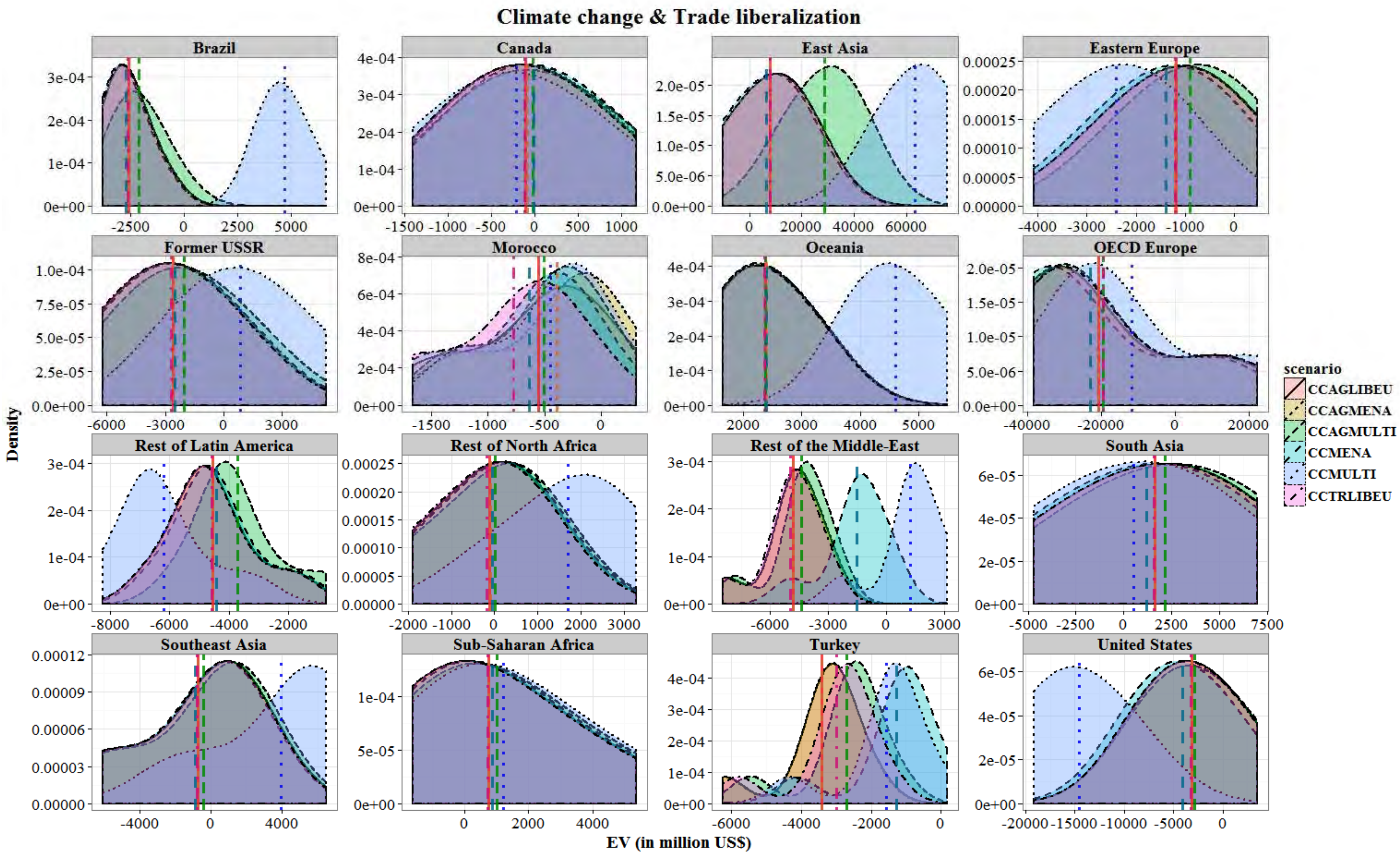
Source: Simulation results.

Table 12: Average climate change impacts on consumption, government expenditures, investment, export, and imports

GTAP region	Consumption		Government		Investment		Export		Imports	
	Baseline	Δ (in %)	Baseline	Δ (in %)	Baseline	Δ (in %)	Baseline	Δ (in %)	Baseline	Δ (in %)
Oceania	452,386	0.80	135,547	0.90	183,497	0.90	144,838	0.51	-161,394	0.77
East Asia	3,940,121	0.03	1,151,517	0.10	2,071,061	0.23	2,027,075	-0.21	-1,689,162	-0.06
Southeast Asia	453,298	0.03	75,111	-0.06	171,632	-0.20	626,954	0.03	-541,096	-0.01
South Asia	581,788	0.32	89,365	0.38	195,239	0.44	141,996	-0.11	-183,007	0.14
Canada	560,645	0.12	198,148	0.06	205,369	0.16	327,799	0.05	-313,210	0.12
United States	8,229,807	-0.01	1,809,229	-0.03	2,196,508	0.03	1,089,304	-0.07	-1,655,869	0.02
Rest of Latin America	1,027,177	-0.23	178,598	-0.41	319,932	-0.97	439,106	0.41	-416,656	-0.16
Brazil	343,677	-0.60	116,629	-0.83	121,678	-1.02	114,881	-0.18	-81,090	-0.53
OECD Europe	7,588,079	-0.09	2,685,864	-0.23	2,527,995	-0.22	4,145,593	0.10	-4,101,769	0.06
Rest of the Middle East	415,316	-0.02	185,749	-0.59	189,276	-0.58	415,112	0.11	-341,334	0.15
Eastern Europe	459,698	0.05	130,899	-0.14	168,766	-0.40	333,291	0.03	-386,718	-0.12
Former USSR	424,214	0.24	134,333	-0.14	159,877	-0.25	325,600	0.14	-263,518	0.13
Turkey	211,126	-0.09	40,679	-0.96	59,077	-0.96	83,630	0.32	-99,075	-0.10
Rest of North Africa	125,903	0.10	31,050	0.03	47,329	0.16	84,538	0.31	-71,754	0.47
Morocco	30,469	0.47	10,420	-0.23	11,968	-0.48	18,179	0.88	-20,849	0.56
SSA	324,194	0.61	91,866	0.56	98,805	0.33	188,930	0.44	-180,323	0.44

Source: Simulation results.

Figure 9: Kernel distribution of welfare impacts of trade liberalization under climate change by scenario



Source: Simulation results.

Table 13: Average welfare impacts of post-climate change trade liberalization scenarios by region

GTAP region	EV (in US$ millions)												
	Climate change only	Climate change and trade liberalization						Net impacts of trade liberalization					
	CCONLY	CCAGLIBEU	CCAGMENA	CCAGMULTI	CCTRLIBEU	CCMENA	CCMULTI	AGLIBEU	AGMENA	AGMULTI	TRLIBEU	MENA	MULTI
World	-31,775.1	-31,761.9	-31,740.6	-4,793.7	-31,224.0	-31,505.8	44,901.4	13.1	34.4	26,981.3	551.0	269.2	76,676.4
Oceania	2,400.6	2,381.8	2,394.7	2,372.3	2,357.9	2,385.6	4,612.7	-18.8	-5.9	-28.3	-42.7	-15.1	2,212.0
East Asia	7,926.2	7,962.8	7,940.2	28,826.9	7,847.3	6,631.4	63,363.9	36.6	14.0	20,900.7	-78.9	-1,294.7	55,437.7
Southeast Asia	-699.8	-697.5	-702.7	-421.8	-759.6	-851.1	3,923.7	2.4	-2.9	278.0	-59.7	-151.2	4,623.5
South Asia	1,635.8	1,631.6	1,627.5	2,160.2	1,583.0	1,181.5	526.1	-4.1	-8.3	524.4	-52.8	-454.3	-1,109.7
Canada	-83.4	-104.7	-83.8	-25.0	-117.3	-14.4	-213.9	-21.3	-0.4	58.4	-34.0	68.9	-130.5
United States	-3,125.6	-3,142.6	-3,137.3	-2,887.2	-3,240.5	-4,086.7	-14,559.6	-17.0	-11.7	238.4	-115.0	-961.1	-11,434.1
Rest of Latin America	-4,540.0	-4,539.0	-4,539.7	-3,702.3	-4,570.2	-4,408.0	-6,206.3	1.0	0.3	837.6	-30.2	132.0	-1,666.3
Brazil	-2,569.7	-2,577.3	-2,572.2	-2,099.5	-2,626.2	-2,695.0	4,707.3	-7.6	-2.5	470.2	-56.5	-125.3	7,277.0
OECD Europe	-20,907.9	-20,741.1	-20,895.8	-19,494.1	-19,631.3	-23,155.6	-11,853.7	166.8	12.1	1,413.8	1,276.5	-2,247.7	9,054.2
Rest of the Middle East	-4,831.8	-4,825.2	-4,802.9	-4,371.3	-4,963.7	-1,518.3	1,252.3	6.5	28.9	460.5	-131.9	3,313.5	6,084.0
Eastern Europe	-1,200.4	-1,182.9	-1,200.2	-894.6	-1,199.4	-1,386.3	-2,400.8	17.5	0.1	305.7	1.0	-186.0	-1,200.4
Former USSR	-2,606.7	-2,618.2	-2,604.9	-2,055.4	-2,699.1	-2,496.3	838.2	-11.5	1.8	551.3	-92.4	110.5	3,444.9
Turkey	-3,428.5	-3,405.1	-3,421.6	-2,699.2	-2,982.1	-1,286.2	-1,554.5	23.3	6.9	729.3	446.3	2,142.2	1,874.0
Rest of North Africa	-110.5	-110.0	-98.2	16.1	-169.4	-42.6	1,704.9	0.5	12.3	126.6	-58.9	67.9	1,815.4
Morocco	-387.2	-551.7	-392.1	-509.9	-776.0	-636.7	-449.9	-164.6	-4.9	-122.7	-388.8	-249.5	-62.7
SSA	753.6	757.0	748.3	991.1	722.7	872.7	1,210.9	3.4	-5.4	237.5	-31.0	119.1	457.3

Source: Simulation results.

Table 15: Aggregate and regional distribution of average allocative efficiency effects by scenario (in US$ millions)

GTAP region	Allocative efficiency (in US$ millions)												
	Climate change only	Climate change and trade liberalization						Net impacts of trade liberalization					
	CCONLY	CCAGLIBEU	CCAGMENA	CCAGMULTI	CCMENA	CCMULTI	CCTRLIBEU	AGLIBEU	AGMENA	AGMULTI	MENA	MULTI	TRLIBEU
Aggregate results													
World	-4,075.6	-4,076.5	-4,030.9	22,334.5	-3,524.8	72,854.8	-3,524.8	-0.9	44.7	26,410.1	357.6	76,930.4	550.8
By region													
Oceania	106	106	106	121	107	647	103	-0.5	0.1	15	1	541	-3
East Asia	415	422	421	21,272	309	36,076	381	7	6	20,857	-107	35,660	-34
Southeast Asia	-78	-79	-78	110	-112	2,379	-85	-0.2	0.1	189	-34	2,457	-7
South Asia	-190	-188	-189	104	-264	4,199	-194	2	1.3	294	-75	4,389	-4
Canada	-112	-109	-111	-117	-112	637	-111	3	0.8	-6	-1	749	0.3
United States	-548	-537	-542	-469	-575	232	-539	11	6	79	-26	780	9
Brazil	-307	-304	-306	-443	-306	-510	-311	3	0.5	-137	1	-204	-4
Rest of Latin America	-826	-814	-821	-1,557	-829	-346	-793	13	5	-730	-3	481	33
OECD Europe	-1,965	-1,995	-1,954	1,577	-2,450	17,420	-1,507	-30	11	3,542	-486	19,385	458
Rest of the Middle East	-173	-175	-172	214	1,474	3,087	-189	-2	2	387	1,648	3,260	-16
Eastern Europe	-365	-367	-364	135	-427	675	-313	-1	1.2	501	-62	1,040	52
Former USSR	-121	-124	-120	43	-22	2,924	-130	-3	1.0	164	99	3,045	-9
Turkey	-4	-15	1	837	-333	904	-39	-12	4	841	-329	908	-35
Rest of North Africa	11	10	15	104	-140	1,176	-8	-1	4	93	-151	1,165	-19
Morocco	78	86	78	319	-37	1,332	215	8	0.5	241	-114	1,254	137
SSA	4	7	5	86	-1	2,022	-1	3	0.2	81	-5	2,018	-5

Source: Simulation results.

Table 18: Impact on domestic and import prices and quantities for private household and firms in OECD Europe by commodity under CCAGLIBEU scenario (in % change)

Commodity	Private household								Firms							
	Climate change only				Net impact trade liberalization				Climate change only				Net impact trade liberalization			
	Domestic		Imports		Domestic		Imports		Domestic		Imports		Domestic		Imports	
	ppd	qpd	ppm	qpm	ppd	qpd	ppm	qpm	pfd	qfd	pfm	qfm	pfd	qfd	pfm	qfm
Paddy rice	8.46	-19.51	-0.97	26.04	-0.10	-2.36	-1.00	2.11	8.46	-26.19	-0.97	9.98	-0.10	-3.19	-1.00	1.01
Wheat	15.60	-5.85	9.60	18.70	0.26	-0.27	0.04	0.72	15.60	-8.44	9.60	14.77	0.26	-0.26	0.04	0.70
Coarse grains	14.32	-1.19	11.03	2.29	0.05	-0.05	-0.08	0.12	14.32	-0.89	11.03	2.56	0.05	0.10	-0.08	0.26
Vegetables, fruits, and nuts	8.85	-2.32	5.49	3.22	0.04	-0.14	-0.14	0.20	8.85	-1.82	5.49	3.70	0.04	0.02	-0.14	0.35
Oilseeds	6.70	-3.47	3.39	3.36	0.05	-0.08	-0.01	0.07	6.70	-3.56	3.39	2.55	0.05	0.07	-0.01	0.20
Sugar cane, Suger beet	11.32	-0.26	4.64	18.58	0.05	0.00	0.01	0.12	11.32	-1.45	4.64	16.56	0.05	0.15	0.01	0.24
Other crops nes	6.28	-2.34	3.88	4.29	0.06	-0.06	-0.01	0.14	6.28	-1.56	3.88	5.05	0.06	0.10	-0.01	0.29
Meat, livestock, raw milk	0.72	-0.60	0.82	-0.88	0.03	-0.02	0.02	0.02	0.72	0.44	0.82	0.15	0.03	0.15	0.02	0.19
Forest, fish and minerals	-0.12	-0.14	-0.12	-0.14	0.00	0.00	0.00	0.00	-0.12	0.39	-0.12	0.40	0.00	0.16	0.00	0.16
Vegetable oils and fats	0.88	-0.37	1.27	-1.65	0.01	-0.03	-0.02	0.06	0.88	0.92	1.27	-0.38	0.01	0.12	-0.02	0.21
Other processed food	0.58	-0.58	0.61	-0.64	0.01	0.00	-0.01	0.03	0.58	0.41	0.61	0.35	0.01	0.15	-0.01	0.18
Textile and apparel	-0.04	-0.16	-0.01	-0.27	0.00	-0.01	-0.01	0.04	-0.04	0.44	-0.01	0.33	0.00	0.14	-0.01	0.19
Manufactures	-0.11	-0.12	-0.08	-0.22	0.00	0.00	0.00	0.01	-0.11	0.43	-0.08	0.33	0.00	0.16	0.00	0.16
Utilities and construction	-0.12	-0.14	-0.10	-0.17	0.00	0.00	0.00	0.00	-0.12	0.40	-0.10	0.36	0.00	0.16	0.00	0.16
Transportation and services	-0.11	-0.14	-0.08	-0.21	0.00	0.00	0.00	0.01	-0.11	0.40	-0.08	0.33	0.00	0.16	0.00	0.17

Source: Simulation results.

Table 19: Decomposition of average welfare impacts of trade liberalization under climate change by region

		GTAP region															
Scenario	Welfare effect	Oceania	East Asia	Southeast Asia	South Asia	Canada	United States	Rest of Latin America	Brazil	OECD Europe	Rest of the Middle East	Eastern Europe	Former USSR	Turkey	Rest of North Africa	Morocco	Sub-Sahara Africa
CCAGLIBEU	Allocative efficiency	106	422	-79	-188	-109	-537	-814	-304	-1995	-175	-367	-124	-15	10	85	7
	Technical efficiency	2083	8166	-788	1585	-181	-3495	-4760	-3227	-16680	-4160	-802	-2276	-3584	231	-379	583
	TOT	131	-768	93	195	186	1440	1036	779	-2088	-604	62	-282	241	-363	-241	180
	Investment savings	61	143	76	40	-1	-551	-1	174	22	114	-76	64	-47	12	-18	-13
CCAGMENA	Allocative efficiency	106	421	-78	-189	-111	-542	-821	-306	-1954	-172	-364	-120	1	15	78	5
	Technical efficiency	2085	8165	-787	1585	-183	-3496	-4762	-3229	-16639	-4176	-801	-2276	-3583	233	-427	583
	TOT	142	-791	87	191	211	1447	1046	791	-2328	-559	44	-271	211	-355	-38	174
	Investment savings	62	145	76	40	-1	-545	-2	172	25	104	-79	63	-50	9	-5	-13
CCAGMULTI	Allocative efficiency	121	21271	110	104	-117	-469	-1557	-443	1577	214	135	43	837	104	319	86
	Technical efficiency	2099	7947	-791	1651	-224	-3543	-4917	-3311	-15917	-4085	-790	-2242	-3552	266	-340	636
	TOT	94	-325	225	311	310	1407	2813	1604	-5325	-642	-139	109	76	-358	-457	281
	Investment savings	58	-67	33	94	7	-281	-41	50	171	142	-101	35	-60	4	-32	-12
CCMENA	Allocative efficiency	107	309	-112	-264	-112	-575	-829	-306	-2450	1474	-427	-22	-333	-140	-37	-1
	Technical efficiency	2086	8164	-787	1584	-183	-3497	-4763	-3229	-16645	-4177	-801	-2277	-3606	234	-427	584
	TOT	146	-2157	-64	-131	280	906	1183	612	-4057	1139	-63	-238	2406	-166	-143	304
	Investment savings	47	315	113	-7	1	-920	1	228	-3	45	-94	41	246	29	-30	-14

Table 19: Decomposition of average welfare impacts of trade liberalization under climate change by region (continued)

Scenario	Welfare effect	GTAP region: Oceania	East Asia	Southeast Asia	South Asia	Canada	United States	Rest of Latin America	Brazil	OECD Europe	Rest of the Middle East	Eastern Europe	Former USSR	Turkey	Rest of North Africa	Morocco	Sub-Sahara Africa
CCMULTI	Allocative efficiency	647	36076	2379	4199	637	232	-346	-510	17421	3087	675	2924	904	1176	1332	2022
	Technical efficiency	2093	7897	-788	1590	-226	-3593	-4980	-3290	-15920	-4103	-787	-2229	-3577	278	-344	646
	TOT	1625	21211	1669	-3769	-976	-7044	-1545	9409	-15657	-154	-1851	-1556	1113	-127	-1245	-1774
	Investment savings	248	-1820	663	-1495	351	-4155	665	-902	2302	2422	-437	1700	4	378	-192	316
CCTRLIBEU	Allocative efficiency	103	381	-85	-194	-111	-539	-793	-311	-1507	-189	-313	-130	-39	-8	213	-1
	Technical efficiency	2083	8165	-788	1584	-182	-3495	-4759	-3224	-16680	-4160	-803	-2277	-3590	231	-382	583
	TOT	113	-890	26	164	175	1399	979	717	-1461	-734	-2	-358	639	-409	-518	153
	Investment savings	59	191	88	29	1	-605	3	191	17	119	-82	65	7	17	-89	-13

Source: Simulation results.

Table 20: Impacts on import prices and quantities of trade liberalization by sector and by scenario in Morocco and Turkey

	Sector	AGLIBEU		AGMENA		AGMULTI		MENA		MULTI		TRLIBEU	
		piw	qiw	piw	qiw	piw	qiw	piw	qiw	piw	qiw	piw	qiw
Morocco	Paddy rice (pdr)	1.10	74.87	0.00	-0.19	-3.30	88.93	-0.04	0.61	-3.85	96.21	1.11	90.07
	Wheat (wht)	3.25	102.51	-0.02	-0.09	2.61	132.48	-0.06	0.30	2.79	132.70	3.27	113.21
	Coarse grains (gro)	0.11	6.46	-0.01	-0.03	1.39	77.14	-0.07	-0.12	1.81	81.81	0.08	13.61
	Vegetables, fruits, and nuts (VegtFrut)	0.78	46.04	0.23	27.15	-0.32	64.46	0.60	26.02	-0.32	67.66	0.78	55.34
	Oilseeds (osd)	0.04	1.78	-0.01	0.13	-0.07	10.02	-0.09	-0.02	0.97	51.54	-0.03	59.70
	Sugar cane, sugar beet (c_b)	1.30	32.19	-0.01	-0.08	1.04	28.28	-0.07	0.34	0.25	42.10	1.28	65.46
	Other crops nested (OthCrop)	0.26	5.23	0.09	1.44	-1.12	19.36	0.11	1.21	-1.31	20.12	0.26	10.69
	Meat, livestock, raw milk (MtLkMlk)	0.01	-4.80	-0.01	-0.10	-0.42	-7.89	-0.06	1.20	0.65	822.87	-0.06	172.33
	Forest, fish, minerals (Extract)	0.00	1.21	0.00	0.03	0.02	2.74	0.31	10.24	-0.13	15.81	-0.01	2.60
	Vegetable oils and fats (VegtOil)	-0.01	-2.40	-0.01	-0.08	0.12	-6.98	0.00	1.12	-0.06	8.91	-0.17	9.27
	Other processed food (XPrFood)	0.00	-4.19	0.00	-0.07	-0.58	-7.69	0.11	3.33	-0.53	53.19	-0.03	41.84
	Textile and apparel (TextApp)	0.00	1.31	0.00	0.02	-0.19	2.87	0.22	7.38	-1.28	62.36	0.00	55.84
	Manufactures (Mnfctrs)	0.00	-0.71	0.00	-0.02	-0.04	-1.28	0.13	3.97	-0.82	23.85	0.01	19.81
	Utilities and construction (UtilCons)	0.00	-0.91	0.00	-0.03	-0.07	-1.61	-0.02	-0.67	-1.01	-2.99	0.01	-0.40
	Transportation and services (Svces)	0.00	-1.52	0.00	-0.04	-0.03	-2.83	0.00	-0.34	-0.62	-3.21	0.00	-0.32
Turkey	Paddy rice (pdr)	-0.03	15.35	-1.44	72.69	7.18	62.19	-1.11	90.44	9.18	65.89	-0.10	17.89
	Wheat (wht)	0.51	9.31	-0.02	0.24	1.97	44.64	-0.05	27.99	2.26	62.66	0.50	12.68
	Coarse grains (gro)	0.07	4.24	0.00	0.17	0.88	15.70	-0.04	5.09	0.13	19.23	0.05	4.91
	Vegetables, fruits, and nuts (VegtFrut)	-0.11	29.77	0.86	28.29	0.30	88.37	0.88	41.32	-0.47	100.48	-0.11	31.44
	Oilseeds (osd)	0.11	1.03	0.07	0.02	0.55	4.26	0.04	9.83	0.04	13.20	0.07	7.04
	Sugar cane, sugar beet (c_b)	-0.05	0.62	-0.01	0.09	1.03	49.04	0.02	15.28	-1.58	70.24	-0.07	3.60
	Other crops nested (OthCrop)	0.04	3.11	0.01	0.45	-0.09	64.32	-0.02	8.57	-0.39	69.64	0.02	4.51
	Meat, livestock, raw milk (MtLkMlk)	0.00	0.24	-0.01	0.02	-0.50	-0.52	-0.10	18.97	-0.30	69.45	-0.01	9.65
	Forest, fish, minerals (Extract)	0.00	-0.06	0.00	0.00	0.03	0.17	0.34	0.94	-0.11	0.94	-0.02	0.07
	Vegetable oils and fats (VegtOil)	-0.01	-0.06	-0.01	0.00	-0.25	-0.45	-0.03	9.50	-0.57	47.09	-0.10	28.34
	Other processed food (XPrFood)	0.00	-0.01	0.00	-0.05	-0.36	-1.78	0.00	15.39	-1.44	52.98	-0.02	25.09
	Textile and apparel (TextApp)	0.00	-0.05	0.00	0.00	-0.21	0.02	-0.08	3.82	-1.90	6.54	-0.05	0.58
	Manufactures (Mnfctrs)	0.00	0.01	0.00	0.00	-0.03	-0.04	-0.01	4.26	-0.94	3.78	0.00	0.89
	Utilities and construction (UtilCons)	0.00	0.08	0.00	0.01	0.04	-0.18	0.07	6.24	-1.13	3.52	-0.01	1.26
	Transportation and services (Svces)	0.00	0.07	0.00	0.01	-0.04	-0.03	-0.01	6.49	-0.77	3.01	0.00	1.25

Source: Simulation results.

Table 21: Impacts on export prices and quantities of trade liberalization by sector and by scenario in Morocco and Turkey

	Sector	AGLIBEU		AGMENA		AGMULTI		MENA		MULTI		TRLIBEU	
		pxw	qxw	pxw	qxw	pxw	qxw	pxw	qxw	pxw	qxw	pxw	qxw
Morocco	Paddy rice (pdr)	-3.84	31.51	-0.06	-0.06	-7.03	-34.50	0.22	-3.63	-5.89	-35.97	-0.80	-2.91
	Wheat (wht)	-4.41	38.38	-0.05	0.34	-7.84	10.32	0.15	-1.54	-7.06	0.95	-1.77	10.60
	Coarse grains (gro)	-2.22	7.63	-0.06	0.10	-6.00	4.38	0.16	-0.62	-5.12	1.41	1.19	-1.22
	Vegetables, fruits, and nuts (VegtFrut)	-1.95	13.09	-0.10	0.47	-5.11	-2.02	0.10	0.40	-4.62	-5.37	0.87	5.71
	Oilseeds (osd)	-2.05	14.89	-0.06	1.56	-5.20	12.94	0.13	0.12	-2.41	-0.07	4.14	-15.51
	Sugar cane, sugar beet (c_b)	-2.08	10.42	-0.06	-0.13	-4.75	24.85	0.15	-1.28	-3.80	15.40	1.85	-9.57
	Other crops nested (OthCrop)	-2.04	42.82	-0.06	3.32	-4.97	38.12	0.07	2.65	-4.87	39.91	0.34	25.09
	Meat, livestock, raw milk (MtLkMlk)	-1.70	13.02	-0.04	0.25	-3.86	25.83	0.11	-2.01	-5.10	-17.75	-0.02	29.69
	Forest, fish, minerals (Extract)	-0.09	0.96	0.00	0.03	-0.17	1.96	-0.81	12.34	-2.67	32.10	-0.64	6.55
	Vegetable oils and fats (VegtOil)	-1.56	10.33	-0.06	0.35	-4.64	32.39	-0.18	1.04	-6.43	995.55	-0.51	1192.53
	Other processed food (XPrFood)	-2.60	10.09	-0.05	0.16	-5.60	21.44	0.00	1.45	-6.66	29.44	-1.34	11.59
	Textile and apparel (TextApp)	-0.75	5.51	-0.02	0.12	-1.73	11.46	-0.79	6.70	-12.19	101.20	-7.85	77.88
	Manufactures (Mnfctrs)	-0.53	3.76	-0.01	0.09	-1.16	8.09	-0.86	7.44	-5.31	34.18	-1.70	12.39
	Utilities and construction (UtilCons)	-0.65	3.12	-0.02	0.08	-1.40	6.65	-0.39	1.88	-3.26	12.97	-0.19	0.90
	Transportation and services (Svces)	-0.79	2.84	-0.02	0.07	-1.69	6.22	0.01	0.04	-2.11	7.22	0.51	-1.72
Turkey	Paddy rice (pdr)	5.20	25124.52	-2.03	21.73	-2.11	1699.71	2.36	-18.93	0.03	1320.64	5.62	24340.75
	Wheat (wht)	0.10	120.27	0.01	0.57	-0.97	25.91	5.66	-38.32	1.89	-10.35	0.68	109.80
	Coarse grains (gro)	0.16	70.74	0.01	1.30	-0.70	53.01	6.91	-14.06	3.11	35.84	0.71	68.56
	Vegetables, fruits, and nuts (VegtFrut)	0.21	6.04	0.02	3.12	-0.92	-4.72	5.62	-12.77	1.95	-14.85	0.82	4.22
	Oilseeds (osd)	-0.09	2.66	0.00	4.00	-1.08	160.36	4.35	-14.56	0.95	92.69	0.64	-1.41
	Sugar cane, sugar beet (c_b)	0.16	-0.84	0.02	-0.74	-0.70	1.01	5.33	-24.79	1.83	-17.18	0.81	-4.29
	Other crops nested (OthCrop)	0.03	2.18	0.00	1.26	-1.96	196.20	3.66	-18.15	-0.67	194.79	0.49	-0.57
	Meat, livestock, raw milk (MtLkMlk)	0.10	-0.64	0.00	-0.03	-0.91	1.85	6.24	2322.28	2.34	2332.58	0.63	9.48
	Forest, fish, minerals (Extract)	0.01	-0.04	0.00	-0.01	0.01	0.23	1.28	2.34	0.45	10.32	0.14	-1.14
	Vegetable oils and fats (VegtOil)	-0.05	0.20	-0.01	0.02	-0.58	0.86	2.61	12.09	-1.21	194.34	-0.07	294.79
	Other processed food (XPrFood)	-0.01	0.01	-0.03	0.11	-1.52	3.81	3.46	1.77	-0.60	19.04	0.47	19.03
	Textile and apparel (TextApp)	0.03	-0.24	0.00	-0.03	-0.16	-0.35	2.48	-6.32	-0.43	-9.40	0.49	-1.58
	Manufactures (Mnfctrs)	0.02	-0.14	0.00	-0.01	-0.09	0.40	2.03	2.03	-0.21	5.73	0.40	-0.09
	Utilities and construction (UtilCons)	0.04	-0.16	0.00	-0.02	-0.12	0.54	2.73	-11.51	0.41	-5.27	0.53	-2.40
	Transportation and services (Svces)	0.04	-0.13	0.00	-0.01	-0.15	0.60	3.28	-10.28	0.74	-2.97	0.64	-2.11

Source: Simulation results.

Table 22: Percent change impact on output disposal, domestic sales and import sales in Morocco and Turkey under climate change only

	Sector	Output disposal		Domestic sales			Import sales		
		Domestic	Exports	Hhds	Gov	Firm	Hhds	Gov	Firm
Morocco	Paddy rice (pdr)	2.76	156.17	6.02	14.56	-3.62	-30.70	-29.37	-32.70
	Wheat (wht)	1.02	8.94	-0.47	-9.18	3.26	35.14	19.74	45.74
	Coarse grains (gro)	10.69	2.01	10.37	-0.94	11.19	13.11	1.30	14.07
	Vegetables, fruits, and nuts (VegtFrut)	-1.43	30.74	-1.08	0.06	-2.54	-5.30	-4.71	-6.56
	Oilseeds (osd)	1.56	32.26	3.56	3.44	0.02	-0.91	-2.62	-2.57
	Sugar cane, sugar beet (c_b)	18.47	-25.14	17.34	-0.26	18.64	55.09	29.21	57.15
	Other crops nested (OthCrop)	1.86	15.17	1.08	-0.67	2.40	3.00	1.19	5.44
	Meat, livestock, raw milk (MtLkMlk)	-0.31	-0.34	-0.10	-0.24	-0.46	0.05	-0.09	-0.51
	Forest, fish, minerals (Extract)	-0.39	0.14	-0.97	-0.17	-0.27	-1.15	-0.35	-0.46
	Vegetable oils and fats (VegtOil)	0.56	-4.03	0.65	-0.33	-0.03	0.82	-0.16	0.13
	Other processed food (XPrFood)	0.89	-6.16	0.97	-0.62	0.78	3.76	2.11	3.85
	Textile and apparel (TextApp)	-1.36	-1.36	-1.10	-0.67	-1.49	-0.43	-0.01	-0.90
	Manufactures (Mnfctrs)	-0.52	0.31	-1.10	-0.21	-0.45	-1.14	-0.26	-0.49
	Utilities and construction (UtilCons)	-0.58	0.32	-1.08	-0.23	-0.52	-1.15	-0.31	-0.55
	Transportation and services (Svces)	-0.59	-0.03	-1.23	-0.23	-0.47	-1.23	-0.24	-0.40
Turkey	Paddy rice (pdr)	-13.20	9.46	-20.84	-7.96	-13.18	-2.73	13.56	7.14
	Wheat (wht)	6.55	14.67	9.35	-0.97	5.83	49.27	33.97	42.05
	Coarse grains (gro)	15.55	5.06	7.73	-2.85	16.24	11.44	0.49	18.90
	Vegetables, fruits, and nuts (VegtFrut)	10.24	-2.56	10.55	-1.04	11.09	16.47	4.13	16.79
	Oilseeds (osd)	3.00	-59.93	25.61	-5.70	-6.36	122.31	59.17	36.00
	Sugar cane, sugar beet (c_b)	39.82	-65.85	37.65	-11.82	39.83	127.78	39.40	124.63
	Other crops nested (OthCrop)	1.94	-21.61	2.68	-3.31	1.63	19.40	12.39	11.77
	Meat, livestock, raw milk (MtLkMlk)	2.51	-19.71	1.64	-2.20	4.15	10.46	6.24	12.49
	Forest, fish, minerals (Extract)	-0.26	0.69	-1.13	-0.92	0.14	-1.55	-1.34	-0.08
	Vegetable oils and fats (VegtOil)	-0.46	-2.05	-0.07	-1.35	-0.96	1.94	0.61	1.01
	Other processed food (XPrFood)	1.20	-6.09	1.25	-1.04	1.06	4.31	1.95	4.13
	Textile and apparel (TextApp)	0.05	1.03	-0.99	-0.90	0.52	-1.57	-1.48	0.14
	Manufactures (Mnfctrs)	-0.38	1.14	-1.23	-0.72	0.05	-1.77	-1.27	-0.48
	Utilities and construction (UtilCons)	-0.89	0.70	-1.34	-0.96	-0.85	-1.59	-1.21	-1.19
	Transportation and services (Svces)	-1.14	0.67	-1.61	-0.96	-0.63	-1.87	-1.23	-1.17

Source: Simulation results.

Table 23: Net impacts on total output disposal in Morocco and Turkey by sector (in % change)

	Sector	BASELINE		Trade liberalization net effects (in % change)											
				AGLIBEU		AGMENA		AGMULTI		MENA		MULTI		TRLIBEU	
		domestic	export	domestic	export	domestic	export	domestic	export	domestic	export	domestic	export	domestic	export
Morocco	Paddy rice (pdr)	3.07	0.05	-20.21	25.39	-0.29	-7.05	-24.84	-36.58	-0.70	-10.21	-27.58	-38.75	-22.39	-5.59
	Wheat (wht)	2389.46	31.86	-33.32	39.48	-0.10	-0.63	-49.61	8.75	-0.57	-2.54	-50.68	-1.23	-35.46	12.92
	Coarse grains (gro)	1072.52	15.32	-2.46	5.41	-1.10	-0.17	-20.64	-1.99	-1.32	-0.69	-17.92	-4.03	4.24	-0.17
	Vegetables, fruits, and nuts (VegtFrut)	1901.69	857.60	-2.83	8.28	-0.90	-2.24	-5.94	-9.15	-1.03	-2.13	-4.42	-11.99	1.67	3.92
	Oilseeds (osd)	195.02	2.45	-0.81	8.72	-0.25	-1.20	-6.53	4.87	-0.86	-2.39	34.49	-4.14	54.57	-14.40
	Sugar cane, sugar beet (c_b)	198.32	0.00	-1.40	13.44	-1.74	3.49	-1.12	24.54	-1.85	2.49	3.44	15.85	13.16	-4.39
	Other crops nested (OthCrop)	692.62	50.47	-2.89	38.28	-0.63	1.88	-9.03	29.72	-0.88	1.32	-8.95	30.95	-2.31	23.51
	Meat, livestock, raw milk (MtLkMlk)	5474.47	118.32	-0.60	10.96	0.02	0.25	-1.22	20.98	0.21	-1.86	-16.50	-21.87	5.02	29.61
	Forest, fish, minerals (Extract)	1755.05	950.52	1.31	0.85	0.07	0.01	2.91	1.77	-10.13	11.41	-23.74	28.55	-9.65	5.84
	Vegetable oils and fats (VegtOil)	231.76	103.24	1.18	9.07	-0.02	0.76	4.38	26.80	-2.40	1.33	-6.40	931.62	2.79	1192.28
	Other processed food (XPrFood)	6206.83	1292.20	-1.25	8.18	-0.12	0.85	-2.47	15.65	-0.79	2.19	-10.33	21.86	-4.82	11.05
	Textile and apparel (TextApp)	3743.79	3524.96	3.05	4.81	0.21	0.26	6.19	9.69	-2.65	6.03	-26.64	76.86	-21.74	64.11
	Manufactures (Mnfctrs)	20916.56	5096.42	0.78	3.12	0.07	0.04	1.72	6.80	-1.76	6.49	-14.02	27.06	-10.65	10.43
	Utilities and construction (UtilCons)	8026.81	27.64	-0.76	2.38	0.04	0.03	-1.66	5.12	1.29	1.45	4.47	9.27	6.09	0.66
	Transportation and services (Svces)	40690.14	5425.08	-0.65	2.26	0.05	0.06	-1.14	4.83	-0.30	0.02	-2.06	4.30	-0.38	-1.40
Turkey	Paddy rice (pdr)	46.82	0.20	-3.50	25848.26	-40.71	17.11	-39.68	1615.87	-43.69	-18.64	-37.76	1281.08	-3.32	25110.52
	Wheat (wht)	4077.63	11.74	-1.16	118.96	-0.69	-0.68	-4.24	28.86	12.24	-35.48	4.61	-5.34	-0.48	109.77
	Coarse grains (gro)	2038.56	18.06	-1.58	70.01	-1.52	0.80	-3.22	51.22	30.02	-8.57	20.66	39.43	-1.22	68.75
	Vegetables, fruits, and nuts (VegtFrut)	14862.20	2319.09	-1.16	6.60	-1.33	3.49	-2.89	-5.14	3.92	-7.57	-0.43	-12.77	-0.40	5.40
	Oilseeds (osd)	756.13	64.45	-1.48	19.44	-0.39	21.58	-4.00	204.35	0.65	4.08	-2.66	129.79	2.98	15.60
	Sugar cane, Suger beet (c_b)	774.98	0.01	-3.00	20.51	-3.13	20.66	-3.25	22.26	2.50	-3.93	-1.16	2.64	-1.33	17.08
	Other crops nested (OthCrop)	4843.05	742.54	-0.95	5.38	-0.32	4.39	-31.56	202.04	3.27	-12.51	-30.60	204.73	-0.54	3.02
	Meat, livestock, raw milk (MtLkMlk)	11166.16	185.00	-0.07	2.19	-0.31	2.69	-0.91	3.71	8.19	2554.69	-0.66	2469.92	-0.11	13.20
	Forest, fish, minerals (Extract)	5582.67	859.17	-0.01	-0.11	0.03	-0.08	0.23	0.17	-1.65	3.57	-1.61	10.72	-0.27	-1.08
	Vegetable oils and fats (VegtOil)	2798.74	260.26	0.06	0.39	0.05	0.25	0.09	0.55	2.44	15.32	-4.98	191.61	3.45	295.63
	Other processed food (XPrFood)	30715.22	2862.33	-0.13	0.72	-0.15	0.80	-1.01	2.99	3.85	6.06	-1.67	19.19	-0.11	20.45
	Textile and apparel (TextApp)	12872.97	17863.03	-0.11	-0.32	-0.02	-0.14	-0.27	-0.63	-3.08	-4.01	-10.08	-10.18	-0.77	-1.20

Manufactures (Mnfctrs)	83831.05	37149.21	0.01	-0.25	0.04	-0.13	0.11	0.18	-0.54	3.93	-2.98	5.39	-0.02	0.19
Utilities and construction (UtilCons)	45907.63	785.38	0.13	-0.20	0.11	-0.09	-0.02	0.34	4.34	-9.16	0.54	-4.96	1.03	-1.96
Transportation and services (Svces)	192256.23	17429.19	0.16	-0.18	0.13	-0.08	0.10	0.26	3.58	-8.60	0.89	-4.28	0.83	-1.82

Source: Simulation results.

Table 24: Net impacts on domestic sales disposal in Morocco and Turkey by sector (in % change)

	Sector	Trade liberalization net effects (in % change)																	
		AGLIBEU			AGMENA			AGMULTI			MENA			MULTI			TRLIBEU		
		Hhds	Gov	Firm	Hhds	Gov	Firm	Hhds	Gov	Firm	Hhds	Gov	Firm	Hhds	Gov	Firm	Hhds	Gov	Firm
Morocco	Paddy rice (pdr)	-26.01	-28.26	-11.38	-5.68	-12.71	3.77	-31.03	-31.69	-14.58	-6.08	-13.74	3.46	-32.25	-35.77	-20.34	-27.79	-32.20	-13.94
	Wheat (wht)	-35.79	-22.91	-29.09	0.47	10.11	-3.14	-53.74	-40.59	-43.25	-0.05	8.78	-3.49	-54.12	-43.49	-45.22	-38.10	-27.55	-30.83
	Coarse grains (gro)	-11.61	-0.80	-9.90	-9.43	0.90	-10.06	-31.03	-7.83	-22.23	-9.64	-0.03	-10.24	-30.59	-11.28	-16.63	-10.18	-2.45	3.39
	Vegetables, fruits, and nuts (VegtFrut)	-2.79	-2.77	2.31	-0.09	-0.70	1.90	-6.36	-4.67	0.66	-0.22	-1.59	1.78	-6.04	-8.24	6.32	-0.85	-4.23	15.59
	Oilseeds (osd)	-5.68	-5.12	0.68	-3.57	-3.43	-0.06	-14.03	-10.38	-2.71	-4.06	-4.51	-0.76	-14.09	-15.14	71.03	-8.53	-11.33	102.65
	Sugar cane, sugar beet (c_b)	-16.51	-1.40	-15.40	-14.82	0.22	-15.72	-18.42	-2.81	-15.15	-14.94	-0.69	-15.81	-17.74	-6.41	-11.19	-13.77	-2.73	-2.76
	Other crops nested (OthCrop)	-4.85	-1.88	-4.21	-1.76	0.32	-2.58	-13.73	-6.69	-8.34	-2.14	-0.63	-2.74	-13.87	-10.25	-8.11	-5.59	-4.42	-2.75
	Meat, livestock, raw milk (MtLkMlk)	-1.40	-1.26	0.50	0.06	0.20	0.46	-2.85	-2.51	0.49	-0.38	-0.74	1.13	-34.12	-26.36	-2.74	-4.87	-5.40	13.02
	Forest, fish, minerals (Extract)	0.62	-1.33	1.87	0.97	0.13	0.31	0.70	-2.60	3.77	-5.52	-6.67	-10.65	-14.32	-19.75	-25.25	-3.90	-6.77	-10.39
	Vegetable oils and fats (VegtOil)	0.39	0.75	2.69	-0.61	0.36	0.10	3.36	3.61	7.36	-3.05	-2.00	-1.78	-12.01	-10.85	29.79	-5.80	-5.81	59.96
	Other processed food (XPrFood)	-2.62	-0.62	-1.10	-0.99	0.58	-0.78	-4.32	-1.67	-1.56	-1.88	-0.56	-1.09	-13.53	-9.78	-7.13	-7.85	-5.16	-2.00
	Textile and apparel (TextApp)	1.18	0.37	5.87	1.11	0.66	1.61	1.55	0.33	10.43	-2.42	-3.17	-0.99	-31.72	-32.85	-22.79	-26.03	-26.61	-18.18
	Manufactures (Mnfctrs)	1.00	-0.83	1.30	1.11	0.18	0.47	1.39	-1.59	2.33	-1.99	-2.10	-1.20	-16.60	-16.29	-13.20	-12.17	-11.22	-9.97
	Utilities and construction (UtilCons)	0.20	-1.40	-0.29	1.07	0.19	0.50	-0.33	-2.81	-1.24	0.22	-0.71	2.01	-1.84	-6.41	5.84	0.15	-2.73	7.43
	Transportation and services (Svces)	0.15	-1.37	0.30	1.22	0.19	0.47	-0.45	-2.74	0.25	0.47	-0.71	0.54	-0.93	-6.35	0.30	0.50	-2.75	1.28
Turkey	Paddy rice (pdr)	5.31	-0.13	9.37	-50.39	-27.04	-32.56	-49.85	-26.34	-31.58	-56.83	-31.27	-35.93	-49.33	-26.21	-29.43	3.66	-0.33	9.58
	Wheat (wht)	-8.46	1.01	-6.21	-8.54	0.98	-5.52	-9.29	0.80	-10.09	-3.42	4.61	9.92	-6.78	1.51	0.96	-7.90	1.61	-5.53
	Coarse grains (gro)	-10.08	2.16	-13.87	-7.31	2.89	-13.99	-20.80	-0.88	-14.75	-5.83	5.37	15.38	-20.71	-0.99	7.55	-9.92	2.67	-13.55
	Vegetables, fruits, and nuts (VegtFrut)	-9.68	0.92	-10.02	-9.83	0.89	-10.22	-11.34	0.30	-11.47	-4.98	4.45	-5.35	-8.99	0.95	-9.37	-9.11	1.51	-8.78
	Oilseeds (osd)	-20.78	5.85	5.07	-20.41	6.03	6.69	-22.05	5.17	1.69	-18.06	9.04	6.50	-21.19	5.42	3.32	-20.37	6.34	12.52
	Sugar cane, sugar beet (c_b)	-27.25	13.31	-28.36	-27.34	13.39	-28.46	-28.22	4.05	-28.56	-23.66	14.40	-24.30	-26.65	1.52	-27.02	-26.77	13.61	-27.13

Other crops nested (OthCrop)	-3.25	2.97	-2.65	-2.70	3.35	-1.76	-31.73	-17.96	-39.75	-0.73	5.66	6.29	-32.03	-18.40	-35.07	-2.93	3.41	-2.04
Meat, livestock, raw milk (MtLkMlk)	-1.56	2.25	-3.56	-1.62	2.25	-4.08	-2.05	2.23	-4.96	2.34	3.70	11.59	-6.95	-5.86	4.01	-1.73	1.92	-3.36
Forest, fish, minerals (Extract)	1.16	0.96	-0.19	1.15	0.93	-0.14	1.31	0.77	0.09	2.38	4.11	-3.12	1.27	1.16	-2.55	1.36	1.50	-0.66
Vegetable oils and fats (VegtOil)	0.06	1.42	0.99	0.06	1.37	0.97	-0.06	1.35	1.23	1.83	3.65	4.20	-7.71	-4.73	-0.49	-3.10	-1.00	13.13
Other processed food (XPrFood)	-1.23	1.08	-1.05	-1.26	1.05	-1.07	-2.13	0.91	-1.87	2.02	4.49	4.92	-3.41	0.84	-0.64	-1.55	1.38	-0.06
Textile and apparel (TextApp)	1.01	0.93	-0.67	1.00	0.90	-0.53	0.97	0.72	-0.88	1.35	3.61	-5.20	-3.87	-0.22	-13.03	1.07	1.36	-1.66
Manufactures (Mnfctrs)	1.25	0.73	-0.10	1.24	0.72	-0.05	1.41	0.61	-0.03	1.97	2.00	-1.30	-0.63	-1.06	-3.66	1.37	0.89	-0.21
Utilities and construction (UtilCons)	1.39	1.01	0.89	1.36	0.97	0.87	1.44	0.80	0.73	4.38	4.60	5.23	2.00	1.50	1.29	1.93	1.60	1.83
Transportation and services (Svces)	1.67	1.00	0.64	1.64	0.97	0.63	1.72	0.80	0.54	5.55	4.56	3.50	2.83	1.49	0.96	2.38	1.59	1.34

Source: Simulation results.

Table 25: Net impacts on imports sales disposal in Morocco and Turkey by sector (in % change)

	Sector	Trade liberalization net effects (in % change)																	
		AGLIBEU			AGMENA			AGMULTI			MENA			MULTI			TRLIBEU		
		Hhds	Gov	Firm	Hhds	Gov	Firm	Hhds	Gov	Firm	Hhds	Gov	Firm	Hhds	Gov	Firm	Hhds	Gov	Firm
Morocco	Paddy rice (pdr)	102.82	112.46	130.38	44.01	41.30	48.33	107.38	121.81	144.01	45.11	41.31	49.67	116.16	121.65	142.90	121.11	124.95	149.67
	Wheat (wht)	-2.85	22.24	5.50	-26.09	-16.59	-31.45	5.33	41.77	24.91	-25.86	-16.90	-31.12	6.40	37.41	23.06	1.92	25.24	12.51
	Coarse grains (gro)	-13.49	-2.70	-11.89	-11.63	-1.34	-12.34	-19.61	7.68	-9.43	-11.77	-2.18	-12.45	-19.00	3.77	-0.96	-11.17	-3.33	4.78
	Vegetables, fruits, and nuts (VegtFrut)	20.33	20.91	26.57	14.71	14.69	16.80	24.69	27.52	33.90	14.35	13.46	16.45	25.86	23.44	44.54	25.76	21.98	49.51
	Oilseeds (osd)	-1.08	1.17	3.69	0.87	2.68	2.69	-3.32	2.56	7.56	0.74	1.91	2.33	-0.71	-0.18	103.96	4.81	3.41	139.95
	Sugar cane, sugar beet (c_b)	-23.58	-8.05	-22.60	-35.61	-22.70	-36.43	-28.01	-12.65	-25.13	-35.40	-23.04	-36.20	-24.93	-13.05	-17.67	-15.46	-2.91	-2.91
	Other crops nested (OthCrop)	-3.00	0.08	-3.93	-2.33	-0.25	-4.25	1.07	9.29	3.81	-2.53	-1.01	-4.16	1.27	5.54	4.94	1.20	2.54	3.77
	Meat, livestock, raw milk (MtLkMlk)	-4.96	-4.81	-3.47	-0.16	-0.02	0.43	-10.34	-10.02	-8.01	0.16	-0.19	1.15	405.94	465.54	588.83	61.46	60.57	90.22
	Forest, fish, minerals (Extract)	0.41	-1.53	1.77	1.15	0.30	0.49	0.09	-3.19	3.41	11.17	9.82	3.27	25.08	17.16	3.82	7.63	4.43	-1.51
	Vegetable oils and fats (VegtOil)	-3.31	-2.96	-1.02	-0.90	0.07	-0.18	-7.69	-7.46	-3.85	-0.85	0.22	0.43	-4.47	-3.21	47.20	-0.48	-0.50	76.69
	Other processed food (XPrFood)	-7.91	-5.99	-6.72	-3.70	-2.15	-3.76	-11.99	-9.52	-9.72	-2.98	-1.66	-2.34	8.25	12.98	17.00	8.10	11.29	15.39
	Textile and apparel (TextApp)	-1.54	-2.32	3.22	0.38	-0.06	0.96	-3.30	-4.45	5.57	1.33	0.56	2.96	9.10	7.31	25.13	10.54	9.67	22.96
	Manufactures (Mnfctrs)	-0.27	-2.06	-0.06	1.12	0.20	0.48	-1.31	-4.21	-0.57	0.97	0.86	1.88	4.41	4.82	8.71	5.78	6.94	8.63
	Utilities and construction (UtilCons)	-0.48	-2.06	0.16	1.13	0.25	0.54	-1.79	-4.22	-0.23	-0.14	-1.06	0.29	-4.32	-8.77	-2.39	-0.02	-2.88	0.72

	Transportation and Sservices (Svces)	-0.56	-2.05	-0.63	1.20	0.18	0.38	-1.94	-4.19	-1.58	0.48	-0.70	0.54	-2.26	-7.60	-1.68	0.96	-2.30	1.11
Turkey	Paddy rice (pdr)	6.21	0.10	7.39	-7.37	36.72	21.32	-7.21	35.37	21.88	-5.44	51.01	34.57	-5.37	36.85	27.06	6.53	1.79	9.73
	Wheat (wht)	-27.65	-19.45	-25.02	-32.87	-25.21	-29.47	-7.37	3.88	-8.44	-14.25	-6.26	-9.97	4.01	14.31	3.25	-25.74	-17.34	-22.69
	Coarse grains (gro)	-11.88	0.13	-15.14	-10.34	-0.46	-15.84	-18.54	1.96	-13.07	-7.06	4.01	-7.68	-17.31	3.27	-8.44	-11.58	0.79	-13.70
	Vegetables, fruits, and nuts (VegtFrut)	-5.37	5.86	-5.54	-5.67	5.70	-5.90	15.95	31.33	16.05	4.02	14.51	3.85	22.59	36.15	22.29	-4.27	7.03	-3.70
	Oilseeds (osd)	-54.41	-36.14	-26.77	-54.97	-37.10	-26.47	-53.57	-34.21	-26.97	-50.73	-31.21	-19.27	-51.29	-31.55	-20.95	-53.68	-35.13	-22.23
	Sugar cane, Suger beet (c_b)	-55.85	-28.06	-55.23	-56.07	-28.24	-55.45	-43.75	-14.75	-43.03	-49.60	-21.08	-48.67	-37.24	-9.30	-36.57	-55.06	-27.07	-53.91
	Other crops nested (OthCrop)	-14.51	-8.97	-10.05	-16.00	-10.74	-10.43	48.27	78.27	1.54	-7.53	-1.54	-5.09	53.06	83.85	4.00	-13.38	-7.68	-8.82
	Meat, livestock, raw milk (MtLkMlk)	-9.24	-5.69	-10.87	-9.45	-5.86	-11.09	-10.73	-6.80	-12.52	7.09	8.55	9.04	35.70	37.36	40.84	-4.09	-0.50	-5.71
	Forest, fish, minerals (Extract)	1.60	1.41	0.02	1.58	1.36	0.08	1.67	1.13	0.28	7.60	9.42	1.01	4.99	4.87	0.59	2.50	2.64	0.08
	Vegetable oils and fats (VegtOil)	-1.99	-0.64	-1.07	-1.91	-0.61	-1.01	-2.75	-1.36	-1.48	6.43	8.35	8.89	21.96	25.92	31.49	9.38	11.77	27.74
	Other processed food (XPrFood)	-4.14	-1.89	-3.98	-4.19	-1.94	-4.02	-6.20	-3.28	-5.95	6.46	9.04	8.13	21.12	26.46	23.20	6.58	9.76	8.20
	Textile and apparel (TextApp)	1.69	1.61	-0.25	1.61	1.51	-0.15	1.71	1.46	-0.42	10.03	12.47	1.45	10.86	15.07	-1.86	3.24	3.54	-0.05
	Manufactures (Mnfctrs)	1.87	1.35	0.48	1.81	1.29	0.49	1.83	1.03	0.38	7.85	7.89	4.06	5.20	4.75	1.39	2.99	2.50	1.26
	Utilities and construction (UtilCons)	1.69	1.30	1.27	1.62	1.23	1.21	1.51	0.86	0.89	7.83	8.05	8.78	4.08	3.58	3.13	2.82	2.49	2.82
	Transportation and services (Svces)	1.99	1.31	1.24	1.92	1.25	1.19	1.89	0.97	1.08	8.97	7.94	6.77	4.53	3.16	2.78	3.26	2.46	2.33

Source: Simulation results.