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IMPACT OF GLOBAL CLIMATE CHANGE ON AGRICULTURAL PRODUCTION: BALKAN COUNTRIES IN 2050

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Abstract. The occurrence of extreme weather events due to today's climate change is having a significant impact on agriculture. The purpose of this study is to estimate the possible effects of global climate change on agriculture at a regional level. To this end, the Global trade analyses project (GTAP) model has been used to examine the possible effects of climate change on agricultural production in Turkey, Romania, Bulgaria, Greece, and other Balkan countries for 2050. GTAP analysis data is compiled from the GTAP database, which includes 6 regions and 33 sectors. It has been calculated that climate change will have negative effects on the gross domestic product (GDP) of Balkan countries. The negative impact of global climate change on crop yields is predicted to reduce the competitiveness of Balkan countries in the foreign trade of agricultural products.

Keywords: agricultural production, Balkan countries, climate change, arable land, GTAP.

AIMS AND BACKGROUND

In addition to causing climate change, the agriculture and food sector is one of the sectors most affected by climate change. Agriculture is one of the human activities the most dependent on climate and, as a result, is one of the sectors where the effects of climate change will be most felt.

Despite increasing research on the effects of climate change on agriculture, there is considerable uncertainty about its effects on the functioning of agriculture, the duration of vegetation and the pressure of agricultural production on human livelihoods around the world[1,2]. There are a limited number of studies specifically on how the Balkan countries will be affected by global climate change. Iuga[3] examined the relationship between GNP of European Union countries and greenhouse gases and revealed the impact of global climate change on the economy. Furthermore, Kurucu et al.[4] stressed that agriculture would directly affect food supply due to its dependence on climates addressing the socio-economic aspect of climate change.

* For correspondence.

The aim of this study is to examine the effects of global climate change on agriculture (Balkan countries) at a regional level. This study examined the impact of global climate change of Balkan countries in 2050 on GDP and agricultural production. To this end, the possible effects of global climate change on the agricultural sector is analysed with the general equilibrium model by taking into account the predictions regarding GNP, labour force, capital and agricultural fields for the year 2050. This study focuses not only on scenario outcomes but also on the state of production factors in the year 2050.

EXPERIMENTAL

Projected climate changes from global climate models are used as inputs into biophysical models. These models use mechanical or statistical methods to simulate the effects of projected climate change on biological and physical processes and systems such as crop yields, water supply, and human health and productivity. The projections from the biophysical models are then used as inputs into economic models, such as CGE models, to simulate economic responses to the impacts of climate change and to explore the effectiveness of alternative policies to either combat or adapt to it[5].

The Global trade analysis project (GTAP), a general equilibrium model, is used to examine the possible effects of global climate change in 2050 on agricultural production in Turkey, Romania, Bulgaria, Greece, and other Balkan countries.

GTAP is a widely used, comparative static, general equilibrium model which exhaustively tracks bilateral trade flows between all countries in the world, and explicitly models the consumption and production for all commodities of each national economy. Producers are assumed to maximise profits, while consumers maximise utility. Factor market clearing requires that supply equal demand for agricultural and non-agricultural skilled and unskilled labour and capital, natural resources and agricultural land, and adjustments in each of these markets in response to the climate change shocks determines the resulting wage and rental rate impacts. The model has recently been validated with respect to its performance in predicting the price impacts of exogenous supply side shocks, such as those that might result from global climate change[6].

Within the GTAP database, there are 140 countries and 57 sectors. During the analysis process, new or current input-output charts are not required to be integrated into the GTAP database and model practitioners are not required to make any additional data entries. In this study, the general equilibrium model analysis is performed using GTAP database version 9 for 6 regions and 33 sectors[7].

The GTAP model cannot give us direct results on the changes that may occur in 2050. To this end, the main model of 2050 has been created by taking advantage of previous studies, projections and Time Series models about the possible levels

of production factors in 2050. To determine the number of arable lands of 2050, FAO (Ref. 8) data covering the years 1961–2011 are used. The data obtained are carried out using the Box Jenkins method to reach the prediction of the year 2050.

One of the methods frequently used in time series analysis is the Box Jenkins method. The estimation methods of this method emphasise the analysis by using the 'let the data run' philosophy, which uses the probability properties of economic time series, not the establishment of a single equation or simultaneous equation systems[9]. The basis of the Box Jenkins method used in the analysis of univariate time series explains the value of time series in any period with a linear combination of observation values (AR) in the past period of the same series and error terms (MA). For this reason, the method mentioned can be named as 'Autoregressive Integrated Moving Mean Method (ARIMA)' in the literature.

In the analysis phase, two separate simulation results are compared. The first of these scenarios involves the possible state of the agricultural sector in 2050 under the assumption that global climate change has not occurred. The second scenario is that climate change has occurred.

Baseline scenarios: GDP and population growth rates, Factor supply variation: projected 2011 to 2050.

Climate change scenarios: Baseline scenarios + if crop yield decline –11%.

When CGE-based climate change analyses are examined, it has described the most significant impact as a reduction in the productivity of land used in the agricultural sector[10]. The biophysical models predicted an average crop yield decline of 17% in 2050 across the scenarios, crops, and geographic regions[11]. CGE model does not account for endogenous yield responses, your climate change experiment will impose the final mean yield change for crops of –11% in 2050 reported by AgMIP models[12].

RESULTS AND DISCUSSION

For the basic scenario, possible changes are made from 2011 to 2050 by giving shocks in accordance with the GTAP model of the Balkan countries. For this purpose, the projected changes for the five macroeconomic variables (real GDP, population, labour, capital stock, and land) are as in Table 1.

In general, in researches and projections carried out, it has been calculated that population and labour force rates in other Balkan countries except Turkey will decrease by 2050. According to the studies, Turkey and Bulgaria will achieve the fastest growth in terms of GNP (Refs 11 and 13). Similarly, Turkey and Bulgaria achieved the highest increase in physical capital increases due to the increase in GNP (Ref. 11).

According to the foresight models for arable lands, the fastest rate of decline is calculated to be 22% in Greece. In general, arable land is expected to decrease in the Balkan countries.

On Earth, it has been calculated that the arable land rate will show an upward trend by 2050. According to some studies, arable land will increase by 4.4% to 11% in 2050 (Refs 14 and 15).

Table 1. Projects for the baseline scenario, from 2011 to 2050 (%)

Country and regions	Reel GDP*	Population*	Labour force**	Physical capital**	Arable land***	
					model	land
Turkey	289.97	31.79	35.35	313.80	Log_ARMA(1,1)	–6.22
Romania	196.03	–17.36	–24.04	197.85	ARIMA(1,1,2)	–15.53
Bulgaria	233.23	–15.83	–39.55	263.33	Log_ARIMA (2,1,2)	–7.09
Greece	107.61	–0.98	–16.38	102.66	ARIMA(1,1,2)	–22.00
Oth_Bal	178.78	–10.43	–11.10	115.14	Log_AR(1)	–5.64
Rest of world	325.91	33.41	31.24	177.78	Log_ARIMA (2,1,2)	6.61

* Projected real GDP and population for 2010–2050 (ref. 13); ** Projected labour force and physical capital growth for 2010–2050 (Ref. 11); *** own calculation (Box 'Jenking Method' time serial 1961–2017).

After performing simulations on the GTAP model, changes in GNP are examined (Table 2). GNP is expected to decrease due to climate change. Romania is the country with the highest drop, with 9.72%. As for worldwide, a revenue loss is expected to be at five percent levels.

Table 2. GDP quantity index of climate change in 2050 (% changes 2011–2050)

Country	With climate change	Without climate change	Effect of climate change (%)
Turkey	280.54	289.97	–9.43
Romania	186.31	196.03	–9.72
Bulgaria	225.48	233.23	–7.75
Greece	103.98	107.61	–3.63
Other_Balkans	174.7	178.78	–4.08
Rest of world	320.27	325.91	–5.64

After examining the impact of climate change on agricultural production (Fig. 1), Romania and other Balkan countries are predicted to be affected at fairly low levels. However, due to climate change, Turkey is expected to experience a decline in production of live animals and animal-derived products. Whereas Greece is expected to experience a negative tendency in agricultural products production in 2050, improvements have relatively been observed in the production of many crops in the event of climate change. When agricultural products production of climate change in 2050 is examined, fluctuations in production are not expected due

to the increase in yield in production. However, considering the rate of population growth, it is estimated that there will be significant reductions in the number of agricultural products per capita. In terms of agricultural production, it was predicted that the fisheries sector would be affected by climate change for the year 2050, alongside meat and meat products.

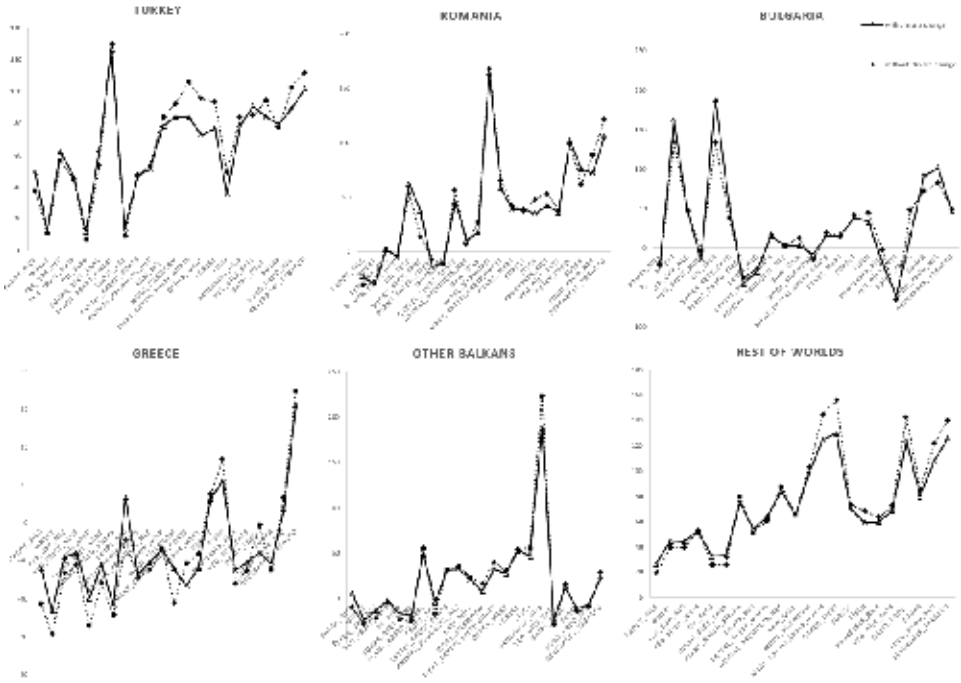

Fig. 1. Agricultural output (% change 2011–2050).

When price changes in agricultural products were analysed (Fig. 2), due to the increase in yield in agricultural product prices for 2050, declines are expected. Turkey has been predicted to see significant price increases in fish and fishery product prices in particular due to climate change. While prices of paddy, fibre crops and raw milk are expected to rise in Bulgaria due to climate change, price increases are expected in Greece in the Fish and fishing sector. It has been predicted that the highest price increase in the world will happen again for the fishing sector. However, due to the increase in productivity, the model results showed that product prices will be lower in 2050 than in 2011.

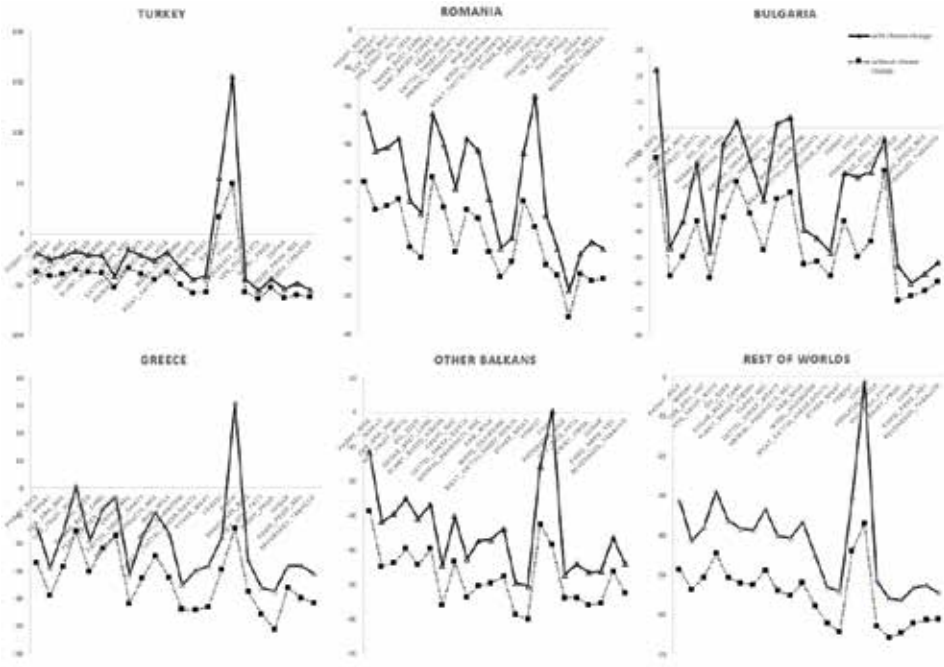

Fig. 2. Effect of climate change on agricultural production price in 2050

Using two different scenario data created with the help of GTAP model, the share of agricultural consumption (import-oriented consumption) and the share of agricultural production (export-oriented production) of Balkan countries were examined (Fig. 3)*. As a result of climate change in Turkey, the share of export-oriented production in many products is projected to increase. Fibre plants, which are important products for Turkey, are estimated to increase the share of imports of vegetable oils and dairy products.

Romania is projected to increase the share of imports in the consumption of mainly agricultural sector products. Production of other animal products and vegetable oil sector products is expected to be export-oriented.

In Bulgaria, like Romania, it is predicted that the share of imports would increase in the consumption of agricultural sector products. Production of other animal products and vegetable oil sector products is expected to be export-oriented.

* CALCULATION Trade Effects of Climate Change in 2050

Import share of agricultural consumption=[Without Climate Change (Agr. Imports-Agr. consumption) – with Climate Change (Agr. imports-Agr. consumption)]

Export share of agricultural production= [Without Climate Change (Agr. exports-Agr. output) – with Climate Change (Agr. export-Agr. output)].

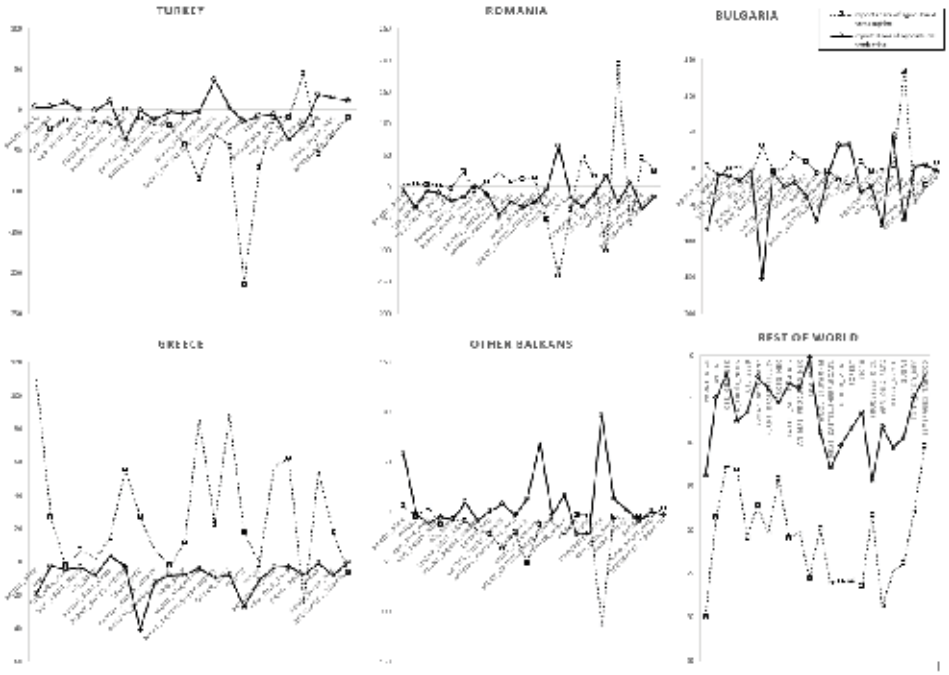

Fig. 3. Calculation trade effects of climate change in 2050

Greece is projected to be the country most adversely affected by global climate change from the agricultural products trade. The share of imports is expected to increase in consumption near almost all of the agricultural products sectors covered. In contrast, the foreign trade of other Balkan countries has been calculated to increase the share of export-oriented production due to the impact of global climate change.

In worldwide, it is expected that foreign trade in agricultural products will decline for 2050 and export-oriented production will be realised by the countries.

CONCLUSIONS

Global climate change is expected to have a negative impact on GDP. It has been predicted that this effect will impoverish the Balkan countries. It is also predicted that the reductions in production will increase the prices of agricultural products.

Furthermore, these studies estimates of agricultural impacts do not always span the plausible range of impacts suggested by recent research, and the mechanics of their modelling framework are not always transparent, providing little insight into the uncertainty associated with estimated impacts. As a result, existing work gives little guidance to decision-makers who need to know which groups in particular

will gain or lose, the reasons why this will happen, and the degree of certainty associated with these estimates[14].

The most important problem under these conditions is ensuring the continuity of food production. When we consider the fundamental questions about global climate change policy, they are when it will happen, how fast it will happen and how costly it will be. This study provides information on some of these basic questions but can not answer.

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