CLIMATE CHANGE, AGRICULTURE AND TRADE LIBERALIZATION: A DYNAMIC CGE ANALYSIS FOR TURKEY

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Paper prepared for presentation at the 3rd AIEAA Conference
"Feeding the Planet and Greening Agriculture: Challenges and opportunities for the bio-economy"

25-27 June, 2014
Alghero, Italy

Summary

This paper analyses the effects of climate change and trade liberalization on Turkish Economy between 2008 and 2099 by using a recursive dynamic CGE model. Results of a crop-irrigation requirement model are used to generate climate change shocks. The results suggest that the effects of climate change will be effective especially after 2030s with acceleration after 2060s. GDP loss gets as high as 3.5 percent. Main drivers of the loss in GDP are the significant decline in private consumption and up to two percent increase in imports. A trade liberalization scenario where tariffs on imports from EU are eliminated unilaterally by Turkey is also simulated to investigate the interaction between climate change and trade liberalization. Trade policy alleviates the negative effects of climate change only marginally for Turkey, as suggested by the literature for many other regions in the world. Trade liberalization with EU causes a trade diversion effect and decreases imports from other trading regions. The main adjustment mechanism of the economy under trade liberalization works through the substitution of factors for intermediate goods, imported consumption goods and intermediate inputs for domestic goods. Maize, oilseeds, fruits and processed food benefit from trade liberalization while production of other crops generally decline.

Keywords: Climate Change, Trade Liberalization, Agriculture, Computable General Equilibrium, Turkey

JEL Classification codes: C68, Q54, Q17

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1. INTRODUCTION

In this study we analyze the effects of trade liberalization in the form of tariff elimination as an adaptation measure to climate change. We develop a dynamic CGE model at the national level with disaggregated agricultural sector, and diversified rest of the world accounts. Then we simulate climate change and trade liberalization scenarios to evaluate the extent of trade liberalization to alleviate the adverse effects of climate change. We use a detailed climate change scenario based on the results of a crop hydrology model. For the trade liberalization scenario we simulate the elimination of the tariffs imposed by Turkey on imports from EU27 countries.

World prices are likely to be affected by the climate change. However neither the sign nor the magnitude of the effect is known. In order to introduce the uncertainty about the world prices, we assume that world prices follow a normal distribution for which the mean and the variation are affected by climate change. We assume that under climate change, mean and variation of the distribution of world prices will increase reflecting the worsening average conditions and increasing climate risk. Then we use the stochastic series obtained from the simulation results to derive conclusions about the importance of the effect of climate change on world prices.

In the following section we present the structure of the dynamic model. The emphasis will be on the modifications done to the static model. A detailed description of the data used to modify the SAM will follow. Then the description of the simulated scenarios and a comprehensive discussion of the obtained results will be provided. Finally, the last section will be reserved for the concluding remarks.

2. TRADE LIBERALIZATION BETWEEN EU AND TURKEY

Trade relationship between Turkey and the EU has been shaped mainly by the Custom Union (CU) Decision of 1996. The benefits and costs of the agreement have been the topic of many studies in the literature since then. Starting from the year 2000, a significant effort has been also devoted to understand the possible economic effects of liberalization of agricultural trade between EU and Turkey. Studies in the literature generally focus on full accession of Turkey to the EU or extending CU decision to agricultural products. So far, the results are ambiguous, but some general trends can be identified.

The foremost addressed question in the literature regarding the full trade liberalization between EU and Turkey focuses on the sign and size of possible welfare effects. Most of the studies reports around 0.5 percent welfare gain or GDP increase under various agricultural trade liberalization scenarios (Eruygur, 2006; Harrison et al., 1997; Lejour et al., 2004; Mercenier et al., 1997; Özer et al., 2009). On the other hand, a deeper integration with the EU is reported to provide higher levels of gain for Turkey. Such actions as: improving EU market access (Harrison et al., 1997), the abolition of nontariff barriers by Turkey (Mercenier et al., 1997; Zahariadis, 2002), the inclusion of Turkey in the CAP support system (Eruygur, 2006; Nowak-Lehmann et al., 2007), creating a sustainable competitive environment (Bayar et al., 2000), maintaining a flexible labor market (De Santis, 2000), improvement of the national institutions and free movement of labor (Lejour et al., 2004), taking into account the scale economies (Sulamaa et al., 2006), timing of liberalization (Acar et al., 2007), harmonization with the EU's health and safety standards (Oskam et al., 2004) are all reported to increase the gains from trade liberalization for Turkey. Depending on the modeling structure and assumptions about the way trade liberalization is implemented, it can be stated that an extension of CU to agricultural sector would result in a welfare gain between 0.5 to 1.5 percent of GDP annually. However, only a few studies report either insignificant total welfare effects (Augier & Gasiorek, 2003; Çağatay, Saunders, & Amor, 2001; Çakmak & Kasnakoğlu, 2003; Grethe, 2004) or even welfare losses (Bekmez, 2002) for Turkey.

The winners and the losers from agricultural trade liberalization are also heavily investigated. The results depend on the scale and structure of the models. Partial equilibrium models give a clear answer for the distribution of welfare gain from trade liberalization across producers and consumers. Producers are generally reported to be losing, while consumers gain (Çakmak & Kasnakoğlu, 2003; Grethe, 2004; Oskam et al., 2004). The main reason for this is the declining producer prices as a result of liberalization. However, this effect is not uniform across all producers (Oskam et al., 2004). Crop producers are generally worse off (Fellmann et al., 2011) while the effect on livestock producers' welfare is ambiguous. Çakmak & Kasnakoğlu (2003), Grethe (2004) and Eruygur (2006) report negative effects while Fellmann et al. (2011) and Leeuwen et al. (2011) report positive effects. As well, consumers' gain is not uniform. De Santis (2000) reports that urban population would be better off, while rural population is likely to be worse off under CU, although the effect on income distribution would be negligible.

Studies based on global or multiregional CGE models provide country or region specific results. The global effect of agricultural trade liberalization between Turkey and EU is found to be negligible (Sulamaa et al., 2006). Change in EU welfare is insignificant whether it is positive (Alessandri, 2000; Augier et al., 2003; Zahariadis, 2002) or negative (Acar et al., 2007; Adam et al., 2008; Alessandri, 2000; Francois et al., 2005). These effects are also not uniform within the EU. Given the fact that Turkey's main competitors for EU market access are the Southern European countries, Southern European countries are more likely to lose while northern European countries win (Nowak-Lehmann et al., 2007; Sulamaa et al., 2006).

The findings about the effects on trade are ambiguous. There is no doubt that the overall effect on volume of trade between Turkey and EU will increase (Bekmez, 2002; De Santis, 2000; Lejour et al., 2004). In some cases this is accompanied with a significant trade diversion (De Santis, 2000). Some studies report that Turkey will become a net importer of crops (Çağatay et al., 2001), while others state that crop exports will increase more than the imports (Çakmak & Kasnakoğlu, 2003; Grethe, 2004; Özer & Özçelik, 2009); others assert that Turkey will be net importer of livestock products (Grethe, 2004). Almost all find that fruits and vegetable exports will increase (Çakmak, 2007; Eruygur, 2006; Nowak-Lehmann et al., 2007).

Impacts of trade liberalization under climate change have not been subjected to any analytical studies for Turkey. However, the issue of interaction between trade liberalization and climate change has been addressed at the global scale. The main argument in the literature is that trade liberalization can alleviate the negative effects of climate change by boosting international trade. Trade liberalization is reported to have welfare improving effects (Calzadilla et al., 2011; Chen et al., 2012; Laborde, 2011; Reilly et al., 1993).

However these effects are generally weak and won't compensate for the adverse effects of climate change (Randhir & Hertel, 2000; Reilly & Hohmann, 1993). Welfare gains from trade liberalization are dependent on the elimination of production and export subsidies (Randhir et al., 2000). The effects are not uniform and depend on the geographic location (Calzadilla et al., 2010; Reilly et al., 1993) and the degree of regional vulnerability to climate change (Reilly et al., 1993). Poor people are expected to be affected more from the changes (Laborde, 2011).

To sum up, trade liberalization is expected to increase the welfare of Turkey, especially through its effects on consumers. However, the findings in the literature are quite diverse and vary based on the data and method of analysis, and exclude the effects of climate change. Most of the studies rely on quite old databases such as the GTAP database with the base year being 1997, long before CU became fully functional. Almost all studies employ static models which ignore the dynamic aspects of the problem. Almost all CGE models lack a detailed disaggregation of agriculture while partial equilibrium models ignore the feedback mechanisms.

In this study we try to fill the gap in the literature with a detailed and enhanced modeling framework. The welfare effects of trade liberalization and its reflection in production, consumption and food security will be at the center of our analysis. We will also explore the relationship between climate change and trade liberalization to see if trade liberalization can alleviate the adverse effects of the climate change. We will address whether unilateral trade liberalization can be considered as a policy alternative to help climate change adaptation efforts of Turkey.

3. Description of the model, data and Simulations

3.1. Model

The recursive dynamic Walrasian CGE model that is used in this study considers production activities, households, firms, government and major trading partners of Turkey as the main economic agents and attempts to model the behaviors of these agents and their interactions in a well-established algebraic framework.

Every sector in the economy is represented with one activity that produces one commodity using labor, capital, rainfed land, irrigated land and water together with intermediate inputs supplied from the other sectors. The production function has a nested structure. The first nest is a Leontief type production function between irrigated land and water to reflect the complementarity between these two factors. The second level nest consists of two separate production functions. The first production function is a CES, and it transforms the water-irrigated land composite obtained from the first level nest and other factors of production to a composite factor. The second production function in the second nest is a Leontief production function that transforms intermediate inputs into a composite intermediate input. In the third level nest, the composite factor and composite intermediate input obtained from the second level nest are introduced to another CES production function to obtain the value added. A detailed description of the production structure can be found in Dudu (2013).

The outputs of the production activities are supplied to the domestic markets as intermediate inputs, and final consumption goods as well as to the international markets as exports. Production activities pay taxes to and receive subsidies from the government.

The value added created by capital is paid to firms as income. Firms receive also transfers from the government and the rest of the world. This income is used to pay capital earnings to the households, institutional taxes to government and profit transfers to the trading partners.

Households receive directly the value added created by labor, land and water as income, while capital income is received by the firms. Households also receive transfers from the government and the rest of the world. Household income is used for consumption, to pay income taxes and to accumulate savings. Consumption is modeled with a linear expenditure system. Households receive utility from the part of the consumption that is above the subsistence level of consumption.

Leisure is also included in the utility function. We used the number of people who are in the work force but who are not looking for jobs as an indicator of leisure to overcome the calibration difficulties. People who are not in the workforce (students, housewives, retired people etc.) are taken as a proxy for the subsistence level of leisure. This approach can approximate the labor supply decision of the household, but labor force participation decision is still treated exogenously in the model, since it is impossible to endogenize the subsistence level of leisure in this framework. However, we define a “rule of motion” for the labor force participation. Labor force participation responses to changes in real wage. A detailed account of the implemented utility maximization framework can be found in Dudu (2013).

Saving behavior of the household is determined by the closure rule. We assume an investment driven saving behavior at the macro level while the adjustments in absorption are spread to the all components uniformly. Hence, the share of investment in absorption is fixed; saving rates of the agents are uniformly scaled to finance the investment (Löfgren et al., 2002).

There is no behavioral assumption imposed on the government. Government collects taxes and receives transfers from the rest of the world. Government income is used for government consumption, savings, and to make transfer payments to domestic institutions and to the rest of the world. The share of government outlays in total absorption is constant. We assume that government savings are flexible while the tax rates are fixed.

Rest of the world account consists of five trading partners who supply imports and demand exports, pay and receive transfers, and invest in Turkey. Imports follow Armington specification while exports are modeled with a CET approach. Accordingly, imported commodities are not perfect substitutes of domestic alternatives and the relationship between demand for domestic and imported commodities is managed by the substitution elasticity. The share of export supply in domestic production is also managed by a constant elasticity of transformation function. Foreign savings are always equal to the difference between value of imports and exports to balance the current account. The share of transfers from and to domestic institutions in their income is constant. We assume that the foreign exchange rate for all trading partners is fixed while the foreign savings are free to adjust.

Following Thurlow (2004), recursive dynamics is introduced to the model through capital accumulation, labour growth and TFP growth. Investment in each period is added to the capital stock of the next period and distributed across regions according to their shares in investment. Population and TFP growth are introduced to the model exogenously.

3.2. Data

We use a social accounting matrix (SAM) for Turkish economy with the year base year 2008 which was developed in Cakmak & Dudu (2013). The agricultural sector is disaggregated into 13 sub-activities for the purpose of this study: wheat, maize, rice, other cereals, oilseeds, sugar beet, other field crops, fruits, vegetables, dairy, meat, livestock and other agricultural production. Rest of the world account is disaggregated into five trading partners who supply imports and demand exports, make and receive transfers, and invest in Turkey. Non-agricultural sectors are kept intact: There are 4 manufacturing activities (food, textiles, energy and other manufacturing production) and 2 services (private and public services).

The disaggregation of the agricultural sector is accomplished using the 2008 production statistics (TurkSTAT, 2012a). We assumed that input-output (I/O) coefficients of all disaggregated activities are the same as the aggregate agriculture (TurkSTAT, 2012b). We then introduced some adjustments in the I/O table. Crop production activities use only their own commodities as intermediate inputs and no other crop products. Milk and meat production activities are linked only with livestock production activity which mainly consists of livestock raising. Livestock activity uses wheat, maize and sugar beet as feed. Agricultural activities do not use any textiles or public services commodities. To balance the I/O table for the agricultural activities, we increased the intermediate input use of food production activity from the agricultural activities. Hence a significant part of the intermediate input supply of agricultural activities is used by food production. Textiles production activities use inputs only from other cereals and other field crops. The energy sector receives input from sugar beet production to reflect the small amount of ethanol production in Turkey. Minor adjustments are done to balance the other sectors in the I/O table. The value added of land is calculated from irrigated and rainfed land rent data reported by G&G Consulting et al. (2005). The share of irrigated land in the total cultivated land is obtained from the agricultural master plans of 81 provinces (Ministry of Food Agriculture and Livestock, 2012). These shares are then used to find the total irrigated land at the national level. We assume that the share of irrigated and rainfed land is the same across different crops, since there is no data at the crop level for the use of irrigated land. However we used priori information for the use of irrigated and rainfed land by specific crops. For example, the production of rice and vegetable requires irrigated land. The value added for water is calculated from the rental difference between the rainfed and irrigated land at 12 NUTS-1 level from G&G Consulting et al. (2005) and aggregated to the national level by using irrigated land data.

Agricultural subsidies are introduced to the national SAM using the OECD data as negative activity taxes. Then capital value added account is adjusted accordingly. The results are presented in Table 1. According to OECD (2013) the highly supported activities are livestock, other field crops, wheat and dairy. Rice and vegetables do not receive any subsidies while support for meat, fruits and other cereals are quite low.

Table 1. Subsidies on agricultural activities (Thousand TL)

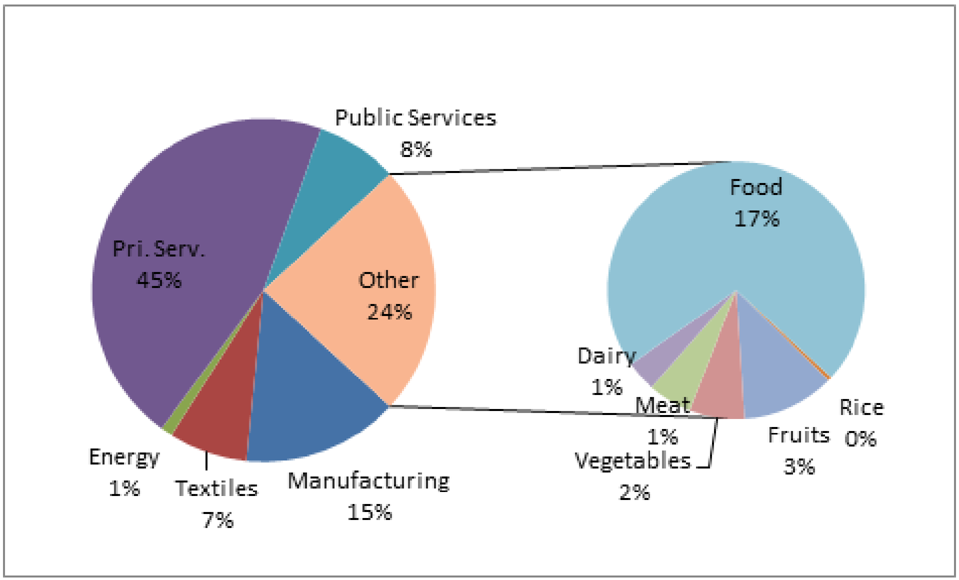
Activity	*Subsidy*	*Activity*	*Subsidy*
Wheat	673,138	Fruits	3,775
Maize	71,414	Vegetables	0
Rice	0	Dairy	310,252
Other Cereals	6,163	Meat	1,210
Oil Seeds	114,583	Livestock	853,277
Sugar Beet	16,722	Other Agriculture	49,027
Other field Crops	682,500		

Source: Authors' calculation from OECD (2011)

Households do not directly consume wheat, maize, other cereals, oilseeds, sugar beet, other field crops, livestock and other agricultural products. The outputs of these activities are used as intermediate inputs, mostly by the food production activity. Households, however, directly consume rice, fruits, vegetables and dairy products. We assume that 'government' does not consume any agricultural products. The resulting consumption pattern is given in Figure 1 with 'private services for the households' being the most important consumption item with a 45 percent share. Agri-food products constitute 24 percent of the total consumption; 17 percent of which is made up of processed food.

The ROW account is disaggregated into 5 trading partners: EU27, MENA, North America, Other Europe, and the Rest of the World. Imports are distributed across trading partners according to foreign trade statistics (TurkSTAT, 2012c). Minor adjustments in saving-investment account were necessary to balance the discrepancy in the trade accounts.

Figure 1: Consumption pattern of households



Source: Author's calculations from the SAM

Tariffs are recalculated according to the GTAP data. We made minor adjustments in the SAM since the reported amount of tariff revenue is lower than the revenue obtained when the GTAP tariff rates are implemented. The increase in tariff revenue is added to the government account while the same amount is discounted from the supply of commodities. The decline in supply is then balanced by reducing the capital value added and hence the capital income of firms is reduced. Transfers from the government to firms are then increased by the same amount to keep household income intact. Changes in capital and government transfers to firms are small relative to the initial levels of these accounts.

The tariff rates used in the model are given in Table . Although the Turkish protection against EU imports is low at the average, dairy products, meat and fruit imports are heavily taxed. High protection against the other regions is likely to favor EU products in case of trade liberalization. The main competitor of the EU27 countries in the Turkish imports market is 'other European countries'. According to the baseline data, Turkey's imports of cereals from other European countries are higher than the amount of imports of these commodities from EU27.

Table 2. Tariff rates according to trading partners (percent)

	EU27	*MENA*	*North America*	*Other Europe*	*Rest of the World*
Wheat	28.5			43.3	42.9
Maize			125.1		121.2
Rice	32.1	0	32.1	31.6	
Other Cereals	92.3		125.1	97.9	121.2
Oil Seeds	1.2		4.8	4.8	8.4
Sugar Beet					
Other field Crops	9.3	12.2			15.6
Fruits	39.1		24.5	35.4	59.5
Vegetables			24.5		59.5
Dairy	101.8		116.4	122.8	118.5
Meat	83.6	22.1		7	102.6
Livestock	2.0		4.9		5.3
Other Agriculture	2.3	7.1		0.1	1.9
Other Manufacturing	0		3.9	2.7	1.8
Food Production	12.3		16.9	18.9	21.2
Textiles	0		6.5		5.1
Energy	0			0	0.3
Services	0				

Source: Authors' calculation from (Narayanan et al., 2008).

Foreign savings and transfers from firms to trading partner accounts are distributed across trading partners according to the foreign direct investment data reported in the General Directorate of Foreign Capital (2009). Transfers from trading partners to households (i.e. mainly workers' remittances) are distributed according to the data reported by the World Bank (2012). Transfers from trading partners to firms are distributed according to the Turkish foreign direct investment in other countries as reported by OECD (2012). This means that that the money transferred from abroad to the firms are mainly profits of firms from abroad and they are proportional to the investment made abroad. The results are given in Table 3. The remaining accounts are obtained by aggregating the SAM developed in Cakmak and Dudu (2013).

Table 3: Foreign savings and transfers (TL million)

		EU27	MENA	North America	Other Europe	Rest of the World
Transfers	from Firms to ROW	10,136	536	1,021	1,072	
	from Government to ROW	19,151	63,195			
	from ROW to Households	1,317	140	189	130	78
	from ROW to Firms	2,979	4,434	461	1,113	
	from ROW to Government			16,907	5,381	53,902
	Foreign Savings	46,745	2,472	4,709	4,945	

Source: Authors' own calculation

3.3. Scenario Design

To simulate the effects of trade liberalization between EU and Turkey under climate change, we run three scenarios over the period 2008-2099. First, we run a baseline scenario that mimics the growth path of the Turkish economy for the period 2008-2099. The results of the baseline scenario are used for benchmarking the other scenarios. Climate change effects on yields and irrigation requirements are then incorporated on top of the assumptions made for the baseline in the second scenario. Lastly, we introduce unilateral tariff elimination by Turkey against the EU imports as a policy response to climate change effects. Climate change and tariff elimination scenarios are run under 52 different changes in the world prices for each year. The series for world price changes are calculated using the Gaussian-Quadrature method from the historical world price series for each commodity.

We start this section with the description of the scenarios. Then the simulation results are discussed. More emphasis will be given on the results of trade liberalization scenario by benchmarking them against the results of the climate change scenario.

Baseline Scenario

The baseline is the "business as usual" scenario where we try to mimic the historical growth rate of the economy over the period 2008 and 2099. In other words, the model is calibrated to yield an average GDP growth rate of 3.5 percent, which is the average growth rate of GDP between 1950 and 2008 (TurkSTAT, 2010b). The annual population growth is assumed to be 0.9 percent. The subsistence consumption levels are automatically updated to reflect the increase in population. Labor force endogenously adjusts to the population growth by taking into account the change in real wages.

We assume that the annual total factor productivity (TFP) growth is 0.8 percent in agriculture, 1.06 percent in industry and 0.4 percent in services. We use the yield projections for wheat presented in Bruinsma (2003) and reported in Kavallari, Rau, & Rutten (2013). We assume that TFP growth in services is half of the increase in agricultural activities, while the industrial TFP growth is 2.65 times the TFP growth in services. Capital growth is endogenous in the model. The growth in capital stock is determined by the dynamics of the model. We assume that the default capital/output ratio is 4.2 [1] and the depreciation rate is 3 percent. We do not change the world prices in the baseline since we assume that world prices are changing due climate change.

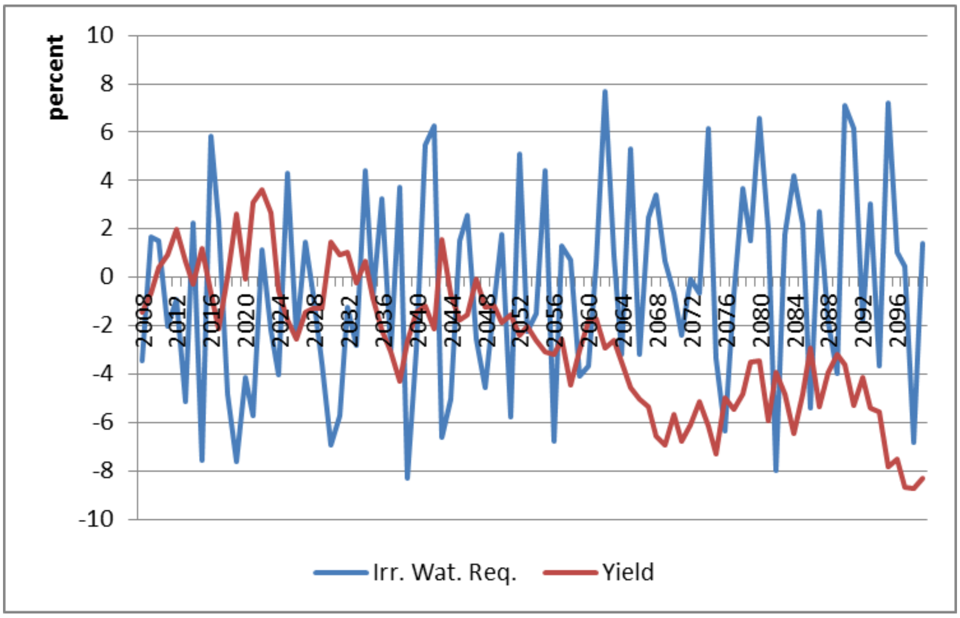
Climate Change Scenario

This scenario introduces climate change effects to the baseline. These effects are in the form of yield and irrigation requirement changes. They are obtained from the crop water requirement model which is based on CROPWAT model of Allen et al. (1997). The details of crop requirement model can be found in Dudu (2013). We use a 5-year moving average for the yield change since there are significant outliers for a few highly irrigated crops. This reduces the extreme events caused by frequent harvest failures foreseen by the crop model. However, deviation from the base year is still significant (Figure 2) and the story line for the climate change effects does not change. Yields are generally increasing between 2008 and 2035; they start to decline between 2036 and 2060. In the last period, 2061-2099, the decline in yields becomes substantial. Irrigated water requirement oscillates significantly throughout the all periods.

Yields of fruits and cereals are not affected much while maize and oilseeds are the most affected crops. The impact is reversed in the case of irrigation water requirements. Effects on wheat, vegetables and other field crops are significant both in terms of yields and irrigation requirements. All crops more or less follow the pattern in Figure . In the first period the change in average yields is rather small and even positive for some crops. Yields of all crops start to decline in the second period, but the magnitude of the average decline is not more than 10 percent. However, the decline becomes prominent in the last period, especially for maize and oilseeds.

[1] We calculated 4.2 as capital/output ratio from the data published by the Ministry of Development (2012).

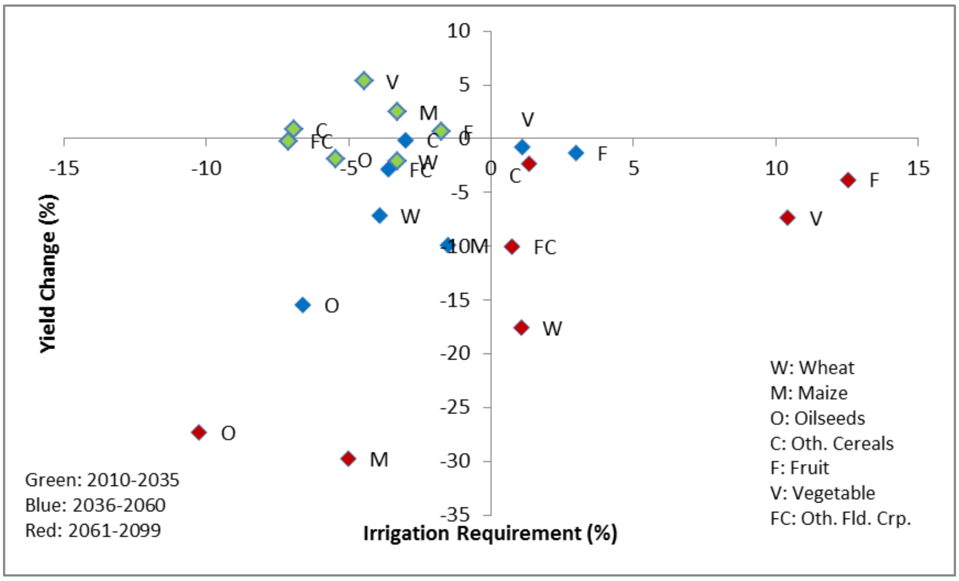
Figure 2: Changes in average yields and irrigation water requirements



Source: Model Results

Figure 3 shows the scatter plot of average irrigation water requirements against average yield changes for each activity in each period. Crops are concentrated around the second quadrant where yield changes are almost non-negative and irrigation requirement changes are negative. In the second period, crops are located around the 45-degree line in the third quadrant, which implies a positive correlation between yield changes and irrigation water requirements. Yields and irrigation requirements decline simultaneously for all crops, except for vegetables and fruits for which irrigation requirements increase. In the last period all crops moves to the fourth quadrant where irrigation requirements increase and yields decline. The only exceptions are oilseeds and maize for which yields and irrigation requirements decline simultaneously. However note that the decline in yields is quite significant for these crops.

Figure 3: Yield and irrigation water requirement changes in periods



Source: Model Results

Climate change is a global phenomenon and hence it is likely to affect world prices of agricultural commodities significantly. However, it is not possible to capture this effect with a small single country model where world prices are assumed to be exogenously determined. Many studies in the literature ignore this effect. We incorporate the effects of climate change on world prices as exogenous shocks. In other words, we assume that climate change does not only affect the yields and irrigation requirements but also the world prices.

There are various studies in the literature that attempts to quantify climate-induced changes on world prices by using global CGE models. These studies generally report significant changes in world prices of major staples. However we cannot incorporate these findings in our simulations since their assumptions about the climate change are generally different from that of ours. Further these studies are generally static exercises and report world prices only for a specific year. Lastly, the reported world price changes are generally inconsistent. Hence instead of taking world price changes from other studies in the literature we use Gaussian Quadrature method to generate different world price series.

Gaussian quadrature is an approximation method for numerical integration. Weighted sum of function values at specific points in the domain of the function are used to approximate the value of the function (DeVuyst and Preckel, 1997). Gaussian quadrature method gives the weights and nodes required to calculate the an approximation to any integration problem as a summation problem. There are various formulas in the literature to calculate the weights and nodes efficiently. Strauds method is used widely in the CGE literature (Arndt, 1996).

Gaussian quadrature method is used for stochastic sensitivity analysis in the CGE literature and is shown to be quite efficient in capturing the uncertainty in the parameter values (Arndt, 1996; DeVuyst and Preckel, 1997). Stochastic sensitivity analysis assumes that model parameters are stochastic variables following a distribution function. Hence the values used in the model are just one point drawn from this distribution. In this case model results are also stochastic. If we consider the CGE model as a function that relates the pre-simulation and post simulation values of the variables in the model, then the expected value and variation of the post-simulation values of the variables can be approximated by using Gaussian quadrature approach. In this way one can select a limited number of parameter sets and weights and run the model for these parameter sets. Then the stochastic properties of the model results can be derived from the output of these runs. A high variation in the values of key model variables would mean that model is sensitive to the relevant parameters.

Preckel et al. (2011) propose an algorithm to extend the quadratures suggested by Straoud. They propose to use two copies of the Straoud quadratures: stretching one and shrinking the other to achieve the desired broadening of the sample while keeping the mean intact and redistributing the weights (or probabilities) so that the variance is maintained. We follow this approach to capture the variation in the model's results due to the world prices. Accordingly, we assume that percentage change in real world price of each agricultural commodity follows a symmetric distribution. The mean of the distribution is assumed to be zero for all commodities in the base period. Then we assume that the mean of the distribution will increase by one, two and three standard deviations in the first, second and last period respectively. We further increase the variation in the percentage change of the world prices (i.e. diagonal elements of the variance covariance matrix) by one percent in each period. Hence in each period we assume that mean of the distribution of percentage change in world prices are increasing together with the variation in the prices. These assumptions are compatible with the recent studies in the literature (Hertel and Rosch, 2010; Valenzuela and Anderson, 2011a and 2011b; Diffenbough et al., 2012; Calzadilla et al., 2013).

Changes in the world prices of different commodities are not independent from each other. This stems from two facts. Firstly, different agricultural commodities are substitutes to some extent. Hence their prices are linked to each other. Secondly, price changes are linked to production, and production of all commodities is dependent on the same climate conditions. For example, if the price of one commodity is rising due to drought, other crops will be affected from the drought as well and their prices will also rise. To take this correlation into account we form the variance covariance matrix by using the historical correlation between the annual price changes of the commodities. We eliminate small correlations to avoid problems in Cholesky decomposition. We also assume that correlation among the percentage change of world prices of different commodities remains constant over time.

Table 4 shows the expected values and standard deviations of the world price shocks calculated by Gaussian quadrature method for all commodities over the three periods. Our assumptions yield world price changes that are consistent with the climate change patterns. The average percentage change increase over time is as expected. The highest increases occur in the world price of rice, wheat, oilseeds and other field crops. Variations for these crops are also high. The lowest increases, on the other hand, occur in vegetables, meat and other agricultural crops.

We run the climate change simulations by shocking the shift parameter of the top level CES production function with the yield changes, the coefficient of water in irrigated land – water nest with irrigation water requirements and the world prices with the world price change series generated by Gaussian quadrature. Hence, we run 48 simulations each with a different world price assumption. Therefore the results for the levels of the variables show the expected values. We also report the standard deviations when it is appropriate.

Table 4: Mean and standard deviation of the world price shocks

	Period 1		Period 2		Period 3	
	Exp. Val.[1]	Std. Dev.[1]	Exp. Val.[1]	Std. Dev.[1]	Exp. Val.[1]	Std. Dev.[1]
Wheat	1.01	1.46	2.01	1.46	3.01	1.46
Maize	0.62	0.76	1.62	0.76	2.62	0.76
Rice	1.27	1.67	2.27	1.67	3.27	1.67
Oth. Cereals	0.99	0.62	1.99	0.62	2.99	0.62
Oilseeds	1.72	0.95	2.72	0.95	3.72	0.95
Oth. Fld. Crp.	3.06	1.10	4.06	1.10	5.06	1.10
Fruit	-0.18	0.57	0.82	0.57	1.82	0.57
Vegetable	0.50	0.26	1.50	0.26	2.50	0.26
Milk	-0.12	0.85	0.88	0.85	1.88	0.85
Meat	5.55	0.41	6.55	0.41	7.55	0.41
Livestock	4.15	0.85	5.15	0.85	6.15	0.85
Other Agriculture	3.63	0.39	4.63	0.39	5.63	0.39

[1] Mean and standard deviation are first and second moments of distribution, respectively Source: Author's calculations

Trade Liberalization Scenario

Under the trade liberalization scenario we assume that all tariffs implemented by Turkey on EU imports are unilaterally eliminated on top of the climate change scenario. This scenario is called "Tariff Elimination scenario (TRF)", and eliminated tariffs are given in Table 3.5. Protection is generally high in agricultural commodities. The share of agricultural imports in the total imports from EU is low with a value of less than two percent. On the other hand, EU's share in agricultural imports of Turkey is significant varying between 20 to 45 percent. Although agriculture is a minor item in imports from EU, EU is still the most important trading partner of Turkey. Hence trade liberalization with EU is likely to have a significant direct impact on Turkish agriculture while the impact on the rest of the economy will be through the backward and forwards linkages of agriculture with the other sectors.

Table5: Tariffs imposed by Turkey (percent)

	Tariff Rate	Share of EU in total imports of commodity	Share of commodity in total imports from EU
Wheat	28.5	25.2	0.36
Maize	0	0.0	0.00
Rice	32.1	19.8	0.03
Cereals	92.3	21.9	0.02
Oil Seeds	1.2	28.6	0.39
Sugar Beet	0	0.0	0.00
Field Crops	9.3	30.4	0.03
Fruits	39.1	9.6	0.03
Vegetables	0	0.0	0.00
Dairy	101.8	39.6	0.05
Meat	83.6	12.0	0.00
Livestock	2	35.8	0.02
Oth. Agriculture	2.3	45.9	0.09
Manufacturing	0	52.3	82.69
Food	12.3	24.0	0.85
Textiles	0	28.6	2.19
Energy	0	8.0	0.00
Services	0	52.3	13.24

Source: Authors' calculation from (Narayanan et al., 2008).

4. SIMULATION RESULTS

In this section we present the main conclusions from the simulation results and explore the main drivers of change in order to derive policy implications. We will present the results relative to the changes in the baseline scenario. In this section, we will first give an overview of macro results of the two scenarios. Then we will focus on the effects of trade liberalization by presenting them relative to the results of climate change scenario.

4.1. Macro Results and Welfare Effects

The results obtained are largely consistent with what have been suggested in the literature and provide important insights about the main drivers of the effects of climate change.

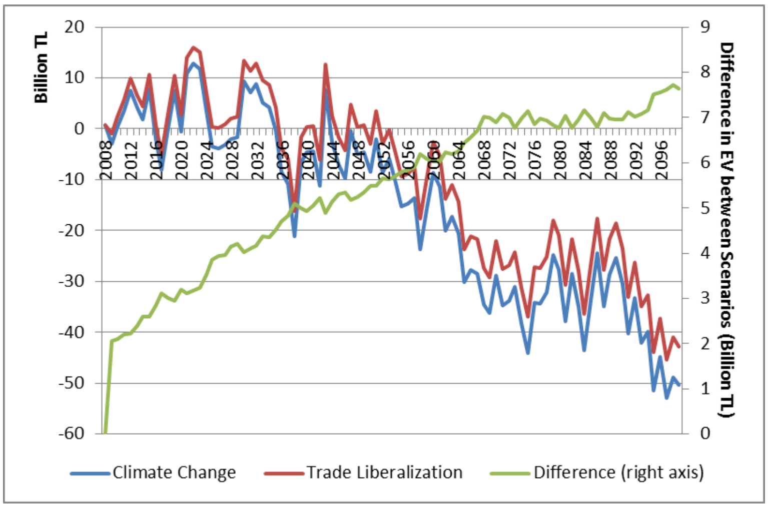
Figure shows the expected value of the equivalent variation[2] (EV), which is an indicator of welfare gains for the households. Change in EV is between -3.3 percent and +1.3 percent of the initial household consumption for climate change scenario and -2.8 percent and 1.63 percent for the trade liberalization scenario.

EV is higher under trade liberalization compared to the climate change scenario. However, the trade liberalization is far from alleviating the negative effects of climate change. In the last period, 2060-2099, the EV is always negative under both scenarios. Though, the difference between the climate change and the trade liberalization scenarios increases as the effects of climate change worsen. This suggests that the welfare

[2] More formally, EV shows the minimum payment that the consumer would require for foregoing the welfare gains under the relevant scenario (Sadoulet and Janvry, 1995).

improving effects of trade liberalization are enhanced when the effects of climate change are worsened. As agricultural production becomes less productive as a result of the climate change, welfare improving effects of trade liberalization are amplified. This is mainly due to the fact that trade liberalization allows economic agents to substitute domestic and imported commodities more freely. Consumers can consume more imported commodities as a substitute to the domestic products which become relatively scarce under climate change. Producers can also substitute domestic intermediate inputs with imported inputs to compensate the decline in the productivity of land. Consequently, the more agriculture is affected from climate change the higher is the welfare improving effect of trade liberalization.

Figure 4: Expected value of equivalent variation

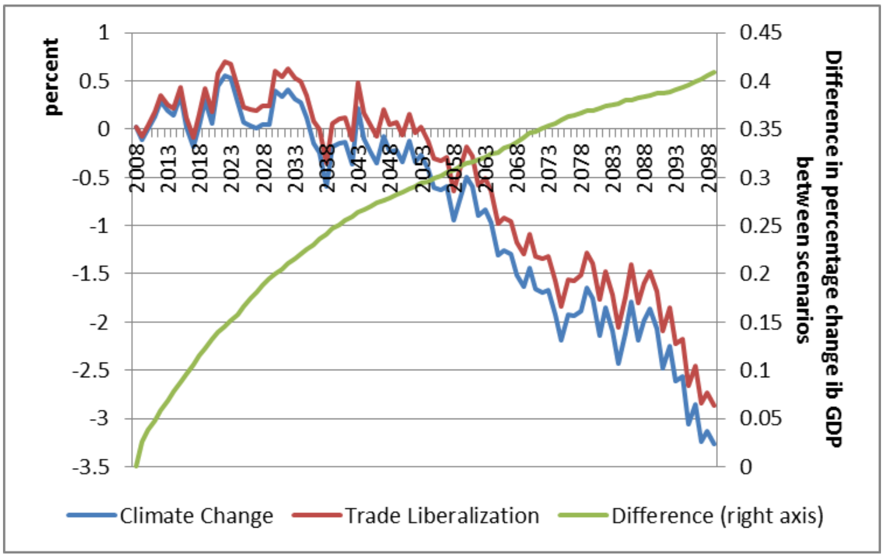


Source: Model Results

The change in GDP is generally small until the 2060s (

Figure 5). Changes in tariffs may not be fully reflected in the production side of the economy up to this period. The impacts of tariff elimination are generally absorbed by the substitution mechanisms in trade, consumption and production. GDP starts to decline after 2035 but the decline is significant only after 2060s. This is consistent with what is generally reported in the literature. Welfare and other macro indicators follow the same path: they get better off in the first period (2008-2035), start to decline in the second period (2035-2060) and worsen in the last period (2060-2099). Thus, Turkey is likely to have time to take necessary measures for adaptation before climate change has significant impacts at economy level. Furthermore ignoring the probable adverse effects of the climate change in the second and the last period can have devastating effects and significant costs for all economic agents.

Figure 5: Real GDP over time (percentage deviation from baseline)

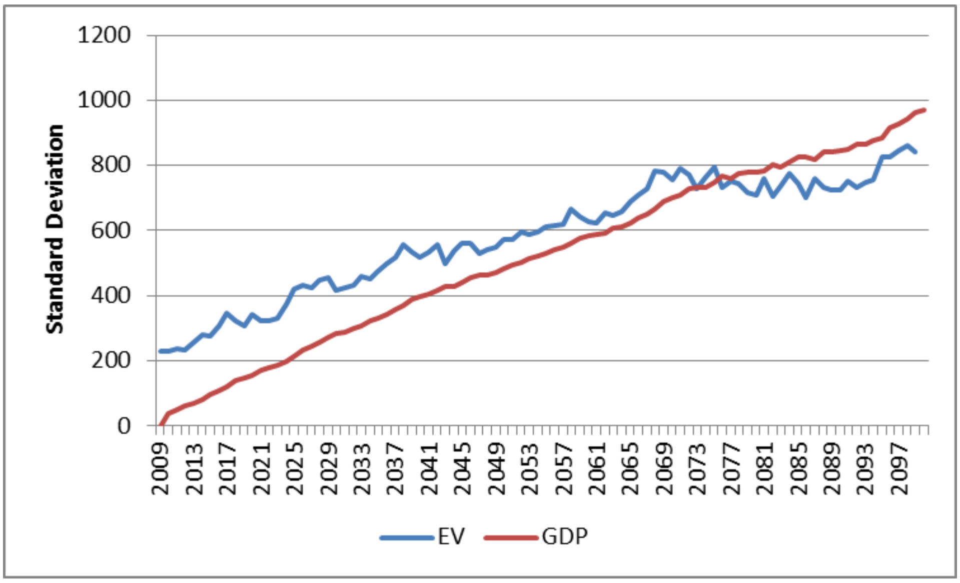


Source: Model Results

Figure 6 shows the evolution of the standard deviation of the GDP and the EV over time. Since we use the same world price shocks in both climate change and trade liberalization scenarios standard deviations in both simulations are very similar. Hence for the sake of clarity we will present only the standard deviations for the trade liberalization scenario.

The standard deviation of EV increases in the first two periods and it stabilizes and follows a horizontal trend after 2060s. On the other hand, although the standard deviation of the GDP starts at a low level compared to the standard deviation of EV, it increases throughout the simulation period. Thus we can conclude that although changes in world prices do not cause any further changes in the variation for household welfare in the last period, their impact on the variation of the GDP persists. This implies that changing world prices affect both the consumption and production sides in the first period and only the production side in the last period.

Figure 6: Standard deviation of EV and GDP levels over time

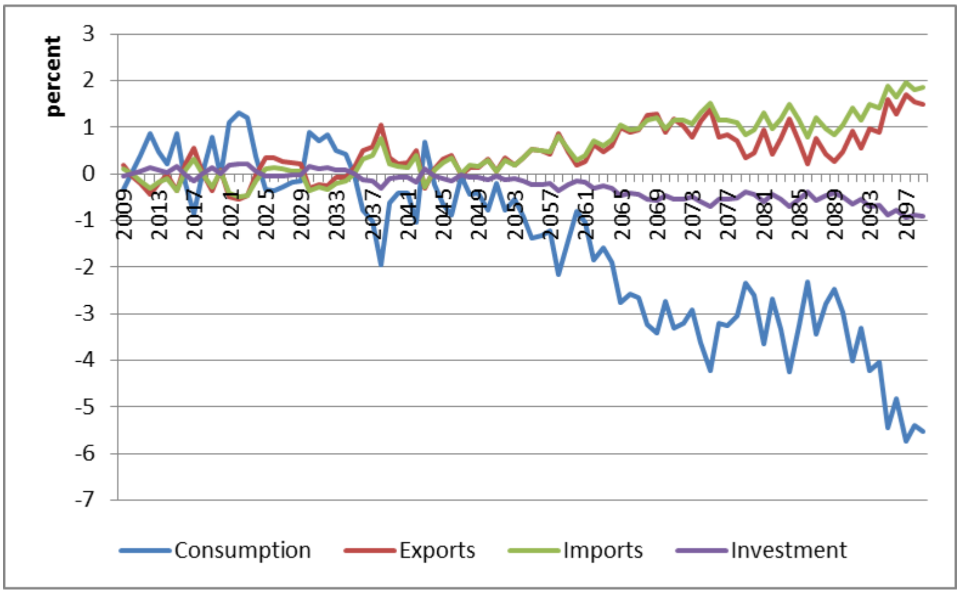


Source: Model Results

Figure 7 shows the decomposition of the changes in GDP under the climate change scenario. The most important drivers of the change in the GDP are private consumption, imports and exports. Government consumption contributes very little to the changes in the GDP and therefore its activity on change will not be reflected in this figure. Changes in fixed investments are however included, and in spite of their minimal influence at the start, their contribution becomes more significant in the last period.

The contribution of the changes in private consumption to the changes in GDP moves generally in opposite direction compared to those in trade. This is valid throughout the whole simulation period. In the first period, trade contributes negatively to the changes in GDP, implying a decreasing value of exports and an increasing value of imports in the first period. The decline in total exports is caused mainly by a decline in exports to the regions other than EU27.

Figure 7: Contribution of the GDP components on the GDP change under climate change scenario (percentage deviation from the baseline)

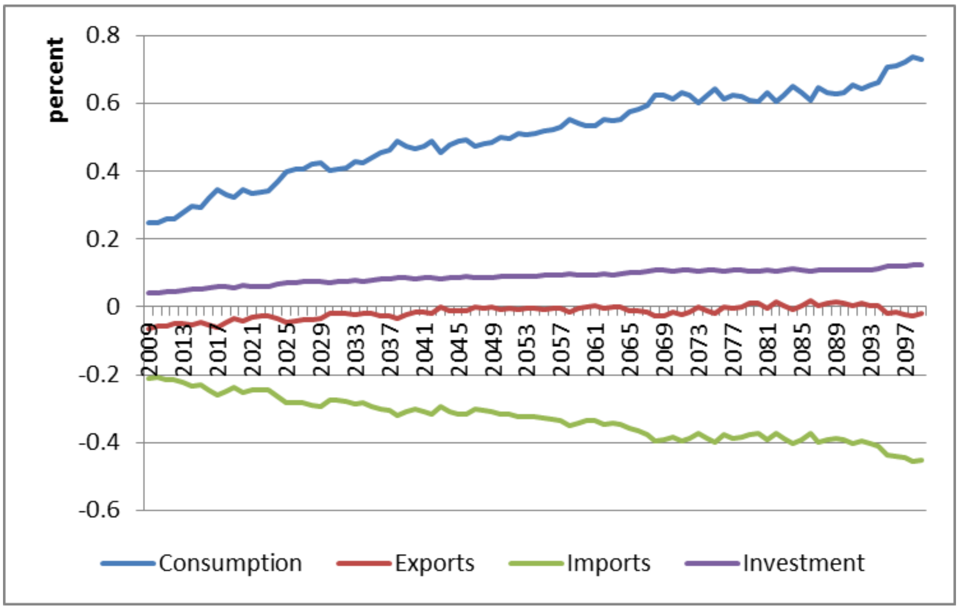


Source: Model Results

In the second and third period, however, the effects are reversed. In the second period, the positive contribution of imports and exports are able to compensate the negative contribution from consumption. However, in the third period the combined effect of consumption and fixed investments has a stronger influence than the combined effect of imports and exports, and as a result GDP declines significantly. In the second and third periods the effects of consumption and trade are almost symmetrical around the horizontal axis since increasing exports and decreasing imports due to increasing world prices put a significant pressure on consumption. Thus consumption adjusts to handle the change in the world prices.

The contributions of the components of GDP to the changes in the overall GDP under the trade liberalization scenario are presented in Figure 8. Private consumption and fixed investments have positive impact on GDP (i.e. less negative, under trade liberalization), while exports' contribution is almost the same between the two scenarios. However, positive contribution of imports decreases under the trade liberalization scenario. That is, as import prices decline the imports are substituted with domestic commodities and this increases the consumption. The changes are weak, as they are not likely to reverse the sign of the GDP change. Hence, trade liberalization only weakly alleviates the effects of climate change in terms of GDP growth. Note that the difference gets higher over time. Hence, the benefits of trade liberalization increase as climate shocks get significant.

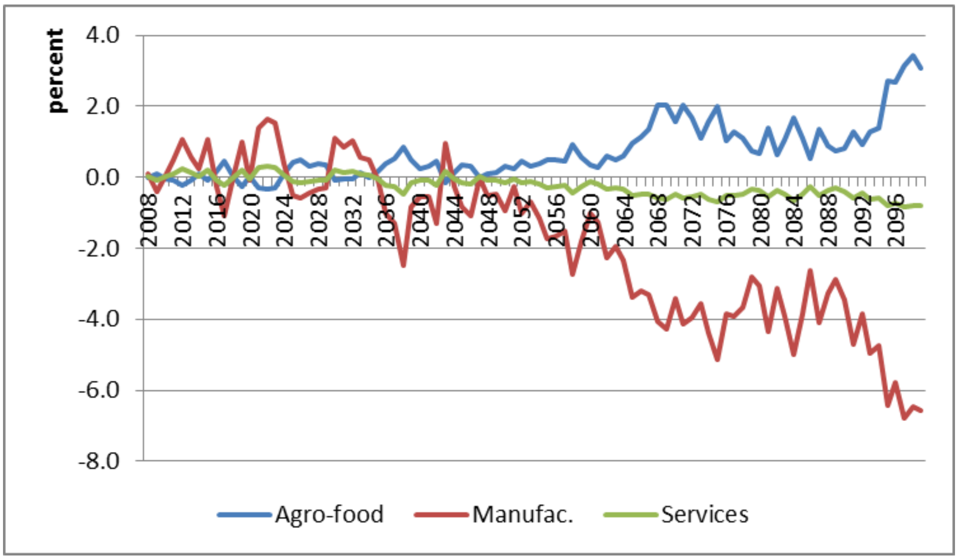
Figure 8: Contribution of GDP components to the GDP change under trade liberalization scenario (percentage deviation from climate change scenario)



Source: Model Results

Figure 9 and Figure 10 show the sectoral decomposition of the change in imports and exports under climate change scenario with respect to the baseline. Contribution of services to the change in imports and exports is small compared to the agri-food and manufacturing. The main driver of the change in imports is manufacturing, especially in the first period. The contribution of manufacturing is generally positive in the first period while it deteriorates significantly in the second and third periods.

Figure 9: Decomposition of changes in the value of imports under the climate change scenario (percentage change from the baseline)

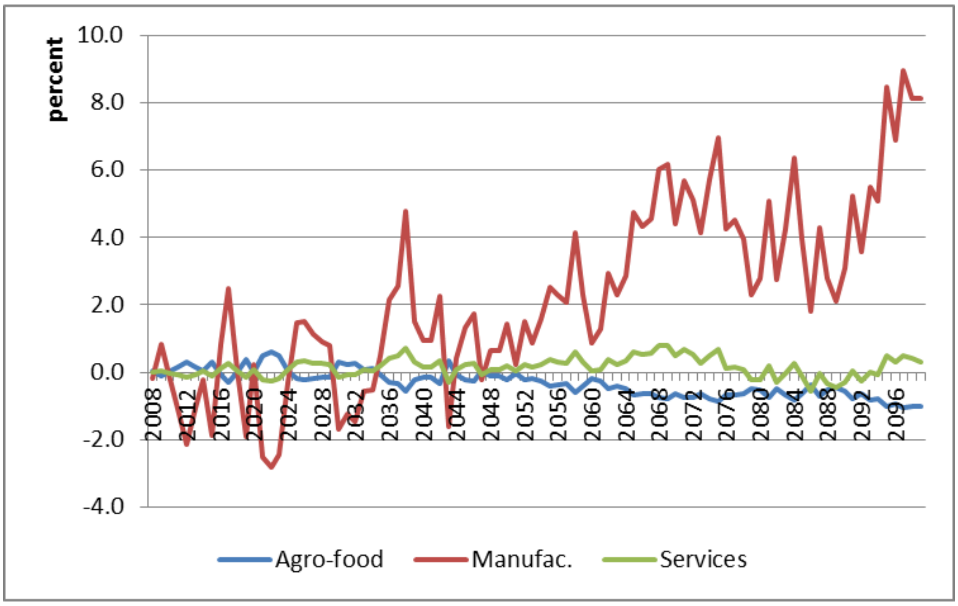


Source: Model Results

Agri-food imports increase the total imports especially in second and third period as the effects of climate change become significant in these periods and Turkey needs to substitute domestic products with imports. However, total imports are still declining, since increase in agricultural imports is rather limited due to the increasing world prices. In other words, Turkey substitutes manufacturing imports with agricultural imports since following the climate change effects, manufacturing sectors becomes relatively more productive and hence more competitive in the international markets.

The effects are reversed for exports (Figure 3.10). Change in export of manufacturing sector is generally negative in the first period while it increases significantly as a result of declining domestic prices of manufacturing goods and increasing world prices of agricultural commodities in the second and last periods. This boosts total exports despite the decline in agri-food exports.

Figure 10: Decomposition of change in exports under climate change scenario (percentage change from baseline)

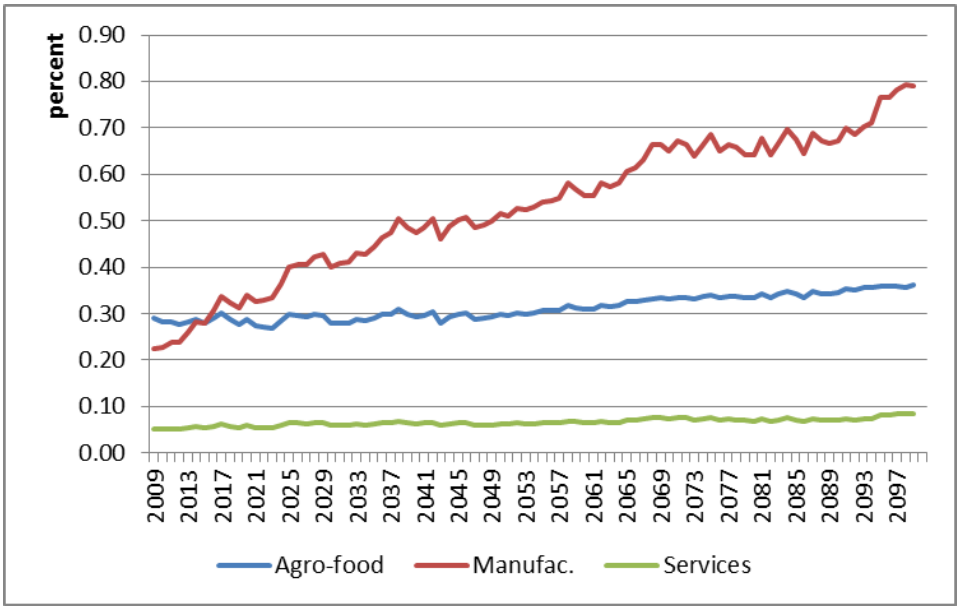


Source: Model Results

Trade liberalization does not change the contribution of sectors to trade significantly (Figure 11 and Figure 12). However, the contribution of manufacturing sector to the change in total imports starts with two percent and climbs up to eight percent. This implies that the negative contribution of manufacturing sector to the total imports decreases by 10 percent throughout the whole period. This points out the importance of the manufacturing sector for the rest of the economy to adjust the adverse effects of the climate change.

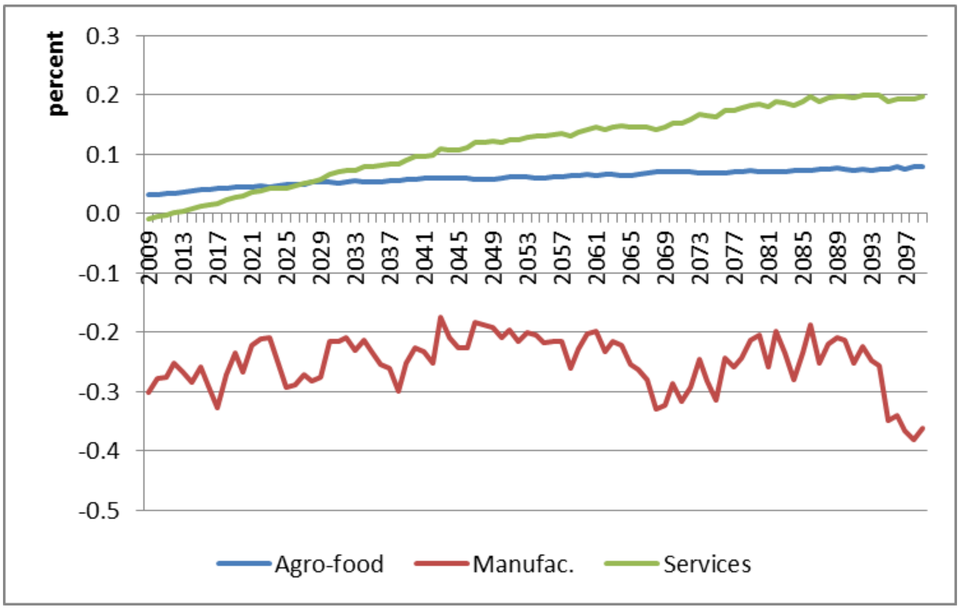
The contribution of manufacturing sector to the change in total exports decreases under trade liberalization and this effect does not follow a consistent path. The effects of trade liberalization on the contribution of agri-food imports are stable around 0.3 percent while the effect on exports is negligible.

Figure 11: Decomposition of change in value of imports under trade liberalization (percentage change from the climate change scenario)



Source: Model Results

Figure 12: Decomposition of change in exports under trade liberalization (percentage change from the climate change scenario)



Source: Model Results

To sum up, effects of climate change become significant after 2035 with declining welfare and GDP. Imports are reduced substantially while there is a boost in exports, mainly due to manufacturing sector. Trade liberalization wirth EU in agricultural commodities is likely to have a limited overall effect to alleviate the adverse effects of climate change.

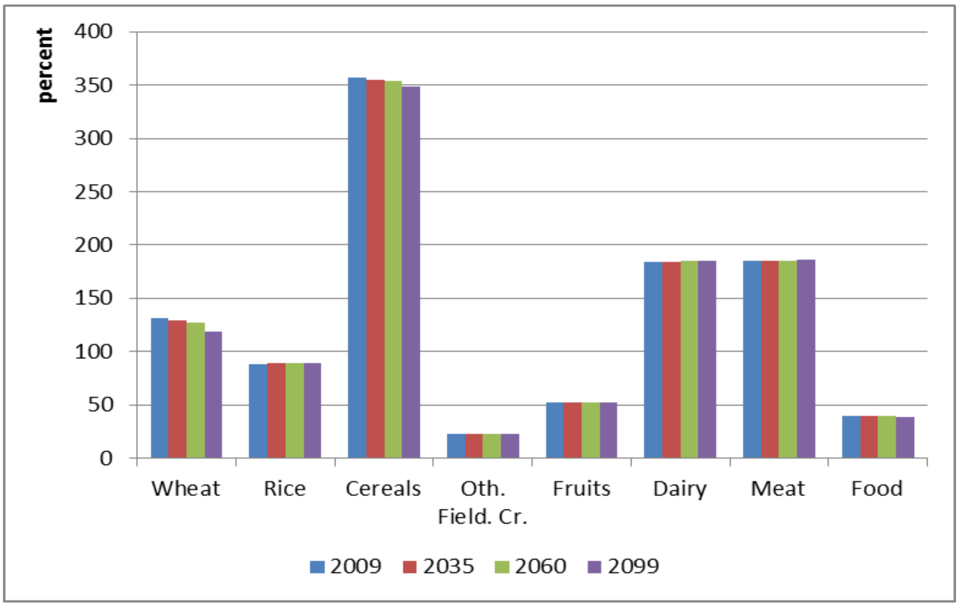
Welfare gains are positive but not significant enough to change the sign of the overall effects. On the production side, the total value added does not change much from the climate change scenario implying a limited feedback effect. The main drivers of change on the GDP are imports and consumption. The positive effect of declining imports on the GDP is reduced by the negative contribution of domestic demand under trade liberalization. Hence the effects of declining productivity in agricultural sector cannot be fully recovered with imports and this causes a decline in consumption which drags down the GDP.

4.2. Prices and Trade

The final effect of trade liberalization on imports and exports of different sectors depends on various factors. First of all, the size of the protection is the main driving factor. Trade volume of the commodities with high protection more is likely to be affected more. Secondly the final effect also depends on the production structure. Commodities which are produced less efficiently or cannot substitute different factors or intermediate inputs easily are also likely to be affected more. Another important factor is income and substitution elasticities in household demand, import supply and export demand.

Figure shows the change in imports of the selected commodities from the EU27. The variation over time is quite small. Imports of other cereals, which are heavily protected in Turkey, increase more than three times. Dairy and meat products follow with more than 170 percent increase. The increase in wheat and rice imports is around 100 percent. Food and fruit imports increase by about 50 percent. These rates are directly proportional to the amount of protection presented in the baseline. The protection on other cereals, meat and dairy is between 85 and 100 percent, while wheat, rice and fruits are protected by 30 to 40 percent. Hence, the more a product is protected, the more the increase in its imports after the trade liberalization. The standard deviation of the changes in imports is quite small (between 0 and 7) compared to the expected value.

Figure 13: Change in imports from EU27 for highly affected agricultural commodities (percentage deviation from climate change scenario)

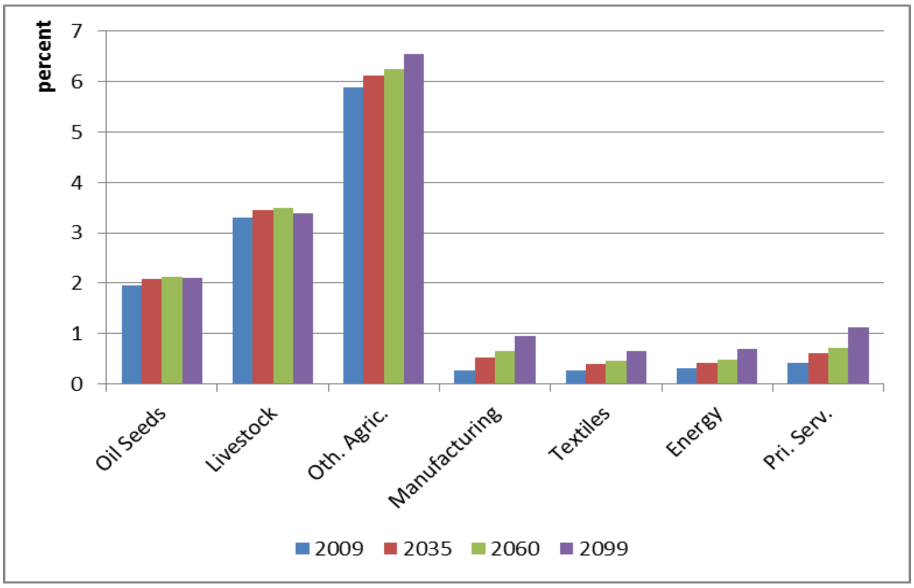


Source: Model Results

The large increase in the imports of other cereals is caused mainly as a result of the low trade level with EU27, and the trade volume does not increase much under the climate change scenario. Hence, the percentage change relative to the climate change scenario is quite high. Furthermore, production cost of other cereals is higher compared to the other agricultural products. Hence, once the import price of other cereals declines as a result of trade liberalization, cheaper imports largely substitutes domestic production. Factors of production are mostly diverted to oilseeds and maize production from the production of other cereals. A similar argument is also correct for the imports of dairy and meat products. The high percentage changes are mostly due the low level of trade under the baseline which does not change much under the climate change scenario. However, since meat and dairy sectors' main inputs are agricultural products that become relatively cheaper (see Figure 18) as a result of trade liberalization, the increase is not as high as the one observed in imports of other cereals.

Effects on other sectors are rather small (Figure 14). Relatively small effects on imports of oilseeds, livestock, and other agricultural sectors' are mostly due to low protection on these commodities (e.g. between one to two percent). Although the change in the non-agri-food sectors is not as significant as that of the agri-food sectors, they are mostly increasing. These small changes are as a result of feedback effects in the economy. Increase in household consumption due to the increasing incomes is the driving factor. Although there are slight increases in production, most of the increase in household consumption is supplied by imports.

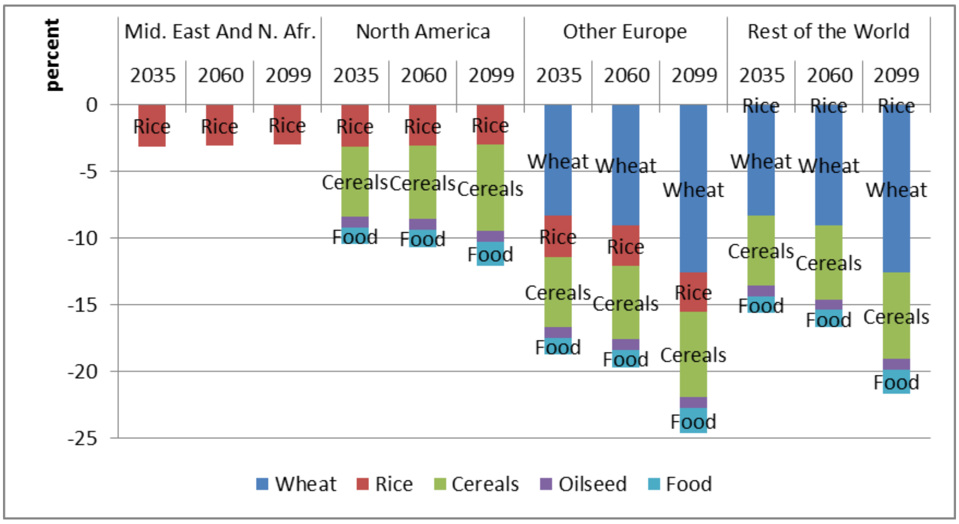
Figure 14: Change in imports from EU27 for other commodities (percentage deviation from climate change scenario)



Source: Model Results

Significant increase in the imports of agricultural products from the EU27 results in a decline of imports from other trading regions (Figure 15). This trade diversion is caused by two effects of trade liberalization. Firstly, as import prices from EU27 fall, imports from the other regions become non-competitive. Secondly, declining import prices cause domestic prices to decrease making domestic products more competitive relative to imports from other regions. Cereals, wheat, rice, other field crops and food are the most affected commodities by the trade diversion. Trade diversion becomes more evident over time especially for wheat and other cereals, both of which are significantly affected by climate change.

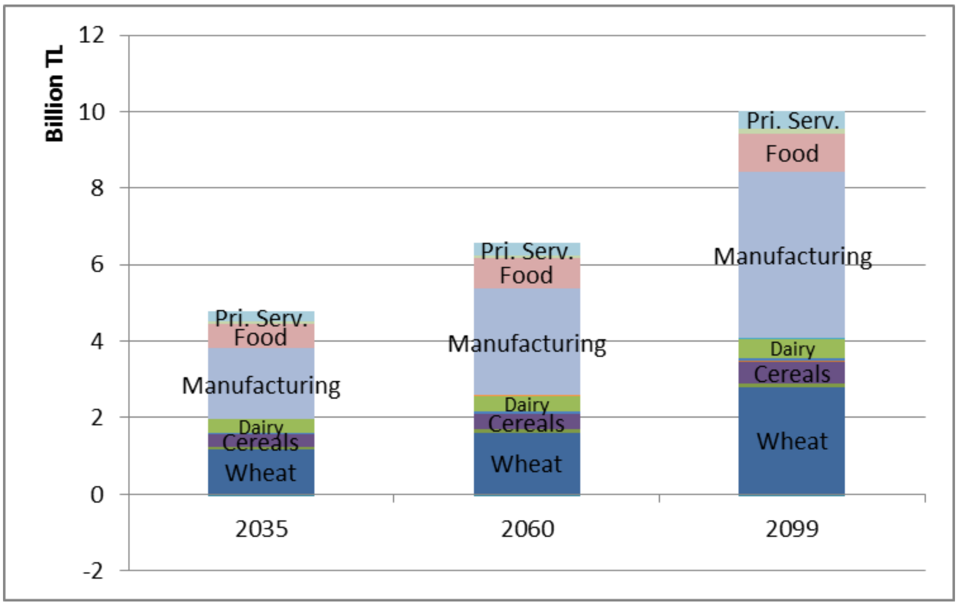
Figure 15: Change in imports from other regions (percentage deviation from climate change scenario)



Source: Model Results.

Figure shows the sectoral decomposition of the change in the imports. Contribution of services to the total imports is relatively small compared to those of manufacturing and agricultural sectors. Almost half of the increase in total imports is due to manufacturing sector in all periods. Contribution of agri-food imports is close to the contribution of manufacturing imports. The most significant contribution to total imports arises from the imports of wheat, dairy products, other cereals and food sectors. Contributions of oilseeds and maize imports are negative under trade liberalization but the negative contribution is relatively higher in the last period.

Figure 16: Change in total imports (difference from the climate change scenario, TL Billion)



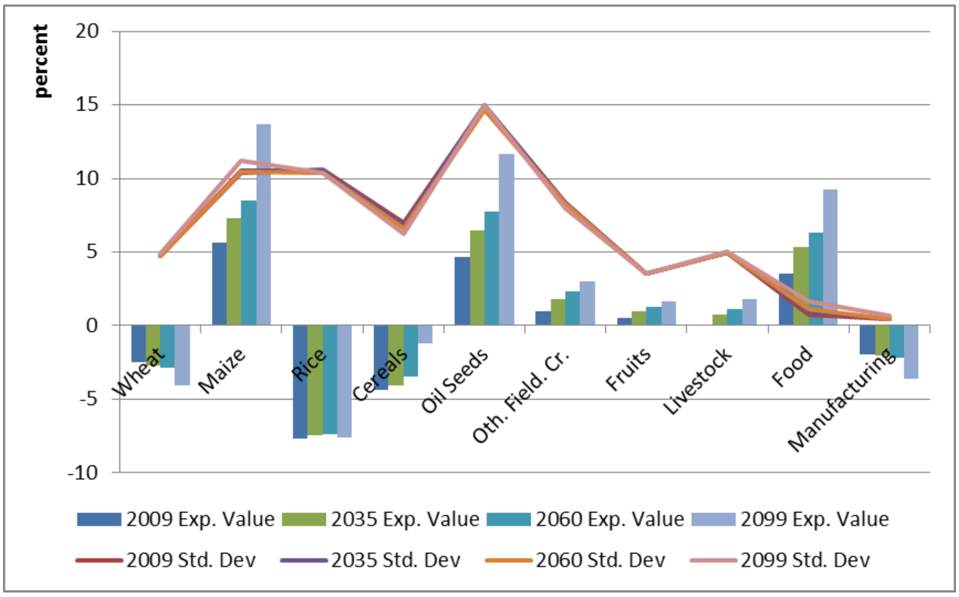
Source: Model Results

The change in exports[3] is given in Figure 17. Under trade liberalization, exports of maize, oilseeds and other field crops and food increase significantly, while exports of rice, cereals and manufacturing declines. The effects get more pronounced over time as the effect of climate change increases. The increases in the exports of maize, oilseeds, other field crops and food are mainly driven by the declining domestic prices due to the elimination of tariffs. This effect gets significant over time as climate change reduces the production of

[3] The change in exports is same for all regions due to the constant CET elasticity assumption.

these commodities significantly and causes more import substitution. Manufacturing exports decline slightly following the small increase in domestic prices. However, exports of wheat, rice and cereals decline despite the fall in their prices. Decline in exports of these commodities is due to the decreasing production. Moreover, it should be noted that the imports of these commodities increase significantly. Contrary to what is observed for the other crops, the cost structure of wheat, rice and cereals makes those less competitive compared to other agricultural activities under climate change. Eventually they cannot compete with other activities for the factors of production, especially land.

Figure 17: Change in exports (percentage deviation from climate change scenario)



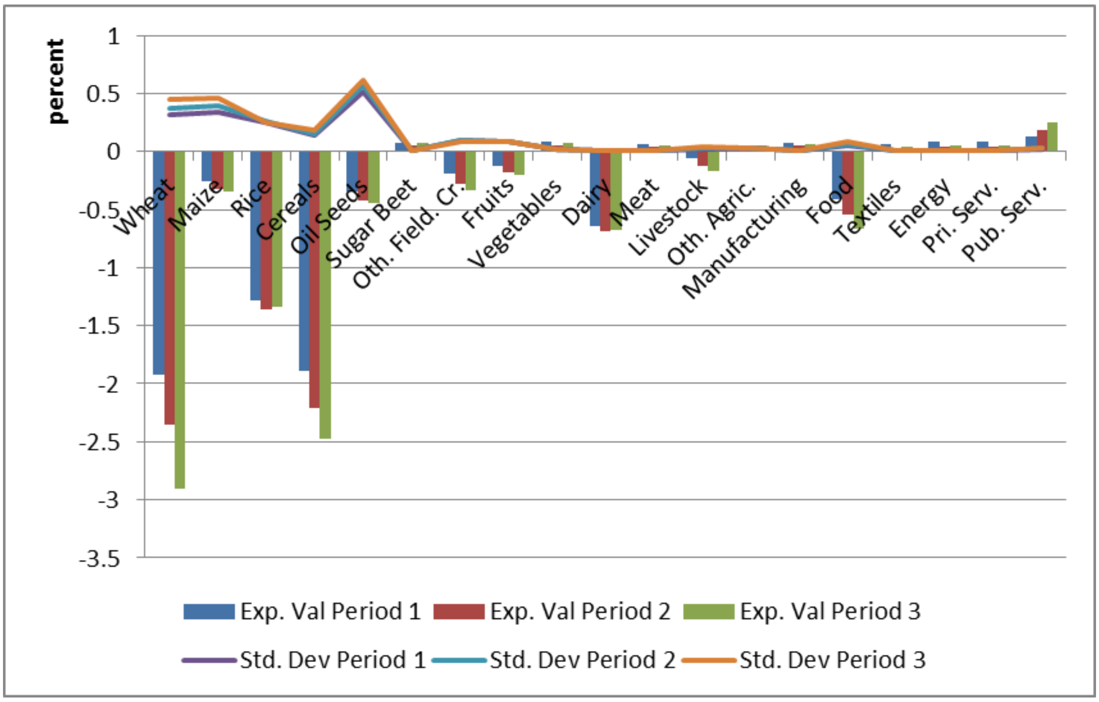
Source: Model Results.

Standard deviation of exports does not change over time but it varies significantly across crops. Standard deviation is significantly higher than what was expected for all crops, implying that Turkish exports are sensitive to the changes in world prices. Hence we can conclude that exported crops face higher climate risk.

Domestic prices can adjust depending on the market conditions dictated by trade liberalization. Households demand shifts to the imports which become relatively cheaper due to the elimination of the tariffs. Decline in demand for the domestic goods decreases the domestic prices. However, indirect effects work on the other direction. Decline in domestic prices may cause exports to become more attractive. Consequently, the final effect depends on the substitutability of the domestic commodities with the imports and demand elasticity of exports. If a commodity is not traded or has low protection then the effect is negligible, since the only impact is through income and substitution effects on household demand.

Prices decline for all agricultural commodities except sugar beet, vegetables, meat and other agriculture (Figure 18). Small positive changes in the prices of these commodities can be explained by the fact that sugar beet and meat are not traded while protection on vegetables and other agriculture is quite low. The decline in the prices of other commodities is higher over time, with the most significant changes being observed for wheat, rice and other cereals for which export demand also declines. Small changes in the prices of oilseeds, other field crops and fruits are due to increasing export demand after the trade liberalization. Prices of commodities of non-agricultural sectors also increase but the changes are negligible.

Figure 18: Domestic prices of agricultural commodities (percentage deviation from climate change scenario)



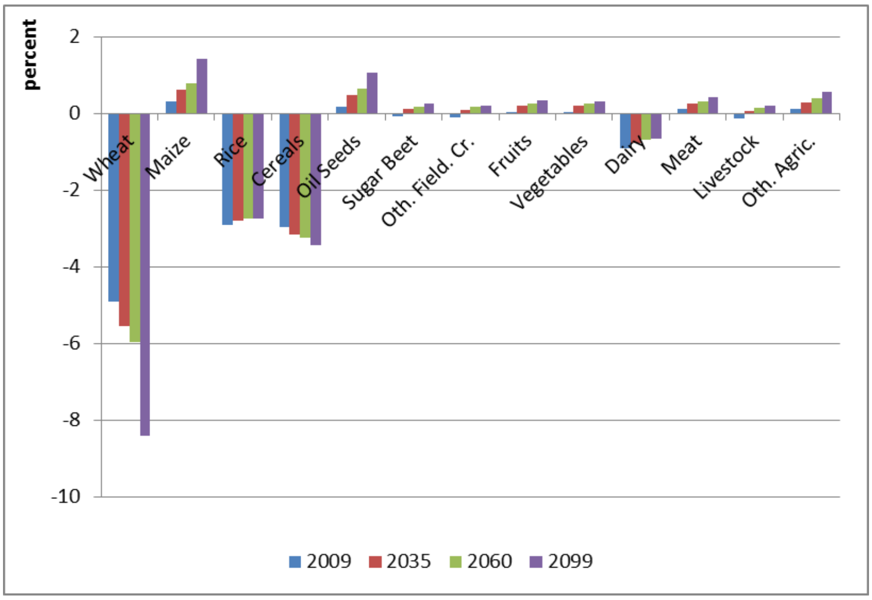
Source: Model Results

Standard deviations of the domestic prices under the different world price assumptions are higher for wheat, maize, rice, cereals and oilseeds. Low expected values and high standard deviations for maize, cereals and oilseeds prices suggest a significant variation and hence sensitivity to the changes in world prices. The standard deviations are quite low for other commodities. This implies the fact that the variations in world prices of the agricultural commodities are not transmitted to the domestic prices of the manufacturing and services sectors. This holds true even for the sectors such as food processing and textiles which have strong linkages with agriculture.

4.3. Production, Employment and Food Security

The effect of trade liberalization on agricultural production is significant (Figure 19). Cereals are generally more affected compared to the other activities. The production of wheat, rice and other cereals declines while the production of maize and oil seeds increases. Moreover, declines pertaining to the production of highly protected cereals seem to be substantial: between 2 and 4.5 per cent. In general, as effects of climate change are worsened, the declines get higher, especially for wheat.

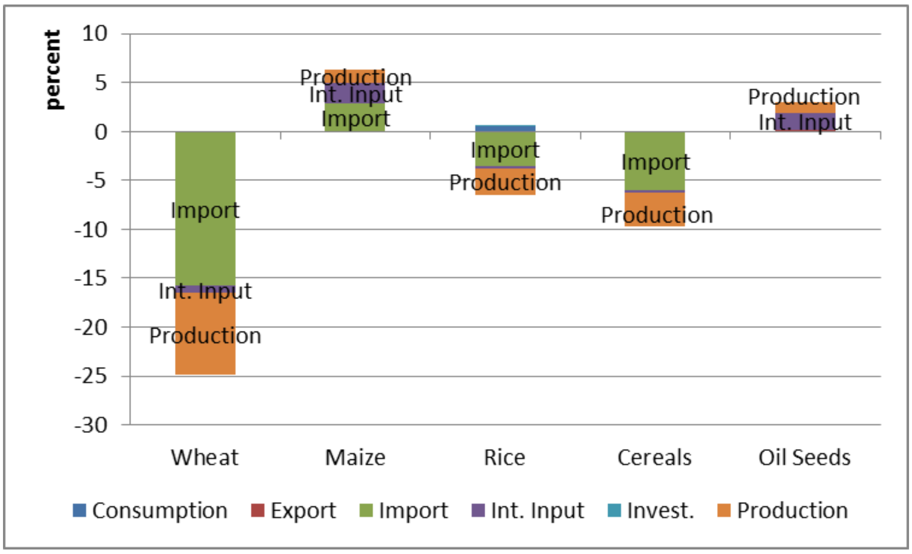
Figure 19: Change in agricultural production (percentage deviation from climate change scenario)



Source: Model Results

The main driver for the change in production is substitution of imports with domestic products (Figure 20). The contribution of production and imports on the change in the amount of composite commodity is negative for the commodities of which production declines. This implies the fact that a decline in production and increase in imports. Although one may expect export demand to increase and drag up the production, this effect remains limited.

Figure 20: Decomposition of the change in agricultural production in 2099 (percentage deviation from climate change scenario)

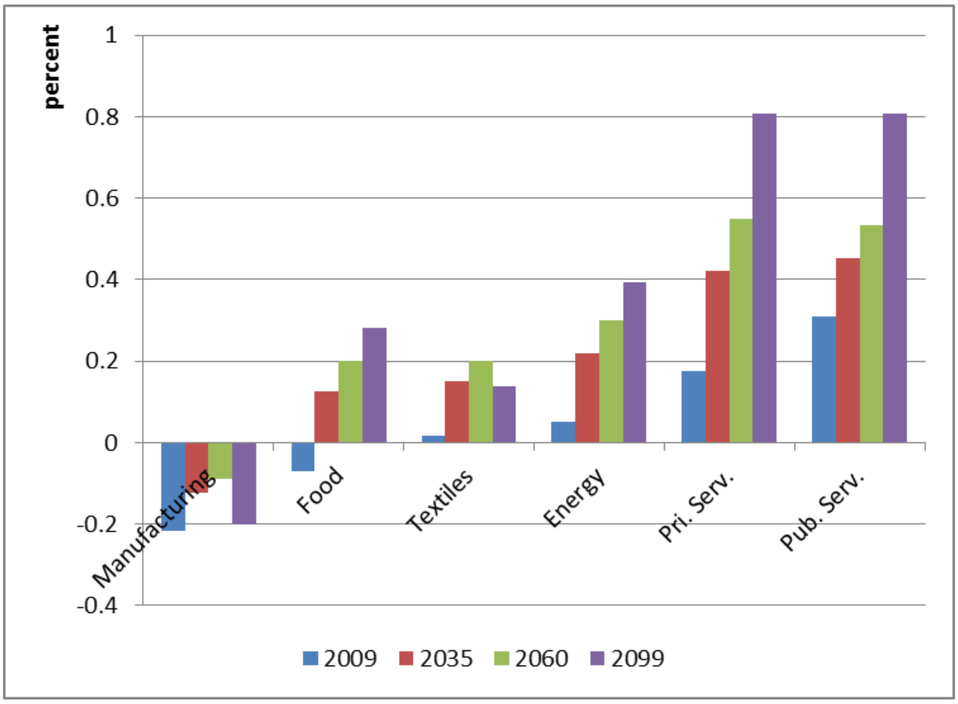


Source: Model Results

The upsurge in maize and oilseeds production is significant especially in the final period of the simulations. The main drivers of this upsurge are the substitution of domestic products with imports, and the increasing demand for maize as an intermediary input. The production of oilseeds increases due to the increasing demand as an intermediate input. Hence, the impact of trade liberalization on agriculture is quite diverse depending on the commodity, and it is determined more by the structure of production, rather than the structure of demand.

The effects of trade liberalization on the production of other commodities are small (Figure 21). The production of manufacturing products and services declines while the production of food increases. The latter is due to the fact that agricultural commodities which become relatively cheaper are the main inputs for the food production.

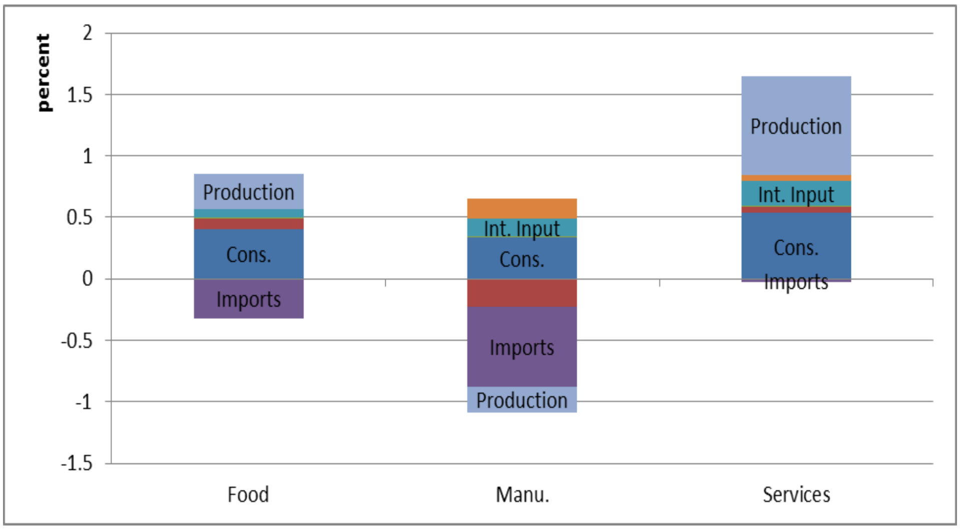
Figure 21: Change in production of non-agricultural commodities (percentage deviation from climate change scenario)



Source: Model Results

The effects on production of non-agricultural sectors are also higher in the final period. The main driver for the change in the production of manufacturing sector is also the substitution of imports with domestic products (Figure 22). Decreasing demand for exports, due to increasing relative price of manufacturing goods, also plays an important role in decreasing the production. The combined effect of these two factors dominates the positive contributions of increasing investments and intermediate input demand.

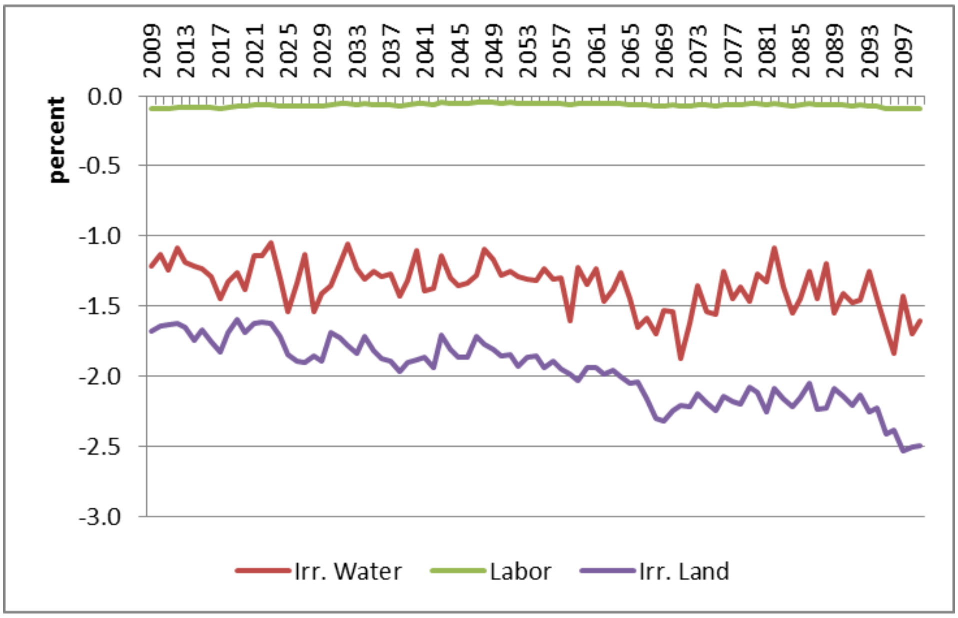
Figure 22: Decomposition of change in quantity of composite good in 2099 for non-agricultural sectors (percentage deviation from climate change scenario)



Source: Model Results

Changes in the use of factors under trade liberalization scenario are given in Figure 23. The use of capital, rainfed land and industrial water is predetermined by the closure rule which assumes a full employment for these factors. Growth in the supply of rainfed land and industrial water is determined by the growth of capital since we assume that the growth of these factors is equal to the 25 percent of growth of capital.

Figure 23: Total factor employment (percentage deviation from climate change scenario)

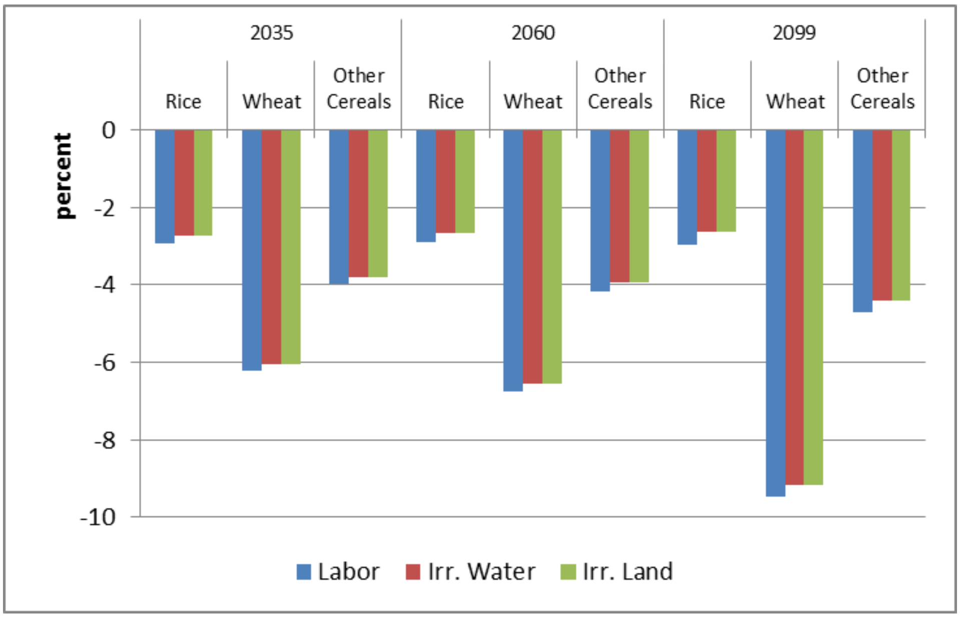


Source: Model Results

In the model, the use of irrigated land, irrigation water and labor is considered endogenous and is therefore not governed by the closure rules. Employment of irrigated land and irrigation water declines significantly under trade liberalization. The main reason for this fall is the decline in the production of rice, wheat and other cereals. As these sectors become uncompetitive under climate change due to the decreasing productivity, they substitute land and water with other factors or inputs. Consequently these factors are employed less.

Wheat, cereals and rice are the sectors that are most affected from in terms of change in factor employment. The impact of climate change on the production of these sectors is also highest. The significant decline is mostly due to the substitution of intermediate inputs with the factors of production, especially with irrigated water and irrigated land. As factors become less productive, producers change their production techniques to reduce the employment of factors. However, since the capital, rainfed land and industrial water are fully employed, the substitution occurs between irrigated land - irrigation water composite and intermediate inputs (Figure 24). Labor that is outlaid from these sectors is absorbed by other sectors which increase their production. However, irrigated land and irrigation water is mostly left unemployed.

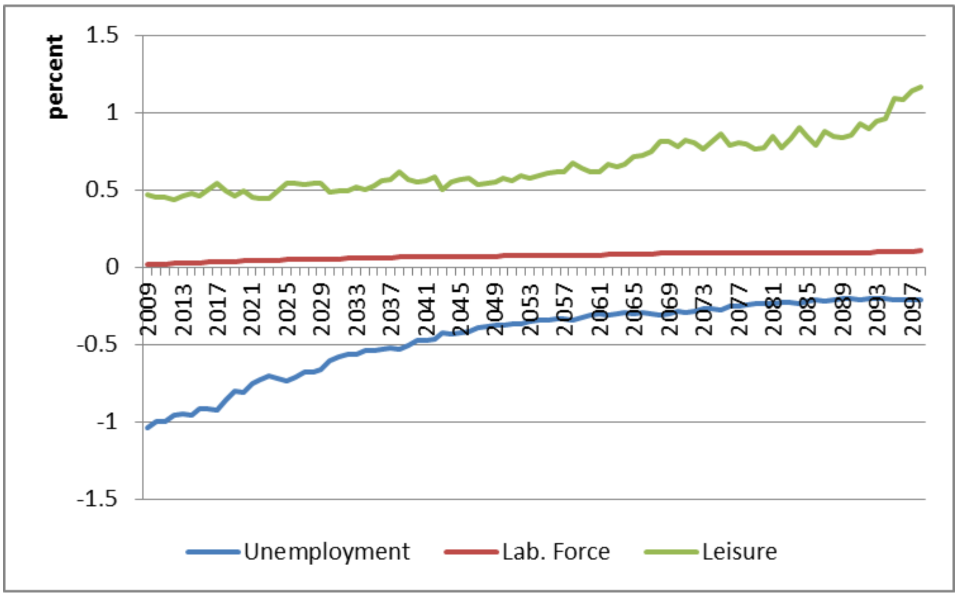
Figure 24: Factor use in selected sectors (percentage deviation from climate change scenario)



Source: Model Results

Unemployment declines at a slow pace over time (Figure 25). The reason for observing declining unemployment together with a decline in employment of labor in all sectors is mainly due to the declining labor supply by households. The labor force increases slightly as a result of an increase in real wages, however the leisure demand by households also increases, especially in the final period. This means that a significant part of the increasing population does not participate in the labor market. This also means that household will limit the supply of labor to avoid a significant decline in wages under the trade liberalization. Instead, "new comers" contributes to the household utility as leisure. Consequently, unemployment rate declines together with the employment. The increase in leisure demand is mainly due to the income effect. Actually, increase in the consumption of leisure is not higher than the increase in the consumption of the other commodities.

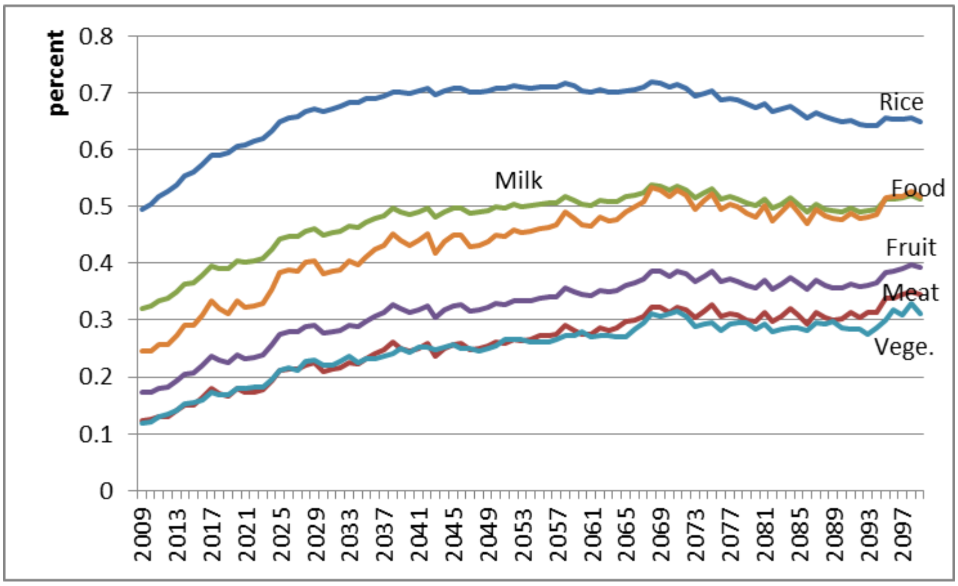
Figure 25: Unemployment, labor force and leisure (percentage deviation from climate change scenario)



Source: Model Results

Consumption increases under trade liberalization as a result of declining agri-food prices and increasing (or at least non-decreasing) household incomes (Figure 26). However the increase is not uniform across commodities. The consumption of agri-food products increases at an increasing pace in the first two periods. In the final period the increase stabilizes.

Figure 26: Trade liberalization impact on agri-food consumption (percentage deviation from climate change scenario)

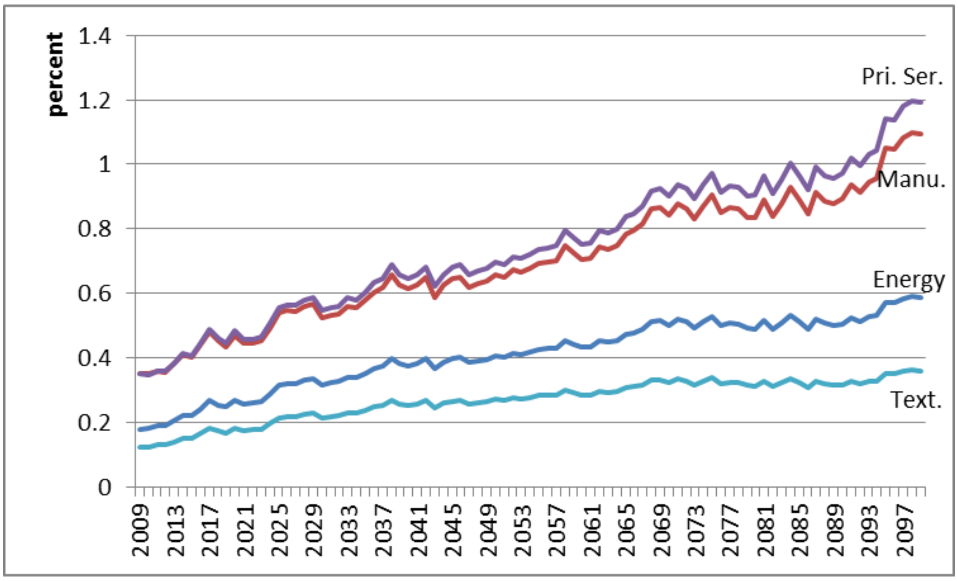


Source: Model Results

The most significant increase is in rice, meat, milk and processed food. Protection is very high in the first three of these commodities and thus tariff elimination causes their prices to decline significantly. Therefore household demand for these commodities increases significantly following the trade liberalization. On the other hand, price of processed food declines due to the the declining costs of this sector as the price of the main intermediate inputs of this sector, e.g. agricultural commodities, declines.

The consumption of manufactured goods and services maintain their increasing pace even in the final period (Figure 27). Manufacturing and services constitute almost 60 percent of the total consumption; hence the increase in their consumption is normal despite the slight increase in their prices. Lastly, the increase in the consumption of energy and textile commodities starts at a much slower pace and almost stabilizes at the end of first period.

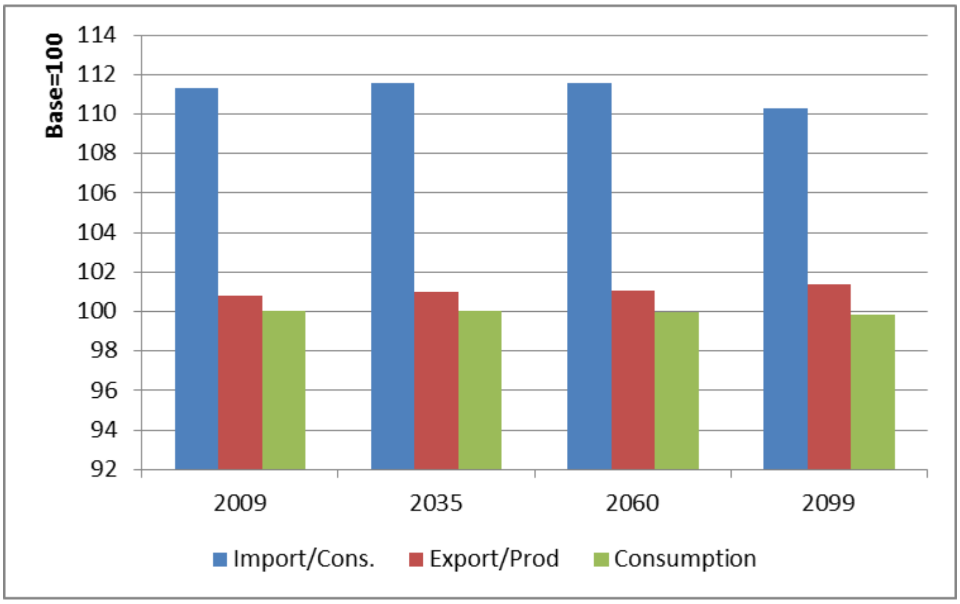
Figure 27: Trade lib. Impact on non-agrifood consumption (percentage deviation from climate change scenario)



Source: Model Results

Increasing food consumption ensures the availability of more food for the population and can be considered as an indicator of increasing food security (Figure 28). Net exporter position of Turkey in food in the baseline does not change much under trade liberalization. The ratio of food exports to imports declines to approximately 1.45 in the first two periods, and to 1.20 in the second period as compared to the 1.60 and 1.3 in the climate change scenario. As mentioned above, this is mainly due to a higher increase in food imports compared to the food exports. The share of imports in consumption increases and larger part of the production is exported. However the difference between the value of imports and production, and the values of exports and consumption also increases. This leaves more intermediate inputs for the food industry and hence improves food security.

Figure 28: Food security indicators (percentage deviation from climate change scenario)



Source: Model Results

5. Conclusion

In this paper we analyzed the effects of elimination of tariffs imposed on agricultural imports from EU under a climate change. For this purpose we simulated climate change and trade liberalization scenarios, by taking into account possible effects of climate change on world prices. The results show that climate change can cause a GDP loss as high as 3.5 percent. Main drivers of the loss in GDP due to climate change are the significant decline in private consumption, and up to two percent increase in imports.

Elimination of tariffs on imports from EU alleviates the negative effects of climate change only marginally for Turkey as is the case for many other regions in the world. The increase in welfare due to trade liberalization is very small compared to the loss caused by climate change. However, benefits from trade liberalization increases as the climate change effects worsen, especially after 2060. This is due to the fact that under trade liberalization the economic agents have more substitution possibility both in production and consumption.

Main adjustment mechanism of the economy under trade liberalization works through the substitution intermediate goods with factors of production, as well as substitution of domestic goods with imported goods. This causes significant changes at the sectoral level. Wheat, rice and cereals are the most affected commodities from trade liberalization, under climate change. They lose competitiveness against alternative commodities both in domestic and international markets, since the climate change reduces their yields substantially. Their production, exports and prices decline simultaneously and substitution of domestic production with imports is highest in these commodities.

Maize, oilseeds, fruits and processed food benefit from trade liberalization. Their production and exports increase, domestic prices decline while imports remain unchanged or increase slightly. Factors of production are directed towards the production of these commodities as they become relatively more competitive after the climate shocks.

Imports from the EU27 countries increase significantly and this causes domestic prices to decline in the trade liberalization scenarios. Consequently, production of agricultural commodities falls. Since the decline in domestic prices is lower than the tariffs imposed to the other trading regions, prices of agricultural imports from the other regions increases. This causes aggregate imports to decline. Hence, trade liberalization with EU causes an "overcrowding" effect and decreases imports from other trading regions. Food consumption increases under trade liberalization. As a result, trade liberalization increases food security.

The findings from the simulation exercises suggest that although overall welfare effect of trade liberalization is limited, it increases the economy's ability to adapt by fostering reallocation of scarce domestic resources to more efficient sectors. This occurs as imports and domestic commodities become more substitutable.

The analysis in this study provides several paths for the improvement of the model's structure and scenario design. For instance, other countries will also be affected by the climate change, and this is likely to be reflected in their demand for Turkish commodities and their supply of commodities to Turkey. This can change the implications of climate change and trade liberalization for Turkey. Secondly, bilateral trade liberalization with the EU is not the only policy option for Turkish policy makers. Trade liberalization with the other countries/regions can have amplified effects. Lastly, analysis in this study uses the results of only one GCM to calculate the economic shock parameters; however various estimates by different GCMs are available. The results can be altered by different climate change scenarios reported by different GCMs.

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