Water Embedded in Turkey's Agricultural Trade Products

Elif Akbostancı*, G. İpek Tunç*, Serap Türüt-Aşık*

*Middle East Technical University, Department of Economics

Abstract

Recently share of agriculture in GDP is gradually descending through time all over the world. However, agriculture still continues to be one of the crucial sectors for human survival. Another vital feature of the sector is that it is the main user of water resources, and its water footprint is significant. Water is one of the resources that become scarcer through population increase, rising standards of living, the diet and lifestyle changes, pollution and climate change. For these reasons lately virtual water flows of agriculture is discussed. Virtual water is defined as the volume of water embedded in the production of an item. This concept and its empirical applications are mostly related to the production of agricultural commodities as water is mainly used by agricultural activities. These agricultural activities include crops, live animals and livestock products. A direct application of neoclassical trade theory when water is considered a scarce factor of production is that water-rich countries should produce and export water-intensive commodities to water-scarce countries. However it is also true that the virtual water trade flows are determined by a number of factors like production technologies, domestic and international prices, trade barriers and quantity of available land; besides water endowments.

Our study concentrates on trade of agricultural products by calculating virtual water flows of Turkish agricultural trade for 324 products and 194 trade partners for the years 2006-2012. Turkey's consumable water estimates show that Turkey would be among the countries having water scarcity problems in 2030. Considering the present growth rate of the economy together with the changes in water consumption habits will exert pressure on water resources in the future. Since agriculture sector is one of the main consumers water looking into virtual water flows of agricultural trade will be crucial in determining sustainable water policies.

Introduction

All over the world even though the share of agriculture in GDP is low and plummeting through time, agricultural sector is still the main user of water resources, and its water footprint is significant. Water is one of the resources that become scarcer through population increase, rising standards of living, the diet and lifestyle changes, pollution and climate change. Since water is too heavy to be profitably transported among countries, direct water trade cannot be a solution to water scarcity problems. This lets the scholars, especially Allan (1997, 1998) to deal with the problem by making use of the “virtual water” concept (Debaere, 2014). Virtual water is simply defined as the volume of water embedded in the production of an item. Similarly, the notion “virtual water trade” is used to mean “water content of trade”.

This concept and its empirical applications are mostly related to the production of agricultural commodities as water is mainly used by agricultural activities. These agricultural activities include crops, live animals and livestock products. International trade of agricultural commodities lets the countries virtually export or import the water used for the production of those items. If water is considered as a factor of production a direct application of Heckscher-Ohlin theorem suggests that water-abundant countries should produce and export water-intensive commodities to water-scarce countries (Hoekstra and Chapagain, 2008).

The virtual water trade flows are determined by a number of factors like production technologies, domestic and international prices, trade barriers and quantity of available land; besides water endowments.

In the literature there are numerous studies on virtual water trade. Therefore, one can refer to Chapagain and Hoekstra (2004), Hoekstra and Hung (2002), Hoekstra and Hung (2005), and Hoekstra and Chapagain (2008) as some of the most cited global studies on the subject.

Our study concentrates on trade of agricultural products by calculating virtual water flows of Turkish agricultural trade for 324 products and 194 trade partners for the years 2006-2012.

Agricultural Policies in Turkey

Import substitution policies of pre-1980 period were supporting small farm production in accordance with the domestic market oriented accumulation model. The crisis of this accumulation model towards the end of 1970s led Turkey to adopt export-led growth strategy. According to this strategy Turkey abandoned the policies supporting small farm production which brought dispossession of peasantry and reduction of rural population (Oral et al., 2015). In accordance with the demands of international capital, as a cure for the economic crisis, Turkey launched a stability program on 24th January, 1980 entrenched by the military coup in the same year. The basic agricultural policy of the stabilization program was to eliminate small scale farm establishments and constitute large scale enterprises instead. In line with this basic aim, the monopoly of the public sector in the provision and distribution of basic agricultural inputs was given an end, pricing and support purchasing functions of the government were abandoned substantially, and the industry based on agriculture was entirely left to private sector (Oral et al., 2015; 76-77).

As another component of the stabilization program, foreign trade was liberalized. Therefore, in addition to the liberalization of the seed and fertilizer prices, their trade was also liberalized. Annual average change for domestic trade margin was 2.99 for the period 1968-1978 and it became -3.70 for the period 1978-1988 (Boratav, 2015; 55). Also, the share of agriculture in GNP has declined from 24.2% in 1980 to 16.3% in 1990. Import of agricultural products has increased extensively during 1980s which was negligible in the pre-1980 period. Import was concentrated on cereals and oil seeds (Oral et al., 2015; 79). The policies in line with export oriented growth model were facing with problems and also the employees gained real wage increases. Agricultural price support mechanism became important once more and domestic trade margin improved during this period (Oral et al., 2015; 80). Annual average change for domestic trade margin was calculated as 4.68 for the period 1988-1998 by Boratav (2015; 55).

The economic model faced with the crisis at the beginning of 1994. As a cure for the crisis the government implemented a stabilization program aiming to decrease wages, salaries and agricultural supports, to reduce budget deficit, and to limit the economic role of the government especially in terms of goods and services production. The repercussions of this program in the agriculture sector were such that; world prices will be taken into account in determining domestic support prices, only cereals, sugar beet and tobacco will be supported, agricultural input subsidies will be limited and privatization of agricultural public economic enterprises will be completed (Oral et al., 2015; 80). Therefore, the privatization of most of the public enterprises in the agricultural sector was realized immediately.

The crisis in the economy continues and in December 1999 Turkey signed a stand-by agreement with IMF which is considered as one of the milestones in agricultural policies in Turkey

(Oral, 2015; 424). This agreement which includes a reform package in agriculture aims to have a radical and rapid structural change in this sector (Oyan, 2015; 115). In accordance with this structural change package, “direct income support” system was initiated as a pilot study which would take place of the existing support policies and then extended to cover all of the country; support prices were determined by taking into account the world prices and the target inflation rate; credit subsidies provided by the state banks were abolished; and input subsidies were abolished gradually (Oral et al., 2015; 82). This direct income support system existed for only seven years and was abolished at the end of 2007 because of the increased inequalities in agricultural sector (Oyan, 2015; 122-123).

As a result of all these policies, the agricultural land area has decreased, investments in irrigation has dropped, and the prices of inputs like fertilizers has increased extensively. On the other hand the price increases in terms of agricultural products were most of the time less than those of the inputs. The number of producers in agriculture has declined and also most of the agricultural goods production has either decreased or stayed the same. Similarly, these policies have led the animal stock to decrease by leading to sharp rises in meat prices (Oral, 2005; 425). Therefore, importation of live animals and meat has been initiated which has negatively affected domestic production and animal husbandry.

All these developments in the agriculture had an impact on the composition of international trade in addition to the important increases in the share of industrial products’ exports. Until 1980s the share of agricultural products in Turkey’s exports has never fallen below 50%. This number has declined to around 3% in 2013. Until 2000s a trade surplus was observed in agricultural sector. However, there is an increasing amount of trade deficit since the second half of 2000s (Şengül and Sarıbal, 2015; 136).

Agriculture and Trade in Turkey

In Turkey, similar to general trend in the world, share of agriculture in GDP is decreasing. Especially after mid-1980s share of agriculture decreased to less than 20% of GDP and to less than 10% by the end of 2000s. Parallel to the changes in the shares of agriculture in GDP, share of agriculture in foreign trade has also declined. Share of agriculture has declined from 50% to 3% in total exports during 1980-2013; whereas its share in total imports has increased from 1% to 3%

during the same period (TÜİK web site).

Since 1980s a structural change has been observed in agricultural trade. This is apparent when we consider the subgroups in agricultural trade data. According to ISIC Rev. 3, there are 5 subgroups: agriculture and husbandry, forestry, fishery, food and beverages and tobacco. In terms of agriculture and husbandry there is trade surplus until 2000s. Since then deficits have been observed in this subgroup. But if we take into account the total of these 5 subgroups, we observe that exports are higher than imports. On the other hand by using SITC Rev. 3 data we can observe the changes in the components of agricultural trade in terms of food items and agricultural raw materials. Since 1980s, there is a continuous increase in the exports of food items which closed the total agricultural product trade deficit and led to a surplus. The basic subgroup that affects and determines the foreign trade values is “food and beverages” (Aydın, 2009).

After 1980s a division of labor is emerged between capital intensive and labor intensive agricultural products. According to this division of labor, developed countries are to produce and export more capital intensive and “lower valued” products like cereals and developing countries are to produce and export exotic products, fruits, vegetables and flowers which are more labor intensive and “higher valued” products. Increasing share of fruits and vegetables in Turkey’s exports fit into this scenario and verify the aforementioned division of labor. That is, Turkey is exporting food items by using low technology and labor intensive techniques (Aydın, 2009).

Although there is surplus in agricultural consumption goods trade, there is deficit in agricultural raw materials trade. This points out to the fact that the increase in total agricultural exports is also leading to an increase in imports.

The existing problems, i.e., growth in agricultural production lagging behind population growth, deficiencies in agricultural infrastructure especially irrigation, and global warming may lead to further increases in deficits of agricultural raw materials.

Water Resources and Water Consumption Patterns in Turkey

The demand for water resources has been accelerating all over the world. Especially, population growth, climate change, changing structure of agricultural and industrial production, improved living standards and increase in tourism activities cause water-based problems to accelerate among countries.

Water, like for all other nations, is a vital natural resource for Turkey. Due to increasing population, socio-economic development, pollution and pressures about international political conflicts the water problem of Turkey has been growing.

The potential water resources of Turkey are 112 billion m^3 per year. Of this, 87.5% is surface water and 12.5% is groundwater. 44 billion m^3 of this potential is used (DSİ 2010a). There are differences in both water potentials and distribution of precipitation according to seasons in the water basins. Thus, there is water insufficiency linked to the basins and seasons.

According to Tenth Development Plan (TC Kalkınma Bakanlığı, 2013), 16% of this amount is allocated to domestic use (municipalities), 11% is used in industry and 73% is used in agriculture (irrigation + livestock). These percentages are 11%, 59% and 30%, respectively, for developed countries and 8%, 10% and 80% for developing countries.

In Turkey while per capita daily water consumption was 98 liters in 1980, it increased to 192 liters in 1990. At present that figure is 200 liters on average (DSİ 2010a). Some studies estimate that number as 270 liters/day (DSİ 2010b).

Turkey's total water footprint and per capita water footprint are given as 107.95 Gm^3/ year and 1615 m^3/year, respectively. On the other hand these numbers correspond to 7452 Gm^3/year and 1243 m^3/year, globally. Therefore, Turkey's share in global water footprint is about 1.44%.

The sufficiency of water resources in a country is evaluated by the amount of annual fresh water consumed: countries which consume less than 500 m^3 of water per capita annually are regarded to have absolute scarcity while those countries which consume 500-1000 m^3 are regarded to have scarcity, 1000-1700 m^3 are called to have water stress and those countries which consume more than 17000 m^3 are regarded as countries with no water stress. In Turkey annual per capita usable water potential is around 1519 m^3 which classifies Turkey among countries facing water stress (Brown and Matlock, 2011). It is forecasted by TÜİK that the population of the country will reach 100 million by 2030. Therefore, due to economic and population growth and changing water consumption habits this number is expected to fall much more in the near future by placing Turkey among water-scarce countries. Using this estimate, it could be argued that consumable amount of water would fall to 1100 m^3 in 2030 which will put Turkey among countries having water scarcity problems (T. C. Kalkınma Bakanlığı, 2013). Therefore, it is clear that considering the present growth rate of the economy together with the changes in water consumption habits will exert pressure on water resources in the future. To satisfy the increasing water demand in agriculture, industry and drinking water an effective future planning is necessary.

Theoretical Background

Virtual water concept was first developed by Allan (1997, 1998). It is defined as the water needed to produce a product. It is not the same as the water actually used. As the concept of water need is hypothetical in nature and therefore difficult to handle, in the relevant literature actual water volume used is considered instead (Hoekstra and Chapagain, 2008). Similarly, virtual water content (m^3/ton) of a product is the volume of water used to produce it, measured at the place where it was actually produced. The term “virtual” refers to the fact that most of the water used in the production is ultimately not contained within the product. The real water content of products is generally negligible compared with the virtual water content. Imported virtual water (exogenous water) becomes an alternative water source in addition to endogenous water sources.

On the other hand, water footprint concept (Hoekstra and Hung, 2002) shows the water use related to consumption within a nation. It shows not only freshwater use within a country, but also fresh water use outside the country’s borders. It refers to all forms of freshwater use that contribute to the production of goods and services consumed by the inhabitants of a certain country. Conversely, the water footprint of a nation excludes water that is used within the national borders for producing commodities for export, which are consumed elsewhere.

The water footprint of a nation has three components: blue, green and gray water use. Blue water use refers to the use of ground or surface water. Green water use refers to the use of rainwater, which is the precipitation water that infiltrates into the soil. Lastly, gray water use refers to water use as a result of pollution. Hoekstra and Chapagain (2008) quantify this gray water footprint by estimating the volume of water needed to dilute a certain amount of pollution such that it meets ambient water quality standards. Among these three types of water use, it is green water that sustains growth and productivity on earth and responsible for most of the water consumption in agriculture (Gerten et al., 2011; Yang et al., 2013).

Related to international trade of commodities, a water-scarce country can preserve its domestic water resources by importing a water-intensive product instead of producing it domestically. By this way this country can save its domestic water resources. In addition to national water saving, international trade can save water globally when a water-intensive commodity is traded from an area where it is produced with high water productivity (low water input per unit of output) to an area with lower water productivity (high water input per unit of output). On the other hand, if a water-intensive commodity is traded from an area with low water productivity to one with high water productivity, then we face a global water loss.

Virtual water content is estimated according to the following formula (Hoekstra and Chapagain, 2008; 10):

$$Virtual\ water\ content\left(\frac{m^3}{ton}\right) = \frac{crop\ water\ use\ at\ field\ level\ (\frac{m^3}{ha})}{crop\ yield\ (\frac{ton}{ha})}$$

In the above equation, the crop water use depends on crop water requirement and actual soil water available. Crop water requirement is the total water needed for evapotranspiration under ideal growth conditions, measured from planting to harvest. “Ideal conditions” means that adequate soil water is maintained by rainfall and/or irrigation so that it does not limit plant growth and crop yield. On the other hand in terms of actual soil water available, soil water is replenished either naturally or artificially through irrigation water.

Actual water use by the crop is equal to the crop water requirement if rainwater is sufficient or if shortages are compensated through irrigation. In the case of rainwater deficiency and the absence of irrigation, actual crop water use is equal to effective rainfall.

In terms of the water footprint data used in this study actual water use is assumed to be equal to the crop water requirement, since irrigation data specified per crop per country are not easily available. For calculating crop water requirements one needs various climate and crop data.

When a primary crop is processed into a crop product, there is often a loss in weight, because only a part of the primary product is used. In such a case, virtual water content of the processed product is calculated by dividing the virtual water content of the primary product by the product fraction. The product fraction denotes the weight of crop product in tons obtained per ton of primary crop.

The virtual water content of live animals can be calculated based on the virtual water content of their feed and the volumes of drinking and service water consumed during their lifetime. In general, livestock products have a higher virtual water content than crop products. A live animal consumes a large amount of feed crops, drinking water, and service water in its lifetime before it produces some output. The higher we go up in the product chain, the greater will be the virtual water content of the product. The virtual water content of products varies greatly from place to place, depending on the climate and on technology adopted for farming and corresponding yields.

Virtual water flows between countries (m^3/year) can be calculated by multiplying commodity trade flows (ton/year) by their associated virtual water content (m^3/ton). The major share (61%) of the virtual water flow between countries is related to international trade in crops and crop products. Trade in livestock products contributes 17% and trade in industrial products 22% (Hoekstra and Chapagain, 2008; 22). International virtual water flows are substantial and likely to increase with continued global trade liberalization.

International trade in agricultural products depends on: differences in availability of land, labor, knowledge and capital; differences in economic productivities in various sectors; and existence of domestic subsidies, export subsidies, or import taxes in the trading nations. Additionally differences in water endowments of the trade partners could be a major factor. Virtual water trade literature investigates this issue.

Literature Survey

Since the first half of 1990s, there is a growing literature in relation to “virtual water” on conceptual basis and virtual water trade. The idea of virtual water trade owes to Allan (1997, 1998). He refers to a number of economic concepts within the HOV paradigm. The idea of virtual water trade has created a lively debate by leading to a controversy among economists although the concept itself did not originate within the economics literature (Reimer, 2012; 135). Antonelli and Sartori (2015) provide a critical review of the concepts of virtual water and virtual water trade.

Ansink (2010) states that most studies have in fact mixed up the concepts of relative and absolute scarcity. He argues that there are two prominent but incorrect claims on virtual water trade stating that virtual water trade levels uneven water distribution and it reduces the potential for water conflicts. His results show that both claims only hold under certain conditions, but do not necessarily follow from the Heckscher-Ohlin model.

Reimer (2012) tries to show that the concept of virtual water trade has a great deal of legitimacy when viewed from the perspective of standard international trade theory. According to him virtual water trade flows can be conceptualized as the international exchanges of the services of the water embodied in traded goods, which can be named as the factor content of trade. He further claims that any weak evidence in relation to the importance of water as a determinant of trade is not due to weak theoretical support as suggested by Ansink (2010) but due to deviation of real world situations from the assumptions of the standard trade model.

According to Debaere (2014) most of the studies are outside the realm of economics as they do not contain notions like opportunity cost of water or comparative advantage. He points out to the fact that a country's trade not only contains water but also contains capital, labor and other factors of production. Utilizing the cross-sectional data for 134 countries and 206 sectors, Debeare (2014) presents empirical evidence in favor of the hypothesis that water is a source of comparative advantage in trade. The factors included in the analysis are water, capital, land and high-skilled work. Although the impact of water on export patterns is less important than that of other factors of production, water abundant countries export more water-intensive goods.

As mentioned in Fracasso (2014) the determinants of virtual water trade flows do not depend only on water endowments, but also on factors such as production technologies, domestic and international good prices, trade barriers etc. In this respect it is important to make use of the gravity model of trade which forms a link between product trade flows to the mass of the trading countries, their geographical distance and other explanatory variables

Gravity model of bilateral trade was initially introduced by Tinbergen in 1962. According to this model, trade is determined by indicators of country size (GDP, population and land area) and of the distance between the pair of countries in question (physical distance as well as dummy variables indicating common borders, linguistic links and cultural similarities) (Frankel and Rose, 2005). This relationship resembles the law of gravity in physics meaning that attraction is larger between larger and more closely placed bodies. Its implication in terms of the trade theory is that, trade increases with size and proximity to trade partners. Through time, the simple gravity model is extended to include variables like population, adjacency, common language and colonial links, remoteness and border effects to the model.

The studies which use gravity model in relation to virtual water trade are not much. One of them is Konar and Caylor (2013). Their study covers Africa by employing a simple model searching the empirical evidence on the relationship between virtual water trade, population growth, and human development. They find that increased virtual water imports increase human welfare. Also they show that levels of undernourishment tend to decrease with increased values of virtual water trade openness. Although the positive relationship between crop exports and crop water use efficiency does not hold for Africa, internal African trade is much more efficient in terms of embodied water resources than any other region in the world.

Another gravity study is done by Tamea et al (2014) for Italy covering the period 1986-2010. Population, distance and GDP are found to be the major drivers of virtual water fluxes.

Fracasso (2014) uses cross section data of 145 countries for the year 2006. Besides the classical determinants of trade, national water endowments and the level of pressure on water resources are found to affect virtual water trade flows. The findings suggest that the water content of the bilateral trade of agricultural products do not present the paradoxical result of the previous studies, that is, water scarce countries tend to export the services of water towards water rich nations.

Fracasso et al. (2015) search the main determinants of bilateral virtual water flows in agricultural goods trade across the Mediterranean basin. Using gravity model of trade the authors include both classical water and land endowments and socioeconomic variables such as per capita GDP, irrigation water price, agricultural tariffs and number of tractors in their analysis. Their findings suggest that larger water endowments do not necessarily lead to a larger export of virtual water. They also find some evidence that higher water irrigation prices reduce virtual water exports and increase virtual water imports.

In the virtual water flow literature, in depth studies on specific countries or regions are on the rise. Garrido et al. (2010) and Duarte et al. (2014) for Spain, Zeitoun et al. (2010) for Nile Basin, Ercin et al. (2015 for France, Dang et al. (2015) for USA, and Chen and Li (2015) forMacao, China. Therefore, our study contributes to the literature by specifically analyzing the virtual water trade for Turkey where water resources are being depleted due to factors like pollution, extensive use of water for irrigation and building many hydroelectric dams on the rivers.

Data and Estimation

Trade data set is retrieved from FAOSTAT database and covers 2006-2012 period, 324 products and 194 trade partners. Estimates of country specific virtual water content for agricultural products are provided by Mekkonnen and Hoekstra (2011). Agricultural trade flows (ton/year) are multiplied by the relevant country and crop specific virtual water contents (m^3/ton). For virtual water, total of green and blue water values are used.

Our initial findings are summarized in Figure 1 where total virtual water flows for 324 agricultural products and 194 trade partners are shown. The virtual water trade balance of Turkey gives a deficit in total, and it grows to a large extent from 2006 to 2012.

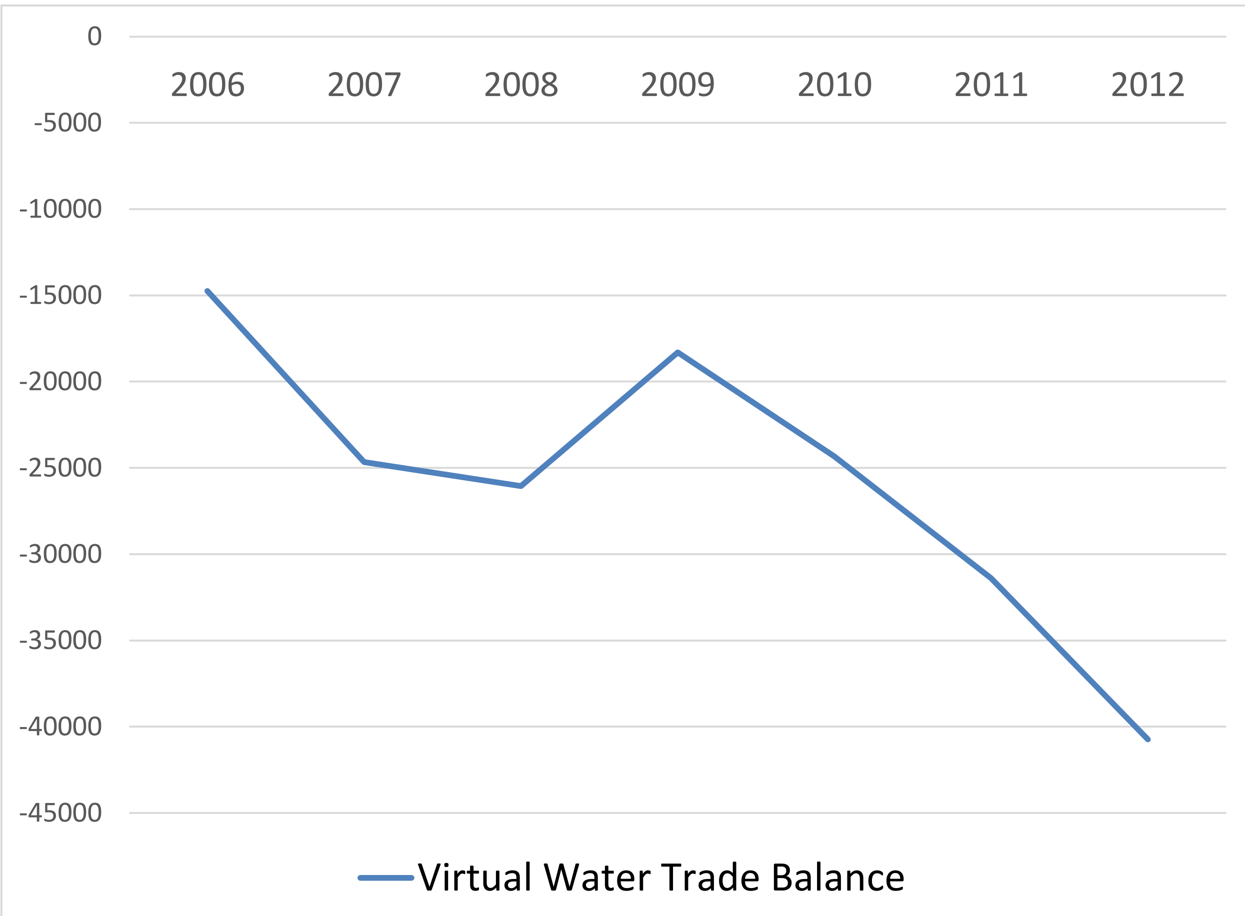

Figure 1 Virtual Water Trade Balance

When we consider countries in which virtual water trade balance gives a positive balance we see that the top ten countries are; Iraq, Libya, Saudi Arabia, Syrian Arab Republic, Israel, Algeria, Cyprus, United Arab Emirates, Iran, Azerbaijan. Figure 2 presents Turkey's virtual water flow balance with these countries. It is apparent from Figure 1 that trade with Iraq has the highest virtual water flow surplus and this surplus tends to increase through time to a large extent.

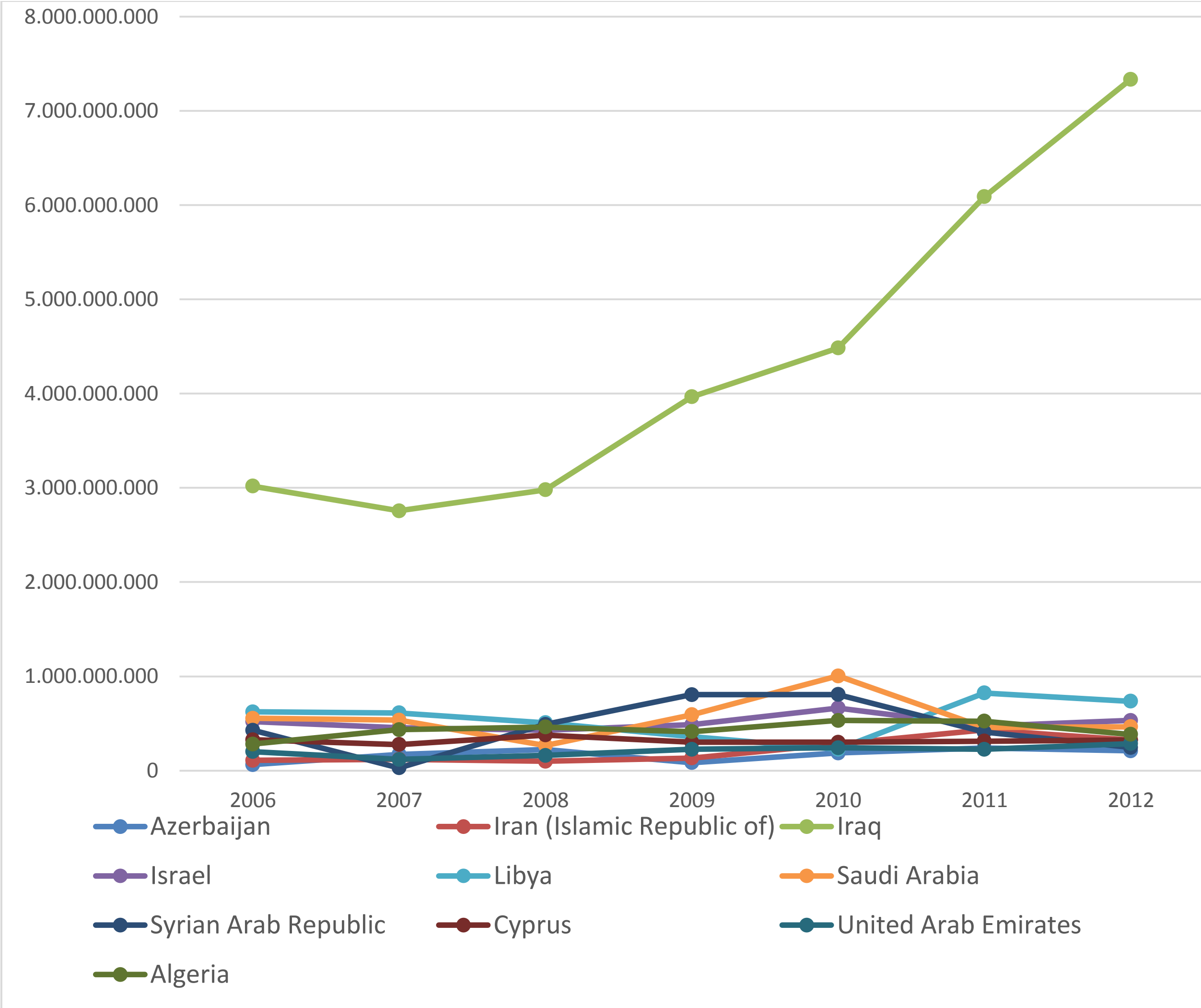

Figure 2 Turkey's Virtual Water Balance: Top Ten Surplus Countries

Figure 3 shows top ten surplus countries excluding Iraq. In general we see that the trade balance fluctuates mostly with Syria, Israel, Libya and Saudi Arabia. Virtual water balance with Syria, Israel and Saudi Arabia increases until 2010 and then radically drops in 2011. However with

Libya it decreases until 2011 and radically increases thereafter. Once we consider the countries with which Turkey gives virtual water surplus are mainly countries that can be considered relatively water scarce compared to Turkey.

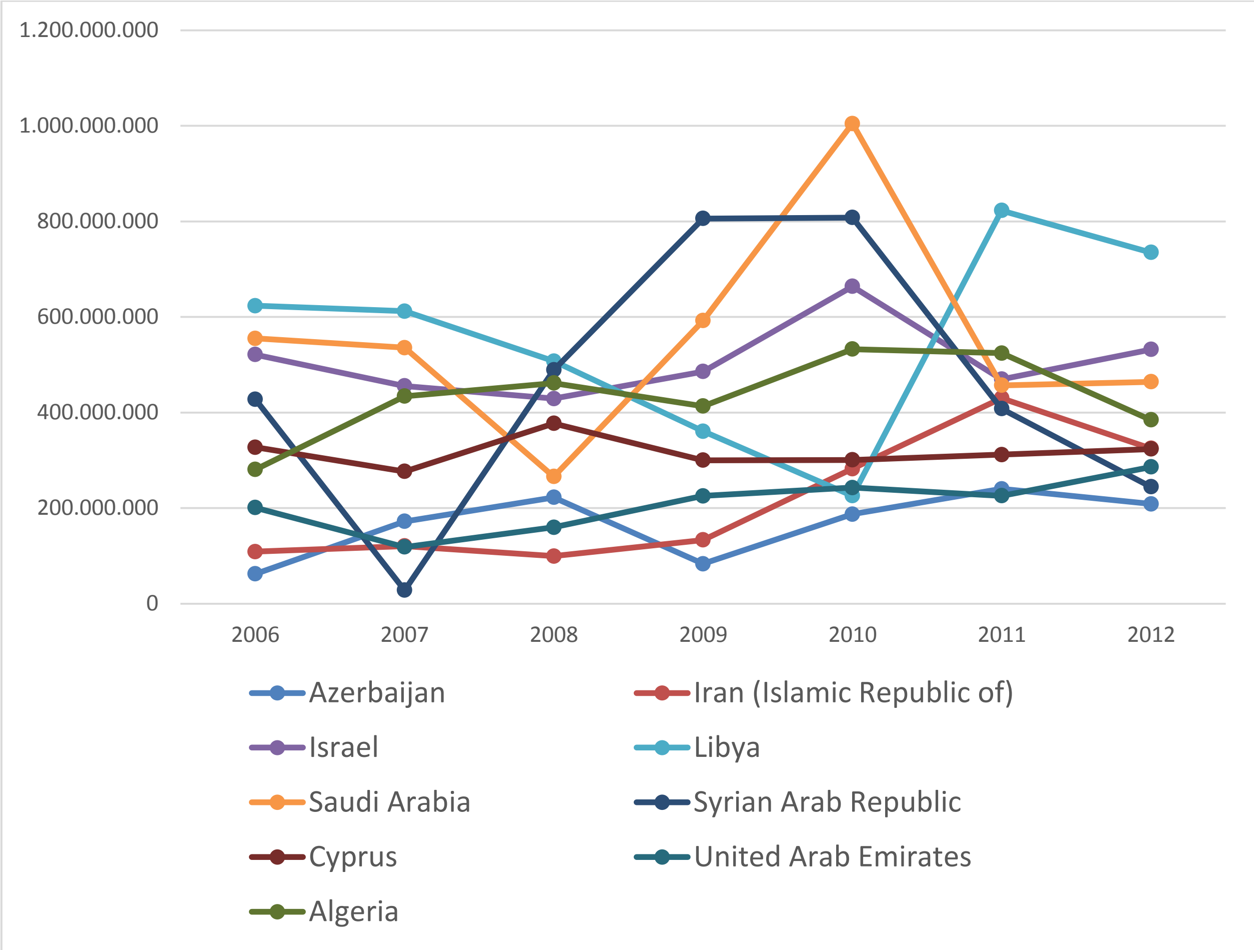

Figure 3 Turkey's Virtual Water Balance: Top Ten Surplus Countries (excluding Iraq)

In Figure 4 we see the virtual water balance with some developed countries with which Turkey has significant agricultural trade. A close look at this graph shows that there exists a trade surplus especially with Germany and Italy that declines during the analysis period to a large extent.

Especially after 2010 we see that this balance declines sharply and turns into a deficit after 2011. Trade balance with Belgium and Japan however is more stationary, and continuously give surplus between 2006 and 2012.

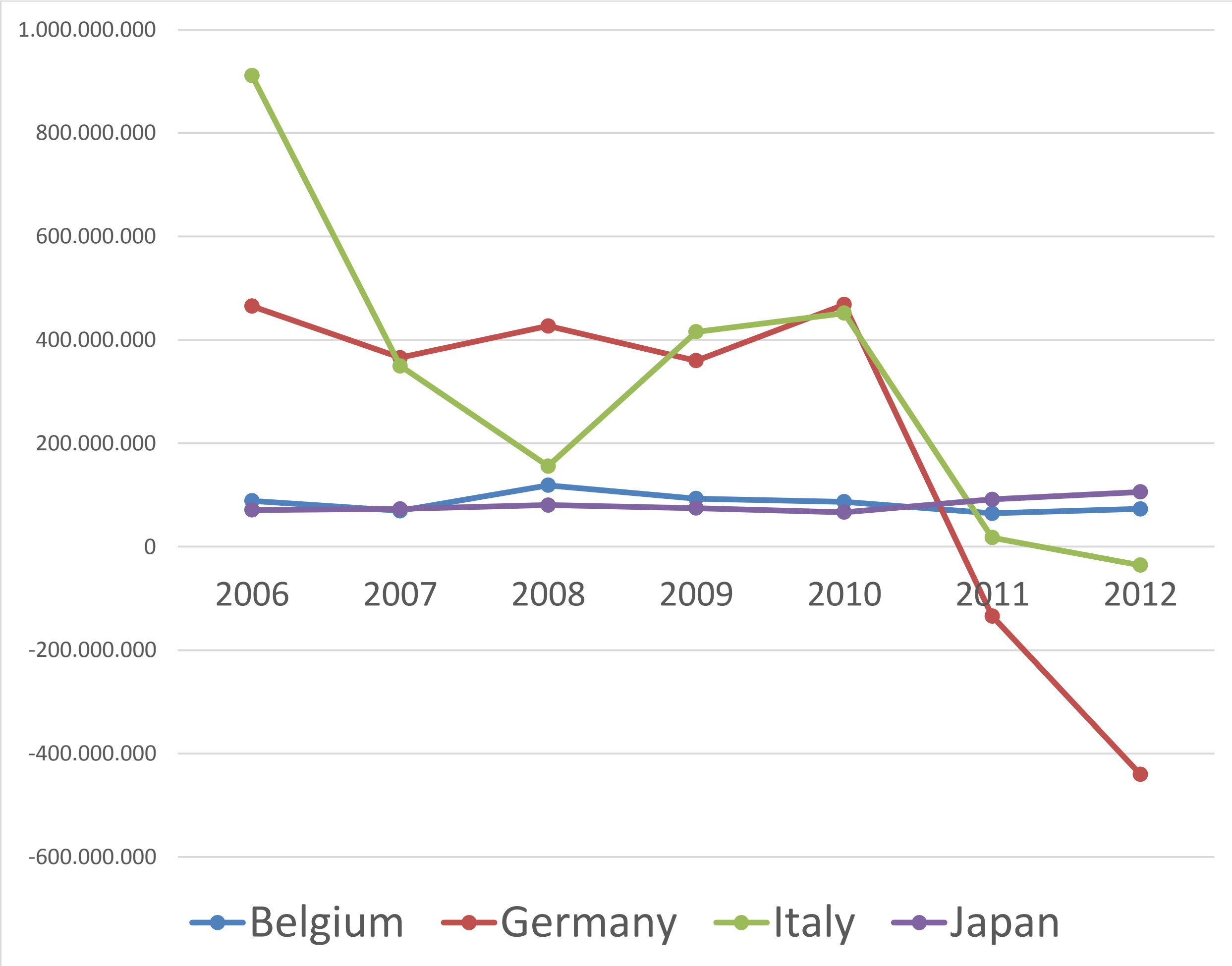

Figure 3 Turkey's Virtual Water Balance: Surplus Countries (Developed Countries)

On the other hand Turkey's virtual water trade gives deficit with respect to following countries: Argentina, Bulgaria, Brazil, Greece, Hungary, India, Indonesia, Kazakhstan, Malaysia, Russian Federation, Ukraine, and United States. Virtual water trade balance of the deficit countries are given in Figure 4. Among these countries the largest deficit is with the Russian Federation, United States and Ukraine. The virtual water trade deficit with Russian Federation increases during tithe me period especially in 2012. Among these countries trade deficit with Hungary has increased after 2009.

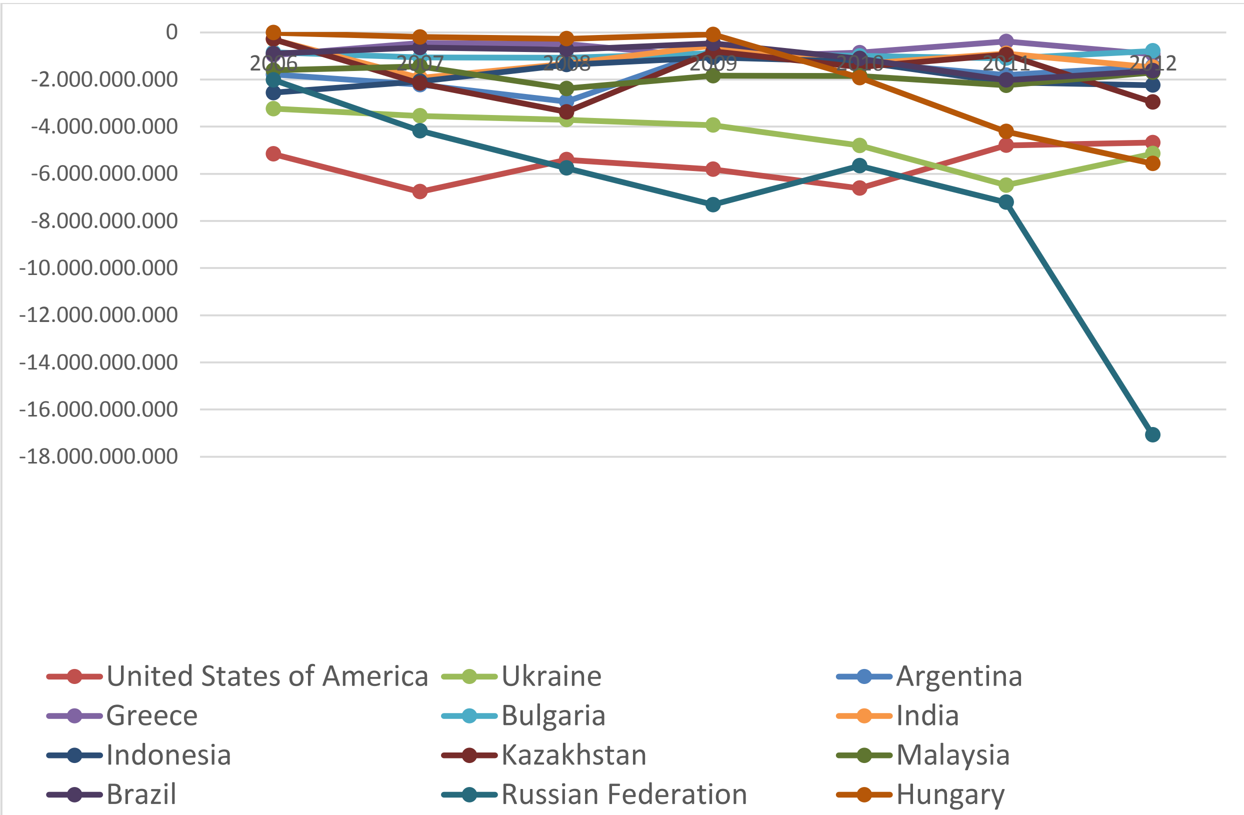

Figure 4 Turkey's Virtual Water Balance: Top Deficit Countries

In Figures 5 and 6 virtual water balances for commodity trade is given for highest net exports and imports respectively. Highest net exports are in flour, wheat and chocolate products. Virtual water net exports of chicken meat as well as eggs increases during the analysis period. Non-alcoholic beverages also shows an increasing trend in terms of net virtual water exports especially at the end of the period. Overall, the highest virtual water net export commodities FAO codes and corresponding product definitions are given in Table 1.

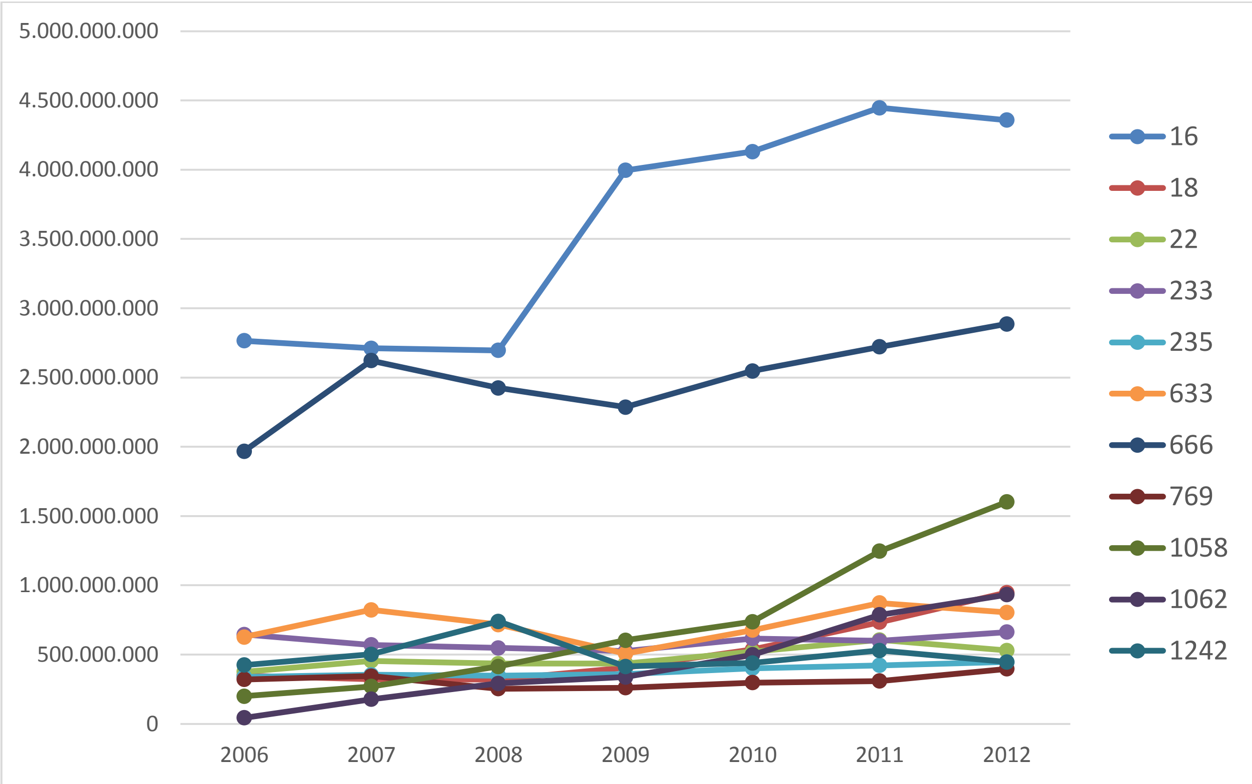

Figure 5 Turkey's Virtual Water Balance: Highest Net Virtual Water Export Commodities

Table 1 Highest Net Virtual Water Export Commodities

FAO Code		
16	Flour, wheat	Defined broadly to include meal, groats and pellets. Strong flours from hard wheat are used for bread, while durum wheat flour is used primarily for pasta. Weaker flours from soft wheat are mainly used in cakes, pastries,
18	Macaroni	Pasta made from semolina, or flour, that is mixed with water and kneaded into a dough. Other ingredients may be included as well. The dough is then shaped into various forms. This heading is limited to macaroni that is not
22	Pastry	All baked products excluding those listed under bread. Pastry products may contain ingredients other than wheat flour, such as milk, eggs, sugar, honey, starch, fats, fruit, seeds, etc.
233	Hazelnuts, shelled	Around 50% of the weight in shell.
235	Nuts, prepared (exc. groundnuts)	Mainly roasted, whether or not containing vegetable oils, salt, flavours, spices or other additives. Excludes prepared groundnuts, except when mixed
633	Beverages, non alcoholic	Includes sweetened or flavoured mineral waters and other non-alcoholic beverages, such as lemonade, orangeade, cola, etc. Excludes fruit and
666	Chocolate products nes	Includes sweetened cocoa powder, chocolate and other food preparations containing cocoa, as well as sugar confectionery containing cocoa in any amount. Excludes white chocolate (see 168).
769	Cotton waste	Waste is produced when cotton is prepared for spinning, or during spinning operations, weaving, knitting, etc., or from garnetting cotton goods.
1058	Meat, chicken	Fresh, chilled or frozen. May include all types of poultry meat ifnational statistics do not report separate data.
1062	Eggs, hen, in shell	Weight in shell.
1242	Margarine, short	Margarine is made principally from one or more hydrogenated vegetable or animal fats or oils in which is dispersed an aqueous potion containing milk products, salt, flavouring agents and other additives. Shortening is a product similar to margarine, but with a higher animal fat content. Shortening and compound fats are used primarily for baking and frying. The fat content of

From Figure 6 it can be seen that highest net virtual water import is in wheat. Net virtual water imports in wheat tends to decrease between 2008 and 2010, however it picks up its pace and increases after 2010 and resumes its highest virtual water import position. The second highest virtual water import occurs in cotton lint. Sunflower cake ranks in the third place in 2012 in terms of net virtual water exports. In general the top commodities in which Turkey is in the virtual water importer position are given in Table 2.

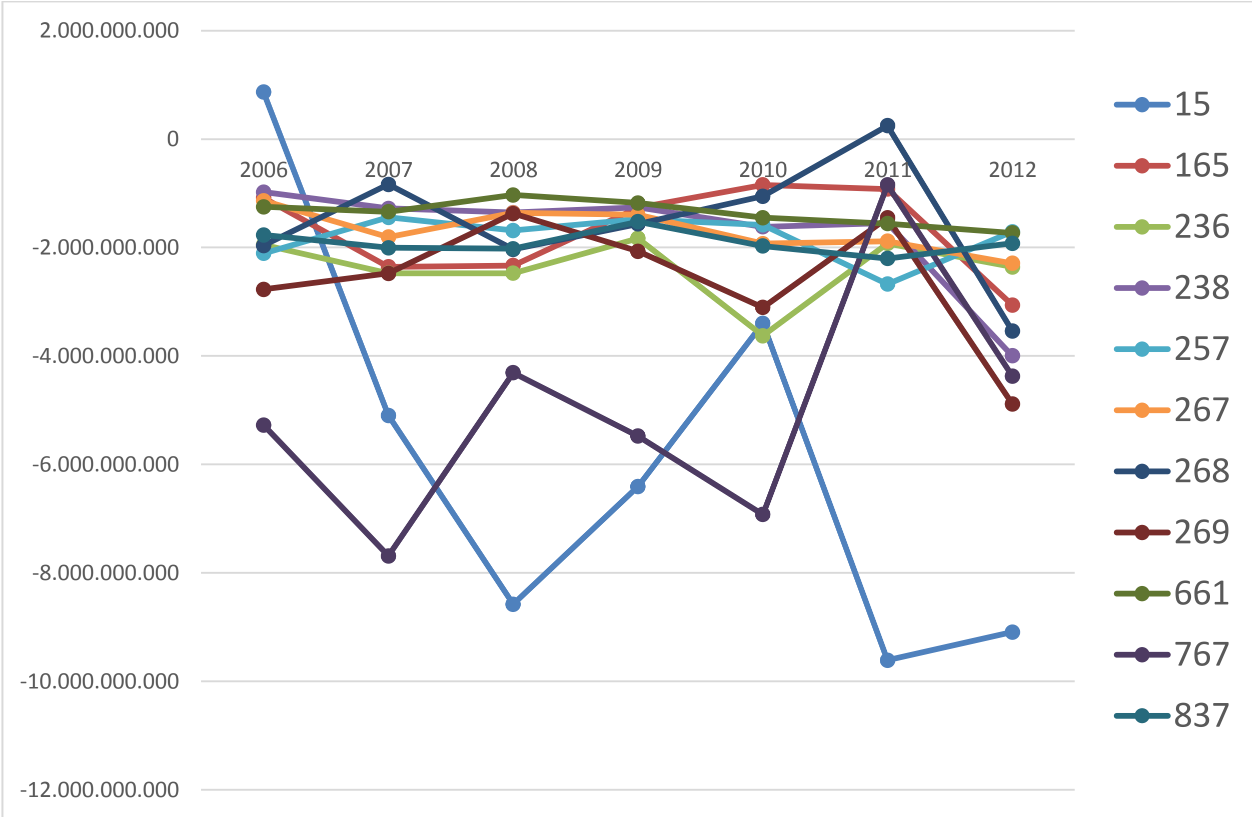

Figure 6 Turkey’s Virtual Water Balance: Highest Net Import Commodities

Table 2 Highest Net Virtual Import Commodities

FAO Code		
15	Wheat	Triticum spp.: common (T. aestivum) durum (T. durum) spelt (T. spelta). Common and durum wheat are the main types. Among common wheat, the main varieties are spring and winter, hard and soft, and red and white. At the national level, different varieties should be reported separately, reflecting their different uses. Used mainly for human food.
165	Molasses	A by-product of the extraction or refining of beet or cane sugar or of the production of fructose from maize. Used for feed, food, industrial alcohol, alcoholic beverages and ethanol.
236	Soybeans	Glycine soja. The most important oil crop. Also widely consumed as a bean and in the form of various derived products because of its high protein content, e.g. soya milk, meat, etc.
238	Cake, soybeans	Oilcake and other solid residues (except dregs), whether or not ground, or in the form of pellets, resulting from the extraction of fats or oils.
257	Oil, palm	Obtained from the mesocarp of the fruit of the oil palm by pressure, and also by solvent from the residues of the pressure extraction.
267	Sunflower seed	Helianthus annuus. Valued mainly for its oil. Minor uses include as a human food and as feed for birds.
268	Oil, sunflower	Obtained by pressure extraction. Mainly for food use.
269	Cake, sunflower	Residue from oil extraction. The cake is used for feed if it is from decorticated seeds, or for fertilizer if it comes from undecorticated seeds.
661	Cocoa, beans	Theobroma cacao. The seeds contained in the fruit of the cacao- tree, including whole or broken, raw or roasted.
767	Cotton lint	Gossypium spp. Fibres from ginning seed cotton that have not been carded or combed. Trade data also include fibres that have been cleaned, bleached, dyed or rendered absorbent.
837	Rubber natural dry	In the form of sheets, crË†pes, re-agglomerated granules, free-flowing powders, etc.; includes technically specified natural rubber (TSNR).

C**onclusion**

In this study we looked into the virtual water flows of Turkish agricultural commodity trade between 2006 and 2012. Using estimates of Mekkonnen and Hoekstra (2011)'s country specific virtual water content for agricultural products Turkey's virtual water flows in agricultural commodities trade is calculated for 324 products and 194 trade partners. Agricultural trade flows (ton/year) are multiplied by the relevant country and crop specific virtual water contents (m3/ton). For virtual water, total of green and blue water values are used.

Initial findings of our analysis shows that Turkey trades in agricultural products in terms of its partner composition is in line with Neo-Classical trade theories suggestions. That is we initially observe that Turkey is a net exporter of virtual water in its trade with relatively water scarce countries and it is a net importer of virtual water with respect to its trade with countries which can be considered relatively water abundant.

In terms of the commodity composition of trade early findings show that Turkey is a net virtual water importer in terms of less processed goods like wheat and cotton lint. However, it is a net virtual water exporter in more processed goods like flour, chicken meat etc. But these findings are still at the very early stage and requires further analysis in terms finding whether Turkey's virtual water lows arising from its commodity trade in agriculture is in line with the new division of labor. As discussed before it suggests that less developed countries tend to specialize in high labor intensive products like fruits and exotic products. There are initial signs of this pattern in terms of commodity trade in agriculture, but it needs further analysis.

At this stage of our research two important research questions arise:

1. Do TR's trade in agriculture reflect water intensity as a comparative advantage?
2. Do Turkey's VWT flows reflect relative water endowments?

Therefore in the next stage of our study we will try to answer these question with conducting some econometric analysis. One of the aims of our research is to conduct an econometric analysis by using a gravity model. By doing so we hope to see the impact of relative water endowments on Turkey's virtual water trade flows.

References

Allan, J. A. (1997) "Virtual water": A Long Term Solution for Water Short Middle Eastern Economies? : Occasional paper, no. 3. Water Issues Study Group, School of Oriental and African Studies, University of London.

Allan, J. A. (1998) "Virtual water: a strategic resource", *Ground Water*, 36, 545–546.

Ansink, E. (2010) "Refuting Two Claims about Virtual Water Trade", *Ecological Economics*, 69, 2027-2032.

Antonelli, M. and Sartori, M. (2015) "Unfolding the Potential of the Virtual Water Concept. What is Still Under Debate?", *Environmental Science and Policy*, 50, 240-251.

Aydın, B. (2009) *Tarımsal Dış Ticarette Değişim*, TMMOB Ziraat Mühendisleri Odası, Ankara.

Brown, A. and Matlock, M. D. (2011) A Review of Water Scarcity Indices and Methodologies, The Sustainability Consortium White Paper #106.

Chapagain, A. K. and Hoekstra, A. Y. (2004) Water Footprints of Nations. UNESCO-IHE Delft, Value of Water Research Report Series, vol. 16.

Chen, G. Q. and Li, J. S. (2015) "Virtual Water Assessment for Macao, China: Highlighting the Role of External Trade", *Journal of Cleaner Production*, 93, 308-317.

Dang, Q., Lin, X. and Konar, M. (2015) "Agricultural Virtual Water Flows within the United States", *Water Resources Research*, 52 (2), 973-986.

Debeare, P. (2014) "The Global Economics of Water: Is Water a Source of Comparative Advantage?", *American Economic Journal: Applied Economics*, 6(2), 32-48.

DSİ (2010a) Faaliyet Raporu. Retrieved from: http://www2.dsi.gov.tr/faaliyet_raporlari/raporlar.htm

DSİ (2010b) İçme ve Kullanma Suyu Tahmini, Devlet Su işleri Genel Müdürlüğü, Ankara.

Duarte, R., Pinilla, V. and Serrano, A. (2014) "The Effect of Globalization on Water Consumption: A Case Study of the Spanish Virtual Water Trade, 1849-1935", *Ecological Economics*, 100, 96-105.

Ercin, A. E., Mekonnen, M. M. and Hoekstra, A. Y. (2013) "Sustainability of National Consumption from a Water Resources Perspective: The Case Study for France, *Ecological Economics*, 88, 133-147.

Fracasso, A. (2014) "A Gravity Model of Virtual Water Trade", *Ecological Economics*, 108, 215-228.

Fracasso, A, Sartori, M. and Schiavo, S. (2015) "Determinants of Virtual Water Flows in the Mediterranean", *Science of the Total Environment*, forthcoming, http://dx.doi.org/10.1016/j.scitotenv.2015.02.059

Frankel, J. A. and Rose, A. K. (2005) "Is Trade Good or Bad for the Environment? Sorting Out the Causality", *The Review of Economics and Statistics*, 87 (1), 85-91.

Garrido, A, Llamas, M. R., Varela-Ortega, C., Novo, P., Rodriguez-Casado, R. and Aldaya, M. M. (2010) *Water Footprint and Virtual Water Trade in Spain: Policy Implications*, Springer.

Gerten, D., Heinke, J., Hoff, H., Biemans, H., Fader, M. and Waha, K. (2011) "Global Water Availability and Requirements for Future Food Production", *Journal of Hydrometeorology*, 12, 885-899.

Hoekstra, A. and Chapagain, A. (2008) *Globalization of Water: Sharing the Planet's Freshwater Resources*, Wiley-Blackwell.

Hoekstra, A. Y. and Hung, P. Q. (2002) Virtual Water Trade: A Quantification of Virtual Water Flows between Nations in Relation to International Crop Trade. UNESCO-IHE Delft, Value of Water Research Report Series, No. 11.

Hoekstra, A. Y. and Hung, P. Q. (2005) "Globalization of Water Resources: International Virtual Water Flows in Relation to Crop Trade", *Global Environmental Change,* 15 (1), 45-56.

Konar, M. and Caylor, K. K. (2013) "Virtual Water Trade and Development in Africa", *Hydrology and Earth System Sciences,* 17, 3969-3982.

Mekonnen, M., and Hoekstra, A. (2011), National Water Footprint Accounts: The Green, Blue and Grey Water Footprint of Production and Consumption, Value of Water Research Report Series, No. 50, UNESCO-IHE, Delft, Netherlands.

Reimer, J. J. (2012) "On the Economics of Virtual Water Trade", *Ecological Economics*, 75, 135-139.

T. C. Kalkınma Bakanlığı (2013) *Onuncu Kalkınma Planı 2014-2018*, Ankara.

Tamea, S., Carr, J. A., Laio, F. and Ridolfi, L. (2014) "Drivers of the Virtual Water Trade", *Water Resources Research*, 50, 17-28.

TÜİK http://www.tuik.gov.tr

Yang, H., Pfister, S. and Bhaduri, A. (2013) "Accounting for a Scarce Resource: Virtual Water and Water Footprint in the Global Water System", *Current Opinion in Environmental Sustainability*, 5, 599-606.

Zeitoun, M., Allan, J. A. and Mohieldeen, Y. (2010) "Virtual Water 'Flows' of the Nile Basin, 1998-2004: A First Approximation and Implications for Water Security", *Global Environmental Change*, 20, 229-242.