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Full Length Research Paper

A general equilibrium analysis of trade liberalization impacts on agriculture and environment

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Iran is required to reduce import tariffs in order to be accepted as a member of the World Trade Organization. This study aims at investigating economic and environmental impacts of tariffs removal especially on agricultural sector applying a computable general equilibrium framework based on the Iranian social accounting matrix and decomposing total emission of the selected pollutants into energy use, production process and final non-energy use emission. The results showed that removing agriculture and agricultural industries tariffs, makes agricultural output and relative prices to fall. Cutting non-agricultural tariffs results in higher output and lower relative prices in agricultural sectors, however, the changes in output exceeds the corresponding relative price changes. Cutting all tariffs also raises the welfare. In particular, the higher income households will be better off much more than others. Pollutants emission also tends to decrease as removing the tariffs. Agricultural output composition will change in favor of horticultural products if tariffs are removed.

Key words: Import tariff, agriculture, welfare, pollution, Iran

INTRODUCTION

Trade would help to increase national income (Abdel Karim and Ismail, 2007) and higher welfare (Markusen et al., 1995). It is strongly likely that excluded countries will be hurt by trade liberalization undertaken by other countries (Stern and Deardorff, 2006). However, this does not mean that trade liberalization is beneficial for all sectors since it is expected to change resource allocation and to induce distributional impacts. Especially, there is some evidence of negative impact of trade liberalization on agriculture. For instance, implementing trade liberalization in Syria (Chemingui and Dessus, 2008) and Norway (Fæhn and Holmøy, 2003) is expected to reduce agricultural output. Arunanondchai (2003) also concludes that implementing Uruguay Round policy changes in agriculture induces welfare losses in Indonesia and Malaysia. Agricultural products are of items that are protected against trade liberalization in developing countries including Syria (Chemingui and Dessus, 2008); Morocco (Philippidis and Sanjuán, 2006) and Iran (Jensen and Tarr, 2003) as well as in developed countries such as New Zealand (Winchester, 2009) and Norway (Fæhn and Holmøy, 2003). However, according to Doha Development Agenda (DDA) which concerns agriculture, it has been emerged as a commitment to substantially improve market access, reduce and eventually phase out export subsidies, and reduce trade-distorting domestic support (Rae and Josling, 2003). Although some empirical evidence illustrates some negative impacts of trade liberalization on agriculture,

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these evidences are strongly dominated by empirical works supporting the economy wide advantages of trade liberalization in both of developing and developed countries, especially of economic growth (Rutherford and Tarr, 2002; Adkins and Garbaccio, 2007; Vennemo et al., 2008) and of welfare (Acharya and Cohen, 2008; Jensen and Tarr, 2003; Fæhn and Holmøy, 2003; Zhu and van Ireland, 2006; Adkins and Garbaccio, 2007). Thus, it is crucially important to examine the trade liberalization impact on agriculture while the whole economy is also considered.

Contrary to strong literature illustrating positive impacts of trade on growth and welfare; empirical works show a divergent view regarding the impacts of free trade on environment. Both of negative (Copeland, 1997; Copeland and Taylor, 1999; and Abler et al., 1999) and positive impacts (Grossman and Krueger, 1993; Kang and Kim, 2004; Rae and Strutt, 2007; Leitão, 2011) of trade on the environment are considered. There are special concerns about environmental effects in developing countries. Free trade increases the risk of environmental degradation especially in developing countries (Dessus and Bussolo, 1998) that are believed to be specialized in dirty products (Birdsall and Wheeler, 1993; Low and Yeats, 1992). Environmental consequences of trade liberalization have recently been considered in empirical works.

The Iranian government has committed itself to prepare the appropriate condition to be as a member of the World Trade Organization (WTO) especially by passing the Third Five Year Economic Development Plan in 2000. The government tries to provide the conditions needed for free trade and joining to the WTO. Tariffs are of main import barriers in Iran and in the most of sectors imports are subjected to import tariffs. However, at the same time this economic development plan contains other important features like non-oil export expansion that aims at agriculture in specific. Moreover, agriculture plays a significant role since it accounts for over 55% of non-oil and its products export. About 21% of labor force and over 29% of population also belongs to agricultural and rural community (Food and Agriculture Organization-FAO, 2008; UN,data 2008). Another issue is pollutants emission that is addressed here. Agriculture sector has a significant role in production process emission of some pollutants. Over 90% of N_2O and more than one-half of CO as well as over 20% of NO_x and CH_4 are emitted by agriculture production (United Nations Development Programme -UNDP, 2010), while Iranian agriculture accounts for around 10% of its GDP (Central Bank of Iran, 2010). In the agriculture-environment context, we may find some more technical discussions useful to improve environmental quality. Adsorption method of clearing environment is one of the innovative techniques. Some of agricultural by-products and wastes like deoiled soya may be used as an adsorbent material to remove dyes from wastewaters (Mittal et al., 2009; 2010). Another innovative and highly efficient use of waste product case is to use hen feather as adsorptive of hazardous dyes (Mittal et al., 2012).

To the best of our knowledge, there are limited works referring to the Iranian trade liberalization scheme while agricultural sectors is considered more in depth and the work conducted by Jensen and Tarr (2003) is unique in this context. However, they considered tariff removal while agriculture decomposed to three sectors including farming, livestock and other agriculture. We decompose the agricultural sector into more sectors to examine the trade reform effects on output composition and achieving more detailed implication for agriculture. Moreover, they did not investigate environmental effects of trade reform. Another feature that distinct this study from most of the related empirical works is that we decompose the total emission of the selected pollutants into energy use, production process and final non-energy use emission.

Exploring the possible sectoral, macroeconomic and environmental impacts of removing trade barriers is what the rest of this paper aims to achieve. But we are focused more deeply on agricultural sector.

MATERIALS AND METHODS

Model

We developed a static small open economy model[1] in which economy contains 26 sectors covering agriculture, agricultural industries and non-agricultural sectors. Agricultural industries are food, beverage and tobacco industries, textile, leather and clothing industries, and wood and paper industries. For brevity, we call the first two sectors food and textile sectors, respectively. Manufacturing includes industrial sectors except for agricultural industries.

Goods are produced using primary factors and intermediate inputs based on the Leontief production structure and a constant return to scale technology in a perfectly competitive environment. Primary factors which are perfectly mobile include unskilled and skilled labor and capital. Goods used as intermediate inputs are an Armington composite of domestic and imported goods. Iran is considered as small economy so the world prices of imported and exported goods are fixed. Outputs of all sectors are allocated between domestic and foreign markets which are determined by constant elasticity of transformation (CET) function.

Government revenues from rents on crude oil, mining products, import tariff revenues, and exogenous lump-sum taxes finance demand for goods and services, transfers to households, subsides to energy products and food items. The exchange rate in the model

[1] Our model originates from Jensen and Tarr (2002); de Melo and Tarr (1992); McDonald et al. (2007); and Beghin et al. (2002).

is also fixed and foreign capital inflow adjusts such that balances the value of exports and imports. This assumption is emphasized in the Iranian CGE based studies of Khoshakhlagh and Mousavi Mohseni (2006) and Behboodi (2008) as more compatible with Iranian economy reality since Iranian government is the main supplier for foreign exchange and has a significant control on the exchange rate.

The model specification described is a standard applied general equilibrium model. At the equilibrium, each industry gains zero profits, the budget constraint is satisfied and for goods in each industry the demand is equal to the supply. There is also external trade balance.

Household utility functions are assumed to be Stone-Geary or linear expenditure system consisting of subsistence and discretionary demand. Households are considered as income deciles in the model. Welfare change also is measured by Hicksian equivalent variation (EV).

The equilibrium module includes market clearing and agents' income balance conditions including the equilibrium of commodity market, factor market, domestic transfer, international trade, and savings and investment.

Another important block of the model is environmental block that is incorporated to examine environmental effects. The environmental effect is based on exogenous coefficients for each sector. The coefficients are linked to input or output such that the coefficients will include the value of the environmental index for each unit of input or output.

Changes in pollutants emission as environmental index may arise from intermediate consumption, output production and final consumption (Dessus and Bussolo, 1998). It is also assumed that primary factors do not pollute. Production process is the residual amount of pollution in production that is not explained by consumption of inputs (Beghin et al., 2002). The most common pollutant as environmental index is CO_2 emission that has largest contribution to global warming (Bohringer and Loschel, 2006), being widely considered in different studies (Dessus and Bussolo, 1998; Strutt and Anderson, 1999; Adkins and Garbaccio, 2007; Fæhn and Holmøy, 2003). However, we consider more pollutants including CO_2, CH_4, N_2O, CO, NO_x and SO_2. The first three pollutants are aggregated into CO_2 equivalent using the corresponding transformation coefficients reported by the UNDP (2010).

Data

We use eight main data sources including: (1) a social accounting matrix (SAM) table of Iran for 1999 that is the latest SAM prepared by the Iranian Central Bank; (2) household expenditure survey (HES) of Iran for 2008 (Iranian Statistical Center, 2008); (3) tariffs as policy data from Iranian Trade Statistical Yearbook for 2009 (Iranian Custom Administration, 2009); (4) agricultural sectors cost and production data for 2008 (Iranian Ministry of Agriculture, 2008); (5) GTAP[2] 6 database to decompose labor account; (6) estimates of Iranian elasticities from Jensen and Tarr (2002); and (7) emission of the selected pollutants from the report of Iran second national communication to United Nations Framework Convention on Climate Change (UNFCCC) for 2010 (UNDP 2010) and (8) Iranian Energy Balance for 2009.

To get the SAM compatible with the model and study objectives, we modified the database of Iranian SAM of 1999 using above mentioned sources of (2) to (6) as auxiliary data. We aggregated most of industrial and services sectors, while agricultural sectors are decomposed into more sectors using shares of total costs and revenue. Iran's SAM contains the agricultural subsectors as a whole, so we first decomposed the agricultural farm subsector into wheat, barley, rice, sugar beet, cotton and maize. We also decomposed rural households account into 10 income deciles using share data from the household expenditure survey.

The emission data of the production process was also disaggregated to make the pollutants emission compatible with the model sectors.

[2] -Now newer versions of GTAP, for example, GTAP 8 are available.

RESULTS

We consider four scenarios including cutting tariffs in agriculture, agricultural industries, non-agricultural industries sectors and economy wide. The simulation results are presented in three parts including sectoral and macroeconomic results, welfare and environmental impacts. In sectoral impact we mainly focus on the changes in agricultural sectors output, relative prices and net export. Welfare implication also includes the impact of the scenarios on rural households' welfare measured in terms of equivalent variation. Environmental impact also means changes in selected pollutant emission.

Sectoral and macroeconomic impacts

The sectoral and macroeconomic results are reported in Table 1. Cutting agricultural tariffs increase import in agricultural sectors, resulting in output decrease of these sectors as well as output expansion of other sectors. Lower prices compared to the initial level, induced by tariff cut in agricultural sectors as well as production factors drawn away from the agricultural sectors are the main reason for increased output of the non-agricultural sectors. Among the agricultural sectors, cotton, livestock and aquaculture experience output expansion. Increased intermediate demand caused by output expansion of textile and food industries accounts for a part of these sectors output expansion. Increased net export also contributes to livestock and aquaculture output expansion. Wheat (-14.7%) and rice (-13.3%) experience the highest output reduction. Lower prices of agricultural sectors compared to the initial equilibrium serves the agricultural industries since they use the agricultural goods as intermediate input, resulting in output expansion of 1.5 to 3.4%. Although the agricultural tariff removal results in decreased relative prices of all sectors, for the most of the sectors, relative price reduction of lower than 0.5% is expected.

Cutting agricultural tariffs induce a negative change in net export of the agricultural sectors, while other sectors

Table 1. Sectoral and macroeconomic impacts of trade reform in Iran (%).

Removing tariffs of sectors	Agriculture			Agricultural industries			Non agriculture			Total		
	Output	Prices	Net export	Output	Prices	Net export	Output	Prices	Net export	Output	Prices	Net export
Wheat	-14.7	-1.1	-39.2	-2.6	-0.3	-3.6	8.3	-2.1	-1.5	-9.4	-3.5	-37.3
Rice	-13.3	-0.6	-162.5	1.1	-0.3	-0.0	3.5	-1.2	0.3	-9	-2.1	-163
Sugar beet	3.9	-0.3	-	-3.3	-0.3	-	5.9	-1.5	-	6.5	-2.1	-
Cotton	2.1	-0.3	-3.5	-2.7	-0.4	-1.6	6.6	-1.7	12.5	6.1	-2.4	7.8
Maize	-3.5	-0.2	-13.9	-0.5	-0.3	1.2	0.1	-1.1	3.1	-3.8	-1.5	-9.3
Barley	-0.8	-0.3	-10.9	-0.6	-0.3	1.5	-0.3	-1.3	4	-1.6	-1.8	-5
Livestock	0.1	-0.4	0.23	-0.6	-0.5	0.9	-0.4	-0.8	1.9	-1.2	-1.6	3
Forestry	-1.8	-0.4	-46.2	-1.1	-0.4	9.3	-3.9	-1.3	31.8	-6.6	-1.9	-2.2
Aquaculture	1.9	-0.6	2.6	1.8	-1	3.5	10.1	-3.5	16.7	14.5	-5	24.3
Other Agriculture	-0.8	-0.3	-6.6	-0.4	-0.3	0.5	5.2	-1.3	9.6	4	-1.8	3.6
Mining	1.1	-0.3	0.92	1.4	-0.4	1.1	-12	-1.8	6.6	-9.7	-2.5	8.2
Food, beverage and tobacco	3.4	-1.7	41.5	-2.9	-1	-93.3	5.2	-1.6	26.3	5.7	-4.2	-12.1
Textile, leather and clothing	1.4	-0.5	3.2	-3.3	-1.2	-13.1	4.2	-1.5	9.3	2.5	-3.2	-0.2
Wood and paper	1.5	-0.3	-0.4	-8.3	-1.5	-16.4	-1.2	-1.6	6.9	-7.9	-3.4	-9.4
Crude oil and gas	0.2	-0.1	0.5	0.5	-0.3	1.2	0.9	-0.5	2	1.5	-0.9	3.6
Gasoline	-	-0.1	0.4	-0.1	-0.3	1.1	-	-0.5	1.6	-0.1	-0.9	2.9
Kerosene	0.3	-0.1	0.7	0.5	-0.3	1.5	1.5	-0.5	3.1	2.3	-0.9	5.2
Gas oil	-0.5	-0.1	-0.1	-0.3	-0.3	0.6	-0.2	-0.5	1.4	-1.1	-1	1.8
Fuel oil	0.4	-0.3	0.7	0.7	-0.8	1.5	-1.9	-1.3	-0.7	-0.9	-2.3	1.4
Liquid gas	2	-0.3	2.4	3.2	-0.7	4.1	4.3	-1.1	5.8	9.6	-2	12.3
Other oil products	0.4	-0.2	4	0.6	-0.4	7.8	-0.1	-1.4	27.4	0.8	-1.9	38.4
Natural gas	0.3	-0.2	-	0.1	-0.3	-	-1.6	-0.6	-	-1.3	-1	-
Electricity	0.3	-0.2	0.9	0.1	-0.4	1.2	-0.9	-5	15.2	-0.5	-5.5	17.5
Manufacturing	0.4	-0.2	0.9	0.6	-0.4	1.8	-9.2	-3.3	-32.7	-8.2	-3.9	-29.9
Transportation	-0.1	-0.2	3.7	-0.4	-0.3	6.2	-1.1	-1.4	25.3	-1.6	-1.9	34.2
Services	-	-0.2	1.5	-	-0.3	2.5	-1.5	-1	5.8	1.5	-1.5	9.6
Macroeconomic variables												
GDP		0.7			0.9			1.6			3.2	
CPI		-0.9			-1.1			-2.1			-4	
Government expenditure		0.9			1			3.8			5.7	

Final consumption	0.8	1.1	3	4.9
Investment	0.7	0.9	-2.2	-0.7
Exports	1.1	1.1	3.1	5.2
Imports	2.3	2.2	13.7	18.3
Net export	-0.4	-0.4	-4.9	-5.6
Factor prices				
Unskilled labor	0.2	0.7	0.4	1.2
Skilled labor	0.8	0.8	1.8	3.4
Capital	0.8	0.9	1.8	3.5
Factor employment				
Unskilled labor	-	-	-	-
Skilled labor	-	-	-	-
Capital	-	-	-	-

enjoy increased net export. However, in terms of absolute values, net export changes of agricultural sectors are more important than the other sectors. Rice has the highest net export changes as it decreases by around 163%, followed by forestry and wheat sectors, experiencing net export reduction of 46 and 39%, respectively.

Now we consider the second scenario in which we cut agricultural industries tariffs. First it is worth to note that among the agricultural industries, food industries are more important as their imports are higher than those of the other two sectors. Despite the lower tariff rate in wood and paper sector compared to the other agricultural industries, the output and relative price changes are higher. Removal of the agricultural industries import tariffs results in output reduction of more than 8% in wood and paper sector, while the corresponding value is less than 3.4% for textile and food sectors. The main reason for such changes is the imported commodity share. About 40% of domestic consumption of wood and paper commodities comes from import, while the corresponding values for textile and food industries are about 4 and 20%, respectively. Removing tariffs on imported commodities of agricultural industries results in an increase in the import of these sectors (decrease in net export) and a decrease in output as well as, in the relative price firms received for their products. Reduction in the agricultural industries output results in decreased intermediate demand for agricultural products, driving down the agricultural prices compared to their initial level. Decreased output of agriculture and agricultural industries sectors makes more primary factors available for other sectors, resulting in expansion of their output by less than 1%.

Despite the fall in output of the most of agricultural sectors, production in aquaculture and rice rises by 1.8 and 1.1%, respectively as cutting agricultural industries tariffs. This may be due to two reasons. Firstly, these sectors uses more commodities from agricultural industries and non agricultural sectors (especially manufacturing) compared to the other agricultural sectors as intermediate input. The lower prices of the agricultural industries and non agricultural sectors comparing to their initial level provide a chance for aquaculture and rice sectors to enjoy lower production cost. Secondly, drawing primary factors from agriculture and agricultural industries may contribute to use more these inputs. These reasons may also explain the output expansion of the non agricultural sectors by less than 1%.

Cutting agricultural industries tariffs also induce producer prices reduction comparing to their initial level; however, the reduction is less than 0.5% for the most of agriculture and non agricultural sectors.

The corresponding values for the agricultural industries also range from 1 to 1.5%. Agriculture relative prices fall while their net exports tend to increase, driving mainly from decreased intermediate demand. Agricultural industries tariff removal improves net export in the most of agriculture and non agricultural sectors, however, net export of agricultural industries decrease significantly.

The third scenario is cutting import tariff of non agricultural sectors. But among the non agricultural sectors, manufacturing and mining are the only sectors that their imports are levied. Contrary to the previous scenarios, removing non agricultural sectors tariff has more significant impact on the selected variables. Removing tariffs of manufacturing and mining sectors induce their prices to reduce relative to the initial equilibrium by 1.8 and 3.3% respectively, changing the terms of trade in favor of the other sectors. This change in terms of trade drives away the production resources from these sectors and lead to reduction in their outputs. Regarding the widespread use of manufacturing commodities in production, more decrease in manufacturing relative prices lead to a fall in production cost of other sectors especially agricultural sectors. As shown in Table 1, output of agricultural sectors, except for barley, livestock and forestry, increases as removing non agricultural tariffs. But a part of agricultural sectors output expansion may be caused from food and textile output increase and their higher intermediate demand for agricultural commodities. Output reduction of forestry is mainly induced by reduction in manufacturing intermediate demand. Increased output of food industries is expected to demand more livestock products as intermediate demand; however, livestock output will reduces as implementing non agriculture tariff removal. Lower cost efficiency of livestock sector may cause such change. Output reduction in livestock also results in decreased demand for barley.

Decline in the relative prices paid by food and textile industries for manufacturing and agricultural goods as intermediate inputs has the impact of increasing output by 5.2 and 4.2% respectively. Contrary to the tariff removal in agriculture and agricultural industries, cutting non agricultural tariffs is favored for agricultural sectors as output in the most of them grows by 5 to 10%. Cutting non agricultural tariffs, except for energy products, wheat and manufacturing, also tends to raise net export. So, non agricultural tariff removal may be as a measure to expend the agricultural export and reducing more dependence on oil and its product export which is an aim following by Iranian government. Like the other scenarios, cutting non agricultural tariffs entails price reduction compared to the initial equilibrium coming from improved resource allocation. For most of the sectors, reduction in relative price is 1 to 2%, while removing tariffs in agriculture and agricultural industries sectors induce a relative price reduction of less than 1%, suggesting that non agricultural sectors tariff entail much greater price distortions than do tariff in agriculture and agricultural industries. For the most of agricultural sectors output price decreases by 1 to 2% compared to the initial level while their output increase is much higher than their corresponding relative price reduction, leading to better off situation for agricultural producers.

The last policy reform is cutting tariff of all sectors or complete tariff removal. To a great extent, the changes in this scenario are the aggregate changes obtained for all previous scenarios. Generally speaking, some of the agriculture as well as most of non agricultural sectors especially manufacturing is disfavored by cutting tariff. Increased output of the food and textile industries after removing tariffs completely are of interesting features. Their outputs expand while they experience net export reduction or import rise. Decreasing prices of agriculture and manufacturing, compared to the initial equilibrium, induced by their tariff removal make a significant fall in production costs of food and textile sectors. This rise in their output happens in the presence of more import stemming from tariff removal. Although changes in agricultural sectors stem from different sources, two sources are more important; removing tariff of agricultural sectors and changes in output of agricultural industries. The former induce output reduction in the most of sectors as we see in the first scenario. However, increase in output of food and textile results in more intermediate demand for agricultural products. These sources change the agricultural output composition in favor of aquaculture and other agricultural sector products while livestock and other sectors are disfavored by these changes. Other agricultural sector mostly contains horticulture products. Net export changes of the agricultural sectors also are similar to their output changes. It is worth to note that other agricultural sector amounts to around half of agricultural sector and its changes is highly important. Tariff removal is a favored policy for agricultural industries and agricultural sectors that may enjoy from output expansion of these industries. Livestock also is another important agricultural sector that account for around 31% of whole Iranian agriculture which experience a positive net export changes.

Lower part of Table 1 shows the macroeconomic

impact of scenarios examined. Most of variables experience a change of lower than 1% as agricultural tariff is removed. Tariff cutting in agricultural sectors for all variables except for net export is favored. Cutting tariff in agriculture leads to more import of agriculture products and results in net export reduction. Compared to the initial equilibrium Iranian GDP rises by over 0.7% while CPI also tends to decrease by about 0.9% as removing agriculture tariffs. Higher factor income and more private consumption are other desired changes induced by cutting agricultural tariffs.

Like cutting agricultural tariffs scenario, removing agricultural industries tariffs also induce same changes in macroeconomic variables, however the absolute value of changes under cutting agricultural industries tariff is slightly higher. Removing non agricultural tariff also, except for investment, induce the same direction of changes in macroeconomic variables.

However, in terms of absolute values, there is difference between cutting tariffs in non agricultural sectors and implementing it in agriculture and agricultural industries. For the most of variables, changes after removing non agriculture tariffs is twice as greater as the changes induced by implementing the policy in agriculture and agricultural industries. For instance, GDP rises by over 1.6% and CPI decreases by 2.1% relative to the initial equilibrium. This higher changes stems from much close relation of manufacturing with other sectors as it severs other sectors in providing their intermediate consumption.

Another interesting result also is reduction in investment under cutting non- agriculture as well as total tariffs removal scenario. The Iranian government accounts for around two-third of total investment. After cutting tariffs in non- agricultural sector the private investment is expected to increase as factor prices and households' income increases. However, total investment decreases since government investment tends to decrease.

Higher consumption entails higher government fund as some commodities like energy products and food item are subsidized, leading to reduction in investment fund and reduction in investment by -2.2% after cutting non agricultural tariffs. The last scenario also contains the aggregate impacts of all scenarios. Only investment and net export changes are disfavored by cutting tariffs. However, comparing to the initial equilibrium GDP rises by 3.2% and private households consume more while they experience lower prices relatively and get higher return for production factors. It is worth to note that gains from trade would come from better resource allocation which is subject to net export reduction.

Welfare impacts

Now we consider the welfare impacts of the scenarios among rural income deciles (Table 2). What is driving the results is the following. All the scenarios results in an increase in welfare of income groups. However, average welfare increase for agriculture and agricultural industries tariff removal are lower than other scenarios. Rural welfare rises by 0.90 and 0.87% on average as removing tariffs in agriculture and agricultural industries, respectively. While their welfare gains under non agricultural tariff removal is higher (1.5%). The gains in welfare for rich income groups are higher since they own more production factors, especially capital and skilled labor. As shown in Table 1, cutting tariffs results in higher return for capital and skilled labor compared to unskilled labor. Therefore, removing tariff and non-tariff barriers entails welfare gains and more inequality simultaneously. For instance, Eliminating imports tariff of all sectors induce aggregate welfare gains of 1.25 for the lowest income, while the corresponding gain for the richest one is over 6%. The corresponding values for removing non agriculture are 0.38 and 3.43% respectively.

Environmental impacts

Results for pollutants emission changes are reported in Table 3. Considering the CO_2 equivalent as aggregation of CO_2, CH_4 and N_2O, we may conclude that Cutting agricultural tariffs results in slight emission reduction of all pollutants. Emission reduction induced by agricultural tariff removal is less than 0.5% which mainly happens via changing production composition. This means that production composition changes in favor of agricultural industries, energy products and manufacturing (Table 1) entails a less pollutant intensive production process. However, these changes in production composition also lead to increased emission of CO_2 and CH_4 from production process, but significant reduction in N_2O emission (4.66%) outweigh their increased emission, leading to CO_2 equivalent reduction of 2.5% from production process. Although, cutting agricultural industries tariff also results in reduction in pollutants emission mainly from energy source, like emission impacts of agricultural tariff removal its environmental impacts is not significant.

Like economic and welfare impacts, emission impact of non agricultural tariff removal also is larger than those obtained under cutting tariffs of agriculture and agricultural industries. Removal of non agricultural tariffs has emerged to reduce energy consumption, leading to

Table 2. Welfare impacts of trade reform in rural Iran (%).

Removing tariffs of	Income deciles	Removing tariffs of	1	2	3	4	5	6	7	8	9	10	overall
Agriculture		Agriculture	0.40	0.37	0.51	0.60	0.57	0.70	0.63	0.76	0.91	1.69	0.90
Agricultural industries		Agricultural industries	0.52	0.62	0.66	0.73	0.73	0.75	0.77	0.80	0.81	0.91	0.78
Non-agriculture		Non-agriculture	0.38	0.60	0.57	0.67	0.72	0.77	1.04	1.18	1.23	3.43	1.48
Total		Total	1.25	1.55	1.70	1.95	1.97	2.18	2.41	2.71	2.92	6.03	3.13

reduction in energy source emission of all pollutants. However, change in production process emission is not same for all pollutants. Regarding the CO_2 equivalent, cutting non agricultural tariff is expected to reduce the emission from production process except for SO_2 which increase slightly. Emission of CH_4 and N_2O increases (Table 3) as production of agriculture and agricultural industries as well as oil and gas sectors rises (Table 1). Reduction in emission of other pollutants from production process occurs since production of mining and manufacturing and energy products decreases as removing non agricultural tariffs. However, considering the total emission and accounting CO_2 equivalent as overall of CO_2, CH_4 and N_2O, non agricultural tariff removal can be regarded as policy that has positive environmental consequences which reduce the pollution at least by 1%.

Cutting tariffs of all sectors results in output reduction of energy intensive sectors like transportation and manufacturing (Table 1), leading to reduction in emission from energy sources. Output composition after cutting tariffs results in emission reduction from production process. While emission reduction for the most of pollutants from energy source is less than 2%, the reduction from production process for majority of pollutants is over 3%. Cutting tariffs disfavors non agricultural output and especially manufacturing and mining which lead to decrease in CO_2 (5.24%), CO (3.14%) and NO_x (5.96%) emission. Increased output of food industries and energy sectors also results in CH_4 increase. Output reduction of agricultural sectors accounts for 3.1% production based N_2O emission reduction. Although cutting import tariffs increase consumption and welfare, at the same time it induces an increase in non energy emission of CH_4 and N_2O which spoils a part of emission reduction caused from energy and production sources. Thus, increased consumption and welfare entails negative externality of more pollution.

Conclusion

The economic and environment consequences of trade reforms are a subject that is still much debated. However, a little effort has been made to examine the mentioned consequences in rural Iran. To address various interrelated issues among the sectors and economic agent we use CGE which is a standard comprehensive tool for integrated assessment of trade policies for small economies (Chemingui and Dessus, 2008). To provide a comprehensive implication for agricultural sectors we consider both of sectoral and rural welfare impacts. Cutting agricultural tariffs, compared to the initial equilibrium, increase these sectors import and induces output and price reduction, leading to decrease in agricultural producers' income. On the other hand, agricultural producers' community as rural households enjoys welfare gains. However, in terms of absolute changes, production impact exceeds that of welfare. Thus agricultural community as a whole loses from tariff removal in agricultural sectors. Similar conclusions on the impacts of tariff removal in agricultural industries can be derived.

Cutting non agricultural tariffs is disfavored only, among the agricultural sectors, by livestock and forestry, but livestock experiences slight output reduction of 0.4%. While other agricultural sectors experience output expansion over corresponding relative price reduction, expecting rise in agricultural producers' income. This scenario also contributes Iranian Economic Development Plan aim of non oil export expansion. At the same time rural households enjoys welfare gain which is

Table 3. Environmental impact of trade reform in Iran (%).

Removing tariffs of	Emission sources	CO_2	CH_4	N_2O	CO_2 equivalent	CO	NOx	SO_2
Agriculture	Energy consumption	0.06	0.04	-0.35	0.05	-0.00	-0.16	-0.34
	Production process	0.33	0.37	-4.66	-0.25	-1.55	-0.42	0.20
	Non-energy final consumption	-	0.75	0.79	0.77	-	-	-
	Total	0.11	0.43	-2.50	-0.01	-0.07	-0.16	-0.33
Agricultural industries	Energy consumption	-0.09	-0.11	-0.31	-0.09	-0.10	-0.23	-0.68
	Production process	0.53	-0.53	-0.87	-0.01	-0.14	0.42	0.48
	Non-energy final consumption	-	1.18	1.11	1.14	-	-	-
	Total	0.03	-0.27	-0.16	-0.02	-0.11	-0.22	-0.65
Non agriculture	Energy consumption	-1.36	-0.63	-0.42	-1.35	-0.10	-1.06	-2.82
	Production process	-6.04	0.31	2.51	-2.74	-1.39	-5.88	0.90
	Non-energy final consumption	-	3.28	2.96	3.12	-	-	-
	Total	-2.26	0.75	2.44	-1.59	-0.16	-1.14	-2.71
Total	Energy consumption	-1.38	-0.70	-1.09	-1.38	-0.20	-1.44	-3.83
	Production process	-5.24	0.15	-3.14	-3.06	-3.13	-5.96	1.54
	Non-energy final consumption	-	5.23	4.86	5.04	-	-	-
	Total	-2.13	0.90	-0.30	-1.63	-0.33	-1.51	-3.66

much higher than that obtained from tariff removal of agriculture and agricultural industries. Even if environmental impacts is also considered, cutting non agricultural sectors is more desired compared to doing it in agriculture and agricultural industries. Thus, non agricultural sectors may be more suitable starting point for cutting tariffs if we are more concerned about rural community and environment. However, according to Fourth WTO Ministerial Conference at Doha, in agriculture also substantial reductions in trade-distorting domestic support are needed to be accepted as a member of the WTO (Konandreas, 2003; Rae and Josling, 2003) which Iranian government plans to achieve. This means that finally cutting whole tariffs including agricultural tariffs is an obligation. Cutting whole of tariffs changes the agricultural output composition in favor of aquaculture, sugar beet, cotton and other agricultural sectors. However, other agriculture is a large sector containing horticultural and grains. Although net export of the most of agricultural sectors has emerged to decrease as cutting tariffs, regarding the absolute value of the net export especially in livestock and other agriculture, this scenario also is expected to expand agricultural export. In addition to agricultural sectors all tariff removal scenarios has some desired impact for Iranian economy as whole. It, compared to the initial equilibrium, drives up GDP while induces a fall in prices level. Only net export is disfavored by this policy; however this may be regarded as a cost of achieving better resources allocation and cost of

approaching a market based economy. Another negative externality is higher non energy consumption based emission that is accompanied by more consumption. However, higher welfare and higher consumption is cornerstone infollowing trade liberalization, needing to be focused on finding less pollution intensive consumption pattern.

As the macroeconomic impact illustrates, tariffs removal induces a welfare increase and emission reduction simultaneously like that is seen in North American Free Trade Agreement (NAFTA) (Grossman and Krueger, 1993) and OECD (Rae and Strutt, 2007) as well as Korea-Japan trade liberalization (Kang and Kim, 2004). This suggests that distortion caused from trade protection has negative externality more than lower output and welfare.

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