ANALYZING COLLECTIVE TRADE POLICY ACTIONS IN RESPOSNE TO CYCLICAL RISK IN AGRICULTURAL PRODUCTION: THE CASE OF THE INTERNATIONAL WHEAT MARKET

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Abstract: *This study shows how cyclical risk and collective trade policy actions can cumulatively worsen international food price spikes. By using spatial Computable General Equilibrium (CGE) and Eaton and Kortum's trade model, this study offers the following conclusions. At first, the cyclical shock in agricultural production might cause agricultural and food price spikes in the international agricultural and food markets. Second, export restrictions and import responses can worsen food price spikes and disrupt trade flows in international agricultural and food markets. Finally, the effect of these collective trade policy actions and resulting food price spikes in international agricultural and food markets do not dissipate even after agricultural production has recovered.*

Key words**:** *collective trade policy actions, cyclical risk, export restriction.*

JEL codes**:** F10, F13, F14, F18, O19, Q17, Q54.

Cyclical variation in agricultural production, which is worsening as a result of climate change (Avnery, et al., 2011 and Baldos and Hertel, 2013), has attracted growing concerns resulting from recent food price spikes in international agriculture and food markets.[1] According to Food and Agriculture Organization (FAO, 2009), strong food demand generates below-trend grain stock supplies in many countries, which leaves international food security more sensitive to cyclical risk in agricultural production. Anderson et al., (2006) states that international agriculture has achieved immense economic benefit through reduced barriers to free trade since 1994 when the Uruguay Round Agreement Act was signed by 123 countries almost all trade including agriculture.[2] However, the increasing vulnerability of international agricultural and food markets to cyclical variation in agricultural production appears to be enticing some agricultural exporting countries to implement distortive trade policies to insulate their domestic markets from international food demand. This new trend quickly caught worldwide attention because it can contribute to rising food prices in developing countries and result in food security concerns across the international agricultural and food market. Kulyk and Herzfeld (2015) observed that it is quite common among food exporting countries to implement export restrictions during food price hike periods.

While agricultural and food exporting countries could insulate their domestic market from food price spikes by implementing export restriction such as export tax, quota, or a complete export ban, agricultural and food importing countries, which have implemented freer trade policy since Uruguay Round Agreement, could try to absorb food price spikes by reducing import tariffs (or financing import subsidies). Since these polices generate financial burden to consumers, most developing countries suffer from increasing food security risk when faced by periods of increasing food prices. As Ivanic and Martin (2008) and Martin and Anderson (2012) state, those food price spikes can have large impacts on poverty in developing countries.

Recognizing such collective action problems, few studies have attempted to analyze the effect of cyclical uncertainty in agricultural production and consequent distortive trade policies on agricultural and food price, trade, and welfare. Tanaka and Hosoe (2011) recognized the risk of productivity shocks in rice exporting countries and export restriction on rice an importing country. By using stochastic CGE model with a *Monte Carlo* simulation, Tanaka and Hosoe (2011) quantified the welfare impacts of productivity shocks and export quotas of major rice exporting countries on the Japanese rice market and found little evidence of Japan suffering from such shocks. Yu et al. (2011) quantified trade policy responses to higher world agricultural commodity prices for a broad range of agricultural crops including grains, oilseeds, soybean, rapeseed, sunflower, palm, and peanuts. By using a set of multi-country, multi-commodity, and partial-equilibrium models, Yu et al. (2011) confirmed that over all, that trade policy responses in various countries increased prices of all agricultural commodities, although the impact on total net trade varied by commodity. Based on the findings of these previous studies, this analysis attempts to describe how productivity shocks and consequent collective trade policy actions affect food price and trade flow in a theoretical context. In doing so, key economic variables such as price elasticities of import demand and export supply will be simply treated as exogenous variables.

This study focus on how food price is affected by supply shocks and trade policies. In academia, it is common for economists to try to explain relationships between events such as supply shock and price or trade policy and price. In this context, Martin and Anderson (2011) tried to explain the relationship between price and exogenous supply and policy shocks. However, Martin and Anderson (2011) used a conceptual form model such that the model did not quantitatively indicate the impact on food price of supply and policy shocks. As Martin and Anderson (2011) supposed in response to supply shocks, agricultural exporting countries impose or raise an export tax or tighten export restrictions (or lower any export subsidy), while agricultural importing countries reduce their tariffs or other import restrictions (or introduce or raise import subsidies) to reduce the rise in their domestic price.

One thing I emphasize in real context is that agricultural export and import of each country are different. As a result, an importing country's trade policy response to offset the impact of supply and policy shocks occurring in an exporting country will generate a different impact on international agricultural and food markets even though both sets of countries try to reduce the impact of the shock on their market to the same extent. For example, Egypt in 2012 imported wheat from three different groups of exporting countries, which accounted for 53% of Egypt's total wheat supply. 27% of total imports originated from the "non-export restriction large wheat exporting countries group" which includes Australia, Canada, France, and U.S., 24% from the "export restriction large wheat exporting countries group" which includes Argentina, Russia, and Ukraine, and the reaming 2% from the "non-export restriction small wheat exporting countries group" which includes Belarus, Brazil, Lithuania, Moldova, and Romania. The remaining 47% was produced domestically. Consider a possible scenario where the "export restriction large and small counties group" charges an export tax on their wheat export and Egypt responds to this export tax by financing a proportional rate of import subsidy on its imports, then Egypt can offset the impact of export tax imposed by Argentina, Russia, and Ukraine. However, these two collective policy actions have serious impacts on the rest of the world. Martin and Anderson (2011) call it "a classic collective-action problem" and indicate that almost 30 percent of the observed change in the international price of wheat during 2005-08 can be explained by these collective trade policy actions.

In order to explain the collective-action problem, this study uses a spatial CGE model and Eaton and Kortum's trade model with trade data matrix obtained from FAO in 2012. The objective is to provide a comprehensive framework to understand the international wheat market under cyclical uncertainty and ensuing collective trade policy actions. This study takes into account risk factors in the form of a wide range of productivity shocks to world wheat supplies. Specifically, this study includes geographical restrictions into the model because trade economists emphasize that trade diminishes dramatically with distance and prices vary across locations, with greater differences between places farther apart (Eaton and Kortum, 2002 and Waugh, 2010).

This study is organized as follows. First, the general economy and household consumption is described using a spatial CGE model. Second, the linkage between cyclical fluctuations in agricultural production and food price and trade flow is explained using Eaton and Kortum (2002) spatial trade model. The next sections provides an overview of the international wheat market focusing on recent price surges under periods of cyclical uncertainty. Forth, five different counterfactual analyses are presented in order to quantify the impact of cyclical shocks in agricultural production and changes in border protection rates by both exporters and importers. Fifth, the analytical results of these analyses are then discussed with some conclusions offered in the final section.

General Economy and Household Consumption

The model development starts with the structure of a CGE model as described by Tanaka and Hosoe (2011). The model is extended to reflect cyclical shocks, resulting exporting and importing country responses to shocks including geographic costs in which 27 regional aggregations are made for agricultural producing, exporting, and importing countries. Large wheat exporting and importing countries represent each independent region and small wheat exporting and importing countries are one independent region depending on specific geography. The African region includes 11 small wheat exporting and importing countries, the American region includes 8, the Asian region includes 17, the European region includes 32, and the Oceanian region accounts for 1 country. So, 27 regional aggregations includes a total of 91 wheat exporting and importing countries (see Table 1). Each region has 8 different sectors, and two factors of labor and capital in its production activity (see Table 2).

[Approximately Here for Table 1]

[Approximately Here for Table 2]

Each sector is represented by a perfectly competitive profit-maximizing firm with a Leontief production function for gross output and with a constant elasticity of substitution (CES) production function for value-added components (see Figure 1). Among the value-added components, capital is assumed to be immobile among sectors in order to model relative short-run phenomena under unforeseen shocks in all counterfactual scenarios except for scenario 5 for which I will discuss later, presuming a situation where productivity shocks are observed after allocation of capital has been determined. In contrast, labor is assumed to be mobile among sectors. International factor mobility is not allowed. These factors are assumed to be fully employed with flexible factor price adjustments.

[Approximately Here for Figure 1]

Gross outputs are divided into domestic outputs and composite exports using a constant elasticity of transformation (CET) function. The domestic goods and composite imports are aggregated into composite goods using a CES function as assumed by Armington (1969). The composite imports consist of imports from various regions at that time when composite imports absorb geographic costs and exporter's trade distortion costs. Also, the composite exports are decomposed into exports to various regions at that time when the composite exports reflect cyclical shock and absorb importer's response. The elasticity of substitution represents the similarity of goods differentiated by the origin and destination of trade. Share parameters in the CES functions are calibrated to reproduce the actual trade flows of wheat. Exchange rates are flexibly adjusted so that the current account balance remains constant in U.S. dollar terms in all regions.

Composite goods are used for consumption by the representative household, as well as for government, investment, and intermediate input. Food commodities are aggregated to make food composite, which contributes to utility with non-food items (see Figure 2). This structure describes substitution among foods in household consumption with a CES function. If the commodity is non-food, it directly influences utility.

[Approximately Here for Figure 2]

This study conducts comparative static analysis considering the following scenario factors: 1) cyclical fluctuation in wheat sector; 2) non-differentiated export restriction imposed by a part of net wheat exporting countries; 3) non-differentiated importing response by high income net wheat importing countries; 4) non-differentiated export restriction imposed by all net wheat exporting countries; and 5) long-run resource allocation recovers international wheat production while maintaining export and import distortive trade policies.

Cyclical Risk, Food Price and Trade Flow

Assuming that the gross outputs in 27 regions is a continuum and production efficiency varies across regions and sectors, then a good *x* can be indexed by $x \in [0,1]$ in the continuum and a country *j*'s efficiency in producing good *x* can be defined as $z_j(x)$. The cost of a bundle of inputs is the same across commodities within a country because within a country inputs are mobile across activities and because activities do not differ in their input shares. However, in short-run, the farming sector cannot fully respond to unexpected shocks, which can be absorbed only by price adjustments. Now, let us assume that an exporting country *j*'s input cost is c_j with constant return to scale, then the cost of producing a unit of good *x* is $c_j / z_j(x)$. As discussed in the previous section, geographic costs and trade restrictions can be accounted for in the model. Then, the price of good *x* produced in country *j* and consumed in country *i* can be defined as follows:

(1) $$p_{ij}(x) = \frac{c_j}{z_j(x)} d_{ij} (t^0_{p_j} + s_i \Delta t_{p_j}),$$

where d_{ij} is a geographic distance, $t^0_{p_j}$ is initial level of export restriction imposed by exporting country *j* before productivity shock happens, and Δt_{p_j} is export restriction imposed by exporting county after productivity shock happens. $s_i = \frac{1}{|e_{m_i} / e_{x_j}| + 1}$ where e_{m_i} is price elasticity of import demand of importing country i and e_{x_j} is price elasticity of export supply of exporting country j and $0<s_i<1$ is the incidence of export tax borne by importing country i.

Simultaneously, importing country i can respond to an export tax by reducing import tariff (or financing import subsidy). Taking importing country i's response into account the price for good x can be redefined as follow:

(2) $$p_{ij}(x)=\frac{c_j}{z_j(x)}d_{ij}t,$$

where $t=\left(\frac{t_{p_j}^0+t_{c_i}^0}{2}\right)+s_i\left(\Delta t_{p_j}+\Delta t_{c_i}\right)$ where $\Delta t_{p_j}>0$ is an export tax imposed by exporting country j and $\Delta t_{c_i}<0$ is importer's response. If there is no trade distortion before productivity shocks happens, then $t_{p_j}^0=t_{c_i}^0=1$, implying that the importing country i should finance import subsidy to respond to the export tax. However, if exporting and importing countries are already implementing trade distortive policies before a productivity shocks happens, then $t_p^0>1$ and $t_c^0>1$, implying that importing country i can reduce import tariffs to respond to the export tax. However, both cases generate a financial burden on importing country i.

If importing country i proportionally responds to the export tax, then the price of good x in importing country i will be reduced as follows:

(3) $$p_{ij}(x)=\frac{c_j}{z_j(x)}d_{ij}.$$

Importing country i imports not only from exporting country j but also from another exporting country k. Therefore, if importing country i proportionally reduces import tariffs (or finance import subsidy) on all imports, then the price imported from country k is as follows:

(4) $$p_{ik}(x)=\frac{c_k}{z_k(x)}d_{ik}(t_{c_i}^0+s_i\Delta t_{c_i}).$$

Equations (2) and (4) show that $p_{ik}(x)$ in equation (4) is less than $p_{ij}(x)$ in equation (2). Therefore, trade flow of good *x* from exporting country *j* to importing country *i* reduces while trade flow from exporting country *k* to importing country *i* increases.

Cyclical Risk

Now, let us examine how cyclical fluctuation in agricultural production affects food price and trade flow. Eaton and Kortum (2002) assumed in their trade model that country *j*'s production efficiency is the realization of a random variable Z_j drawn independently from its country-specific probability distribution. The extreme probability theory provides a form for the probability distribution, $F_j(z)$, that makes a simple expression for the resulting distribution of prices called the *Type II* extreme value distribution as follows:

(5) $$F_j(z) = \Pr[Z_j < z] = e^{-T_j z^{-\theta}},$$

where $T_j > 0$ and $\theta > 1$. The distribution is independent across countries. The country-specific parameter T_j governs the location of the distribution. Therefore, a bigger T_j implies that a high efficiency draw for good *x* is more likely. The parameter θ is common to all countries and reflects the amount of variation within the distribution. In this study, the parameter T_j represents country *j*'s state of productivity, reflecting country *j*'s absolute advantage in a trade context while the parameter θ regulates heterogeneity across goods in countries' relative efficiencies, reflecting comparative advantage in a trade context. A lower value of θ, generating more heterogeneity, means that comparative advantage exerts a stronger force for trade against the resistance imposed by geographic distance and trade restriction.

Food Price and Trade Flow

Since production efficiency is a random variable, the price, p_{ij} in equation (2) is also random variable. Therefore, the probability distribution of the random variable, P_{ij} can be obtained by substituting equation (2) into equation (5). If there is a price *p* which is a maximum level of price in order to occur trade flow from country j to country i, then the probability distribution of the price for country j to export good x to country i is

(6) $$G_{ij}(p) = \Pr[P_{ij} < p] = 1 - e^{-T_j (c_j d_{ij} t)^{-\theta} p^{\theta}}.$$

This is a probability that $(c_j d_{ij} t)^{-\theta} / z_j(x)$ is less than $c_i / z_i(x)$. Equations (5) and (6) represent inverse relationship between production efficiency and price. Since other countries can export good x to country i, importing country i buys good x following the principle of the lowest price. Hence, the distribution for what country i actually buys is a joint probability distribution as follows:

(7) $$G_i(p) = 1 - e^{-\Phi_i p^{\theta}},$$

where $\Phi_i = \sum_{j=1}^{N} T_j (c_j d_{ij} t)^{-\theta}$ is a price parameter.

Eaton and Kortum (2002) obtained the aggregate price for the CES utility function, assuming $\sigma < 1 + \theta$, as follows:

(8) $$p_i = \gamma \left(\sum_{j=1}^{N} T_j (c_j d_{ij} t)^{-\theta} \right)^{-1/\theta}, \quad \gamma = \left[\Gamma\left(\frac{\theta + 1 - \sigma}{\theta} \right) \right]^{1/(1-\sigma)}.$$

Since $t = \left(\frac{t^0_{p_j} + t^0_{c_i}}{2} \right) + s_i \left(\Delta t_{p_j} + \Delta t_{c_i} \right)$ and $s_i = \frac{1}{|e_{m_i} / e_{x_j}| + 1}$, the aggregate price can be obtained as follows:

(9) $$p_i = \gamma \left(\sum_{j=1}^{N} T_j \left(c_j d_{ij} \left(\frac{t^0_{p_j} + t^0_{c_i}}{2} + \frac{\Delta t_{p_j} + \Delta t_{c_i}}{|e_{m_i} / e_{x_j}| + 1} \right) \right)^{-\theta} \right)^{-1/\theta}.$$

Also, since country i's average expenditure per good x does not vary by source, trade flow from country j to country i is the probability that country j exports good x at the lowest price in country i. Thus, trade flow can simply be expressed as country j's contribution to country i's price parameter as follows:

(10) $$\frac{X_{ij}}{X_i} = \frac{T_j (c_j d_{ij} t)^{-\theta}}{\Phi_i} = \frac{T_j \left(c_j d_{ij} \left(\frac{t_{p_j}^0 + t_{c_i}^0}{2} + \frac{\Delta t_{p_j} + \Delta t_{c_i}}{| e_{m_i} / e_{x_j} | + 1} \right) \right)^{-\theta}}{\sum_{k=1}^{N} T_k \left(c_k d_{ik} \left(\frac{t_{p_k}^0 + t_{c_i}^0}{2} + \frac{\Delta t_{p_k} + \Delta t_{c_i}}{| e_{m_i} / e_{x_k} | + 1} \right) \right)^{-\theta}} .$$

Equations (9) and (10) can be used to identify the impact of productivity shock and collective trade policy actions on price and trade flow given geographic distances, production costs, price elasticities of import demand and export supply, and degree of comparative advantage. Furthermore, these two equations can be used in a set of various counterfactual analyses to identify the impact of change in each country's market and policy behaviors on the international market. For example, the impact of change in price elasticity of import demand and/or export supply on price and trade flow in international agricultural and food market can be identified by using equations (9) and (10). Also, the impact of change in export tax and/or import subsidy on price and trade flow in international agricultural and food market can be identified. However, in this study the focus is on identifying the effects of productivity shock and consequent collective policy actions on price, trade flow and welfare in international wheat market. Since those equations include multi-countries, the impact of productivity shock and collective trade policy actions that occurred in parts of the world on multi-nation's welfare can be identified.

Overview on World Wheat Market

Global wheat exporting countries such as Argentina, Kazakhstan, Russia, and Ukraine implemented export restrictive policies and decreased their export supply to the international wheat market (Bouet and Laborde, 2010; Martin and Anderson, 2011; Yu et al., 2011; and Kulyk and Herzfeld, 2015). China switched to being a net importer of wheat due to trade policy change in 2009 (Yu et al., 2011). Significant decreases in import tariffs in India led to a higher domestic demand for imported wheat in 2006 and 2007 (Yu et al., 2011). Countries which did not adjust their import policy regimes in this environment decreased their imports of wheat due to higher prices in the international wheat market. The increases in Indian and Chinese wheat net imports were more than enough to offset the declines in wheat imports of other countries during the period of international wheat market price hikes. Martin and Anderson (2011) state that almost 30% of the observed change in the international price of wheat during 2005-08 can be explained by the changes in border protection rates. Yu et al., (2011) also show that those countries that did not implement the policy interventions encountered an increase in wheat price, while those which implemented policies saw a price decline.

Table 3 shows coefficient of variation of yields of 10 major wheat exporting countries during the last two decades. As seen, wheat yield variation is not least. As a result, the effect of cyclical variation in wheat productivity on international wheat market will be tangible. Depending on fluctuation of production, international wheat price jumped by 144% from $2.78/bushel in 2001 to $6.78/bushel in 2008. This price jump might be due to a negative productivity shock as well as consequent collective trade policy actions. During that period of time, Argentina, India, Kazakhstan, Russia and Ukraine implemented export restriction and decreased export supply to the international market.

[Approximately Here for Table 3]

Counterfactual Analyses

To quantify the economic impact of cyclical variation in agricultural production and trade distortive policies on the international wheat market, this study conducts comparative static analyses considering the following scenario factors: (1) productivity shocks occur in twenty-five net wheat exporting countries; (2) export restrictions on wheat trade imposed by fourteen net wheat exporting countries including Argentina, India, Kazakhstan, Russia, and Ukraine; (3) eighteen high income net wheat importing countries response to export restriction by reducing import restriction; (4) the other five major exporting countries including Australia, Canada, France, Germany, and U.S. implement export restrictions, and (5) international wheat production recovers through resource allocation but trade distortive policies implemented by exporting and importing countries still exist (see Table 1).

As benchmarked by using FAO 2012 trade data, trade flow $\left(X_{ij}\right)$, domestic consumption $\left(X_{ii}\right)$ and domestic production $\left(X_j\right)$ was calculated. Then by using equation (9), the benchmark value of aggregate price was estimated. In estimating aggregate price, the parameter values estimated by Eaton and Kortum for d_{ij} and θ were used, it was assumed that price elasticity of import demand $\left(e_{m_i}\right)$ was equal to price elasticity of export supply $\left(e_{x_j}\right)$ and there is no trade distortion at the beginning, $\left(t_p^0 = t_c^0 = 1\right)$. Then, the total expenditure was calculated using the following equations:

(11) $$TE = p_i \times X_i .$$

In counterfactual scenario 1, the yield shock is introduced in twenty-five net wheat exporting countries (see Table 1). Then by using equations (9) and (10), the counterfactual aggregate price and trade flow under yield shocks is estimated. And then, by comparing the estimates with benchmark values obtained from 2012 FAO trade data, the changes in price, trade flow, and welfare as change in total expenditure (EV, equivalent variation) are calculated.

In counterfactual scenario 2, five large and nine small net wheat exporting countries implement export restrictions by charging export tax in order to insulate their domestic price from world price spikes after yield shocks happen in twenty five wheat exporting countries. In this scenario, the government revenue of these fourteen exporting countries is calculated by using the following equation:

(12) $$GR_j = t_p \times \Delta\left(\sum_{i \neq j}^{N} p_i \times X_{ij}\right), \quad j = 1, \ldots, 14.$$

In counterfactual scenario 3, eighteen high income net wheat importing countries respond to the export restriction by financing import subsidy to stabilize their domestic price (see Table 1). In this scenario, the financial burden of these eighteen net wheat importing countries is calculated by using the following equation:

(13) $$GR_i = t_c \times \Delta\left(\sum_{j \neq i}^{N} p_i \times X_{ij}\right), \quad i = 1, \ldots, 18.$$

In counterfactual scenario 4, the other five large net wheat exporting countries that participate in implementing of export restrictions by charging the same amount of export tax to increase domestic supply under high pressure on price, which occurs after international wheat supply decreases and trade distortive policies are enacted. Then, in counterfactual scenario 5, the impact of these trade distortive policies on price, trade flow, and welfare are analyzed even after the supply shocks disappear. In each scenario, the changes in price, trade flow, welfare as equivalent variation, government revenue and burden are calculated.

Analytical Results

In order to quantify the effect of cyclical shock on international wheat market, a set of counterfactual analyses based on five different scenarios were conducted. For counterfactual scenario 1, yield data was obtained for 1993 to 2012 for twenty five net wheat exporting countries. The annual yield by time variable is regressed in order to estimate average yield without time trend. And then, a 95% confident intervals with minimum values was calculated. The regression mean is lower than the simple arithmetic mean except for Slovakia. This is because the annual yield shows an upward trend during 1993-2012 except for Slovakia, which showed a downward trend during that period of time. Kazakhstan shows the largest yield variation by ± 30% while U.S. and Germany is the smallest by ± 6% during the period of time. The average yield variation is ± 12% in twenty five wheat net exporting countries (see Table 4). In this study, a negative 12% yield shocks is utilized in the counterfactual scenarios.

[Approximately Here for Table 4]

In general, a negative cyclical shock increases wheat price and decreases wheat trade in all countries. However, the magnitude of a yield shock effect on each country is different. As Table 5 shows, effect of yield shock directly affects net wheat exporting countries where yield shocks happened, which is then transferred to importing countries so that the effect of yield shock is larger in net wheat exporting countries than in net wheat importing countries. Table 5 shows that yield shock increases domestic price, on average, by 17.9% for net wheat exporting countries while yield shock increases domestic price by 7.4%

for net wheat importing countries. Among net wheat importing countries, if wheat consumption in a net wheat importing country depends mainly on domestic wheat, then the effect of shock is smaller. Conversely, wheat consumption in a net wheat importing country that depends mainly on imported wheat, the effect of a shock is larger. 96% of China's wheat consumption depends on domestic wheat and 94% of Iranian wheat consumption depends on domestic wheat so that these countries have a relatively small effect on the shock while Brazil (77%), Japan (87%), Korea (99%), and Morocco (96%) heavily depend on imported wheat so that the effect of a shock is larger in these countries. Also, the effect of a yield shock on wheat net importing countries depends on from where they import. For example, if a net wheat importing country imports wheat from small yield variation country then the effect of yield shock is relatively small, while if a net wheat importing country import wheat from large yield variation country then the effect of yield shock is relatively large. By region, the effect of a yield shock is larger in African, Asian, and American regions, while the effect of yield shock is smaller in European and Oceanian regions. As a whole, the result shows that if average yield decreases by 12%, then international wheat price increases by 10.95%, domestic consumption decreases by 6.82%, trade flow decreases by 10.10% and international welfare measured by equivalent variation decreases by 8.46%.

[Approximately Here for Table 5]

As seen in counterfactual scenario 1, the yield shock largely affects net wheat exporting countries resulting in the implementation of export restrictions to stabilize domestic price and supply. In order to identify the effect of export restrictions on the international wheat market, a counterfactual analysis was conducted based on counterfactual scenario 2. Counterfactual scenario 2 assumes that at first wheat production decreases in twenty five wheat net exporting countries and then fourteen wheat exporting countries implement export restriction by charging 30% export tax (see Table 1). In counterfactual scenario 2, the case of exports restriction implemented during the food crisis (2006-2008) reported by Bouet and Laborde (2010) was used.

As expected, Table 6 shows that implementation of export tax alleviates domestic price spikes and consumption decreases caused by yield shocks in these fourteen export restriction implementing countries, while aggravating domestic price hike and trade flow in other countries. Tables 5 and 6 show that increasing rates of domestic prices are reduced from 15.92% to 0.80% for Argentina, from 20.90% to 5.41% for India, from 42.31% to 23.93% for Kazakhstan, from 16.45% to 1.34% for Russia, and from 22.88% to 6.86% for Ukraine by implementing export tax in these countries, while increasing rates of domestic prices increase from 8.7% to 10.9% on average for other countries. As a result, total consumption in fourteen export restriction implementing countries recovers, while total consumption in other countries decreases. The implementation of export restrictions worsen price spikes caused by yield shocks in 80 countries, while ease price spike only in 11 countries. As a whole, implementation of export restrictions increases international wheat price by 12.55% and decreases wheat trade by 12.61% and decrease international welfare by 8.26% as measured by equivalent variation.

[Approximately Here for Table 6]

As seen in counterfactual scenarios 1 and 2, productivity shocks and implementation of export restrictions increases international wheat price. In order to respond to price spikes in the international wheat market, high income net wheat importing countries try to implement import subsidies. In order to identify the effect of high income net wheat importing countries' responses to price hike on international wheat market, a counterfactual analysis was conducted based on counterfactual scenario 3. Counterfactual scenario 3 assumes that high income net wheat importing countries implement releasing import restrictions by financing a 30% import subsidy when faced with a price hike in the international wheat market (see Table 1).

Table 7 shows that implementation of an import subsidy eases domestic price spikes and trade flow in these high income net wheat importing countries while worsening domestic price spikes and trade flow in other net wheat importing countries. One thing this study notes is that the effect of an import subsidy implemented by high income net wheat importing countries on international wheat price and trade flow is relatively small while very large on lower income net wheat importing countries. As Table 7 shows, the implementation of import subsidy reduces price spike caused by yield shocks and export restriction on average by 1% for high income net wheat importing countries such as Italy, Japan, Korea, and Spain, while the implementation of import subsidy raises price spike by 20% for lower income net wheat importing countries such as Algeria, Brazil, Egypt, Indonesia, Iran, Mexico, and Morocco. Furthermore, implementation of import subsidy can worsen price spikes caused by yield shocks and export restrictions in 75 countries while releasing price spike only in 16 countries. As a whole, implementation of import subsidy increases international wheat price by 26.22%, and decreases trade flow by 18.80% and decrease international welfare by 17.03%.

[Approximately Here for Table 7]

The previous results confirm the cumulative effects of yield shocks and collective trade policy actions on the international wheat market. Although the distortive trade policies worsen the international wheat market, the distortive trade policies can recover their domestic market from cyclical shocks in agricultural production. This fact will encourage other countries to participate in implementing trade distortive policies to protect their domestic market from cyclical shocks in agricultural production. In this context, a counterfactual analysis based on counterfactual scenario 4 was conducted. In counterfactual scenario 4, five major wheat exporting countries such as Australia, Canada, France, Germany, and U.S. participate in implementing export restriction by charging 30% export tax.

As expected, Table 8 shows that wheat price increases and trade decreases in all countries. Since these five countries represent 55% of total international wheat trade, if these countries implement export restriction then most countries might be affected so that wheat price increases and trade decreases in all countries. Furthermore, international wheat price increases by more than 36% and trade decrease by 22%. As a result, if exporting and importing countries implement distortive trade policies in order to reduce the effect of cyclical shock in agricultural production, then these distortive trade policies will worsen wheat consumers in developing countries by increasing international wheat price and decreasing trade flow cumulatively.

[Approximately Here for Table 8]

Lastly, a counterfactual analysis was conducted in order to confirm the effect of these distortive trade policies on international wheat market after recovering agricultural production in counterfactual scenario 5. Table 9 shows that although agricultural production is recovered in all countries, the international wheat price increases and trade decreases with these trade distortive policies.

[Approximately Here for Table 9]

Conclusion

In the 2000s, food price spikes in international agricultural and food market pressured food consumers in developing countries. Many household in low income countries were face with added economic hardship. Beginning from strong demand for agricultural goods from bioenergy boom, the cyclical variation on the supply side have contributed to the recent food price spike. It is common in agricultural markets that a small reduction in agricultural production causes a large price effect in the market. Therefore, agricultural exporting countries try to stabilize the domestic market when they have a comparable poor production. Often, they try to implement distortive trade policies to restrict agricultural export. The distortive trade policy makes the international agricultural market worse by increasing price and decreasing trade flow. This effect of export restriction on price and trade flow might stimulate importing countries to respond to international agricultural and food price spikes.

Although high income importing countries can implement an import subsidy (or reduce import tariff) to ease domestic price, the response of high income importing countries makes lower income importing countries worse because the response of high income importing countries increase the international food price more. Furthermore, since this policy generates a financial burden or reduces government revenue, lower income importing countries find it more difficult to respond to agricultural and food price spikes caused by yield shocks and collective policy actions. As a result, food consumers in low income countries suffer more from international food price spikes. As this study confirmed, these trade distortive policies affect international agricultural and food markets even after agricultural production has recovered. Since the Uruguay Round Agreement in 1994, the international agricultural sector has benefited from free trade. However, the recent food price hike caused from cyclical variation and distortive trade policy might threaten the benefit of free trade.

In this context, this study tried to contribute to a better understanding about how cyclical shocks and trade distortive policies can worsen international food price spikes cumulatively. In a way, this study provides a different approach in analyzing the recent emerging issue in agricultural and food markets. The first part of his study describes the whole global economy and utility to understand what is concerned in international agricultural and food markets by using a spatial CGE model. Second, this study illustrates the relationship between cyclical shocks and aggregate price by using Eaton and Kortum’s spatial trade model. Third, the model used by this study quantifies the effect of cyclical shocks and collective policy actions on price, trade flow, and welfare. Fourth, price elasticities effect on international agricultural market can be tested in counterfactual scenarios by examining different ranges of price sensitivity in food consumers and producers. Furthermore, many other micro- and macro-economic variables affecting international agricultural and food market can be tested by modifying the model.

This study confirms the following three points. At first, the cyclical shock in agricultural production causes agricultural and food price spikes in the international agricultural and food market. Second, export restriction and import responses worsen food price spikes and trade flow in the international agricultural and food market. Finally, the effect of these collective policy actions on food price spikes in the international agricultural and food market does not dissipate even after agricultural production has recovered.

Footnote 1.

The Intergovernmental Panel on Climate Change (IPCC) reported on March 2014 that extreme climate and weather events will, *with high confidence*, reduce food production.

Footnote 2.

Uruguay Round Agreement, spanning from 1986 to 1994 and embracing 123 countries as contracting parties, achieved greater liberalization of trade in agriculture and bring all measures affecting import access and export competition under strengthened and more operationally effective rules and disciplines and led to create World Trade Organization (WTO) in 1995.

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Table 1. List of Countries in Five Counterfactual Scenarios.

Country	Region	Scenario 1 (25 Countries)	Scenario 2 (14 Countries)	Scenario 3 (18 Countries)	Scenario 4 (19 Countries)	Scenario 5 (25 Countries)
Albania	Europe					
Algeria	Large Importer					
Argentina	Large Exporter	Yield Shock	Export Tax		Export Tax	Yield Recover
Armenia	Asia					
Australia	Large Exporter	Yield Shock			Export Tax	Yield Recover
Austria	Europe	Yield Shock				Yield Recover
Azerbaijan	Asia					
Bangladesh	Asia					
Belarus	Europe					
Belgium	Europe			Import Subsidy		
Bhutan	Asia					
Bolivia	America		Export Tax		Export Tax	
B & H	Europe					
Brazil	Large Importer					
Bulgaria	Europe	Yield Shock				Yield Recover
Burundi	Africa					
Canada	Large Exporter	Yield Shock			Export Tax	Yield Recover
Chile	America					
China	Large Importer		Export Tax		Export Tax	
Colombia	America					
Croatia	Europe	Yield Shock				Yield Recover
Cyprus	Europe			Import Subsidy		
Czech	Europe	Yield Shock				Yield Recover
Denmark	Europe	Yield Shock				Yield Recover
Ecuador	America		Export Tax		Export Tax	
Egypt	Large Importer					
Estonia	Europe	Yield Shock				Yield Recover
Ethiopia	Africa		Export Tax		Export Tax	
Finland	Europe	Yield Shock				Yield Recover
France	Large Exporter	Yield Shock			Export Tax	Yield Recover
Germany	Large Exporter	Yield Shock			Export Tax	Yield Recover
Greece	Europe			Import Subsidy		
Hungary	Europe	Yield Shock				Yield Recover
India	Large Exporter	Yield Shock	Export Tax		Export Tax	Yield Recover
Indonesia	Large Importer					
Iran	Large Importer		Export Tax		Export Tax	
Ireland	Europe			Import Subsidy		
Israel	Asia			Import Subsidy		
Italy	Large Importer			Import Subsidy		
Japan	Large Importer			Import Subsidy		
Jordan	Asia					
Kazakhstan	Large Exporter	Yield Shock	Export Tax		Export Tax	Yield Recover
Kenya	Africa					
Kyrgyzstan	Asia					
Latvia	Europe	Yield Shock				Yield Recover
Lebanon	Asia					
Lithuania	Europe					
Luxembourg	Europe			Import Subsidy		
Madagascar	Africa					
Malaysia	Asia					

Mexico	Large Importer					
Morocco	Large Importer					
Nepal	Asia		Export Tax		Export Tax	
Netherlands	Europe			Import Subsidy		
New Zealand	Oceania			Import Subsidy		
Niger	Africa		Export Tax		Export Tax	
Nigeria	Africa					
Norway	Europe			Import Subsidy		
Oman	Asia					
Pakistan	Asia	Yield Shock	Export Tax		Export Tax	Yield Recover
Paraguay	America	Yield Shock				Yield Recover
Peru	America					
Philippines	Asia					
Poland	Europe	Yield Shock				Yield Recover
Portugal	Europe			Import Subsidy		
Korea	Large Importer			Import Subsidy		
Moldova	Europe					
Romania	Europe	Yield Shock				Yield Recover
Russia	Large Exporter	Yield Shock	Export Tax		Export Tax	Yield Recover
Rwanda	Africa					
Saudi Arabia	Asia			Import Subsidy		
Serbia	Europe					
Slovakia	Europe	Yield Shock				Yield Recover
Slovenia	Europe			Import Subsidy		
South Africa	Africa					
Spain	Large Importer			Import Subsidy		
Sri Lanka	Asia					
Sweden	Europe			Import Subsidy		
Switzerland	Europe					
Thailand	Asia					
Tunisia	Africa					
Turkey	Europe					
Uganda	Africa					
Ukraine	Large Exporter	Yield Shock	Export Tax		Export Tax	Yield Recover
United Kingdom	Europe			Import Subsidy		
Tanzania	Africa		Export Tax		Export Tax	
United States	Large Exporter	Yield Shock			Export Tax	Yield Recover
Uruguay	America	Yield Shock				Yield Recover
Venezuela	America					
Yemen	Asia					
Zimbabwe	Africa					

Note: B&H is Bosnia and Herzegovina.

Table 2. List of Regions, Sectors, and Factors in the Model .

Region	Sector	Factor
Algeria^{M}	Wheat^{F}	Labor
Argentina^{X}	Other grains^{F}	Capital
Australia^{X}	Other agriculture^{F}	
Brazil^{M}	Processed wheat^{F}	
Canada^{X}	Other food^{F}	
China^{M}	Manufacturing	
Egypt^{M}	Services	
France^{X}	Transportion	
Germany^{X}		
India^{X}		
Indonesia^{M}		
Iran^{M}		
Italy^{M}		
Japan^{M}		
Kazakhstan^{X}		
Korea^{M}		
Mexico^{M}		
Moroco^{M}		
Russia^{X}		
Spain^{M}		
U.S.^{X}		
Ukraine^{X}		
Other Africa (includes 12 subregions)		
Other America (includes 8 subregions)		
Other Asia (includes 17 subregions)		
Other Europe (includes 31 subregions)		
Other Oceania (includes 1 subregion)		

Notes: ^{X} indicates large wheat exporters, representing 85% of world wheat exports.

^{M} indicates large wheat importers, representing 45% of world wheat imports.

^{F} indicates food commodities used for the food composite.

Table 3. Coefficient of Variation in Wheat Yields of Ten Large Net Wheat Exporting Countries.

	Argentina	Australia	Canada	France	Germany	India	Kazakhstan	Russia	Ukraine	U.S.
C.V.	21.5	15.9	13.2	6.6	9.6	6.3	12.8	8.3	16.9	12.0

Table 4.Mean and Variation in Wheat Yield in Wheat Net Exporting Countries from 1993 to 2012.

Mean	Argentina	Australia	Canada	France	Germany	India	Kazakhstan	Russia	Ukraine	US
Arithmetic	0.3272	0.2261	0.3275	0.9064	0.9529	0.3542	0.1293	0.2462	0.3738	0.3661
Regression	0.2699	0.2338	0.2571	0.8854	0.8848	0.3075	0.1113	0.1987	0.3645	0.3253
t-value	15.20	10.22	16.32	31.63	32.42	10.05	6.99	14.83	11.20	33.46
Min[a]	0.2328	0.1861	0.2243	0.8270	0.8279	0.2542	0.0781	0.1707	0.2966	0.3050
Max[b]	0.3069	0.2815	0.2900	0.9438	0.9418	0.3607	0.1445	0.2266	0.4324	0.3455
Δ% Min[c]	-13.72	-20.41	-12.78	-6.59	-6.43	-17.32	-29.82	-14.07	-18.63	-6.24
Δ% Max[d]	13.72	20.41	12.78	6.59	6.43	17.32	29.82	14.07	18.63	6.24

Mean	Austria	Bulgaria	Croatia	Czech	Denmark	Estonia	Finland	Hungary	Latvia	Pakistan
Arithmetic	0.5084	0.3151	0.4323	0.4845	0.7198	0.2515	0.3613	0.3999	0.3024	0.2402
Regression	0.4959	0.2416	0.3549	0.4282	0.7136	0.1576	0.3421	0.3785	0.1986	0.1925
t-value	22.38	11.12	15.22	20.19	37.47	9.09	17.55	13.19	14.15	42.53
Min[a]	0.4495	0.1961	0.3061	0.3838	0.6737	0.1213	0.3013	0.3184	0.1693	0.1830
Max[b]	0.5423	0.2870	0.4037	0.4725	0.7534	0.1939	0.3829	0.4385	0.2280	0.2020
Δ% Min[c]	-9.35	-18.82	-13.76	-10.36	-5.59	-23.02	-11.92	-15.87	-14.79	-4.92
Δ% Max[d]	9.35	18.82	13.76	10.36	5.59	23.02	11.92	15.87	14.79	4.92

Mean	Paraguay	Poland	Romania	Slovakia	Uruguay
Arithmetic	0.1999	0.3754	0.2711	0.4114	0.5518
Regression	0.1404	0.3201	0.2387	0.4230	0.2021
t-value	7.92	27.94	9.15	16.69	7.97
Min[a]	0.1033	0.2961	0.1840	0.3700	0.1491
Max[b]	0.1775	0.3440	0.2933	0.4761	0.2552
Δ% Min[c]	-26.43	-7.49	-22.89	-12.54	-26.25
Δ% Max[d]	26.43	7.49	22.89	12.54	26.25

Note: [a] Min represents a minimum value in regression mean in 95% confident intervals.

[b] Max represents a maximum value in regression mean in 95% confident intervals.

[c] Δ% Min represents percentage change from regression mean to Min.

[d] Δ% Max represents percentage change from regression mean to Max.

Table 5. Counterfactual Scenario 1.

	Negative Yield Shocks in 25 Net Wheat Exporting Countries[A]					
	ΔP_i	ΔX_i	ΔX_{ii}	ΔX_{ij}	EV	ΔGR
Algeria[M]	6.85	-6.41	0.00	-7.09	0.06	0.00
Argentina[X]	15.92	-13.74	-13.74	-6.53	0.14	0.00
Australia[X]	25.61	-20.39	-20.39	-0.01	0.20	0.00
Brazil[M]	11.60	-10.39	0.00	-15.29	0.10	0.00
Canada[X]	14.60	-12.74	-12.77	-6.23	0.13	0.00
China[M]	0.13	-0.13	0.00	-15.56	0.00	0.00
Egypt[M]	2.38	-2.32	0.00	-11.04	0.02	0.00
France[X]	7.05	-6.59	-6.59	-5.19	0.07	0.00
Germany[X]	6.91	-6.46	-6.43	-7.01	0.06	0.00
India[X]	20.90	-17.29	-17.32	-14.86	0.17	0.00
Indonesia[M]	21.49	-17.69	0.00	-17.69	0.18	0.00
Iran[M]	0.34	-0.33	0.00	-5.67	0.00	0.00
Italy[M]	3.30	-3.20	0.00	-9.01	0.03	0.00
Japan[M]	7.56	-7.03	0.00	-10.90	0.07	0.00
Kazakhstan[X]	42.31	-29.73	-29.81	-14.07	0.30	0.00
Korea[M]	15.82	-13.66	0.00	-13.98	0.14	0.00
Mexico[M]	1.97	-1.93	0.00	-7.38	0.02	0.00
Moroco[M]	12.29	-10.94	0.00	-11.27	0.11	0.00
Russia[X]	16.45	-14.13	-14.07	-29.65	0.14	0.00
Spain[M]	5.10	-4.86	0.00	-9.54	0.05	0.00
Ukraine[X]	22.88	-18.62	-18.62	-8.01	0.19	0.00
U.S.[X]	6.77	-6.34	-6.23	-11.26	0.06	0.00
Africa (12)	8.93	-6.65	0.00	-10.22	0.88	0.00
America (8)	13.58	-14.41	-16.25	-11.39	1.03	0.00
Asia (17)	11.91	-6.71	-0.82	-13.67	1.45	0.00
Europe (31)	8.60	-6.08	-5.66	-7.77	2.12	0.00
Oceania (1)	3.50	-3.38	0.00	-20.39	0.03	0.00
ROW (1)	2.92	-2.83	0.00	-12.96	0.03	0.00
World	10.95	-7.60	-6.82	-10.10	8.46	0.00

Note: ΔP_i represents a percentage change in aggregate wheat price in country *i*.

ΔX_i represents a percentage change in total wheat consumption in country i.

ΔX_{ii} represent a percentage change in domestic wheat consumption in country i.

ΔX_{ij} represent a percentage change in imported wheat consumption in country i.

ΔX_j represent a percentage change in total wheat production in country i.

[A] see Appendix I.

Table 6. Counterfactual Scenario 2.

	30% Export Tax by 14 Countries[A]					
	ΔP_i	ΔX_i	ΔX_{ii}	ΔX_{ij}	EV	ΔGR
Algeria[M]	7.22	-6.74	0.00	-7.45	0.07	0.00
Argentina[X]	0.80	-0.80	-0.80	-6.53	0.01	0.00
Australia[X]	25.61	-20.39	-20.39	-0.01	0.20	0.00
Brazil[M]	20.52	-17.03	0.00	-25.05	0.17	0.00
Canada[X]	14.60	-12.74	-12.77	-6.23	0.13	0.00
China[M]	-12.84	14.73	15.00	-16.12	-0.15	0.00
Egypt[M]	3.40	-3.29	0.00	-15.64	0.03	0.00
France[X]	7.05	-6.59	-6.59	-5.20	0.07	0.00
Germany[X]	6.91	-6.47	-6.43	-7.05	0.06	0.00
India[X]	5.41	-5.13	-4.92	-20.08	0.05	0.00
Indonesia[M]	22.15	-18.13	0.00	-18.13	0.18	0.00
Iran[M]	-12.01	13.65	15.00	-7.82	-0.14	0.01
Italy[M]	3.48	-3.37	0.00	-9.49	0.03	0.00
Japan[M]	7.56	-7.03	0.00	-10.91	0.07	0.00
Kazakhstan[X]	23.93	-19.31	-19.28	-25.27	0.19	0.00
Korea[M]	18.23	-15.42	0.00	-15.77	0.15	0.00
Mexico[M]	2.01	-1.97	0.00	-7.51	0.02	0.00
Moroco[M]	16.62	-14.25	0.00	-14.68	0.14	0.00
Russia[X]	1.34	-1.32	-1.18	-38.75	0.01	0.00
Spain[M]	6.64	-6.22	0.00	-12.22	0.06	0.00
Ukraine[X]	6.86	-6.42	-6.42	-9.00	0.06	0.00
U.S.[X]	6.77	-6.34	-6.23	-11.27	0.06	0.00
Africa (12)	13.13	-8.16	4.77	-15.09	1.15	0.50
America (8)	15.29	-15.15	-14.85	-15.64	1.10	0.39
Asia (17)	14.72	-6.30	3.73	-18.15	1.57	0.01
Europe (31)	9.15	-6.20	-5.66	-8.40	2.20	0.00
Oceania (1)	3.50	-3.38	0.00	-20.39	0.03	0.00
ROW (1)	3.78	-3.64	0.00	-16.66	0.04	0.00
World	12.55	-6.60	-4.73	-12.61	8.26	1.29

Table 7. Counterfactual Scenario 3.

	30% Import Subsidy by High Income Net Wheat Importing Countries[A]					
	ΔP_i	ΔX_i	ΔX_{ii}	ΔX_{ij}	EV	ΔGR
Algeria[M]	23.26	-18.87	-13.04	-19.48	0.19	0.00
Argentina[X]	-10.83	12.14	12.14	-18.72	-0.12	0.00
Australia[X]	44.45	-30.77	-30.78	-13.05	0.31	0.00
Brazil[M]	37.34	-27.19	-13.04	-33.85	0.27	0.00
Canada[X]	31.79	-24.12	-24.15	-18.46	0.24	0.00
China[M]	-22.79	29.51	30.00	-27.00	-0.30	0.00
Egypt[M]	18.78	-15.81	-13.04	-26.18	0.16	0.00
France[X]	23.11	-18.77	-18.78	-17.56	0.19	0.00
Germany[X]	22.95	-18.67	-18.64	-19.17	0.19	0.00
India[X]	57.01	-36.31	-36.40	-29.98	0.36	0.00
Indonesia[M]	40.38	-28.77	-13.04	-28.77	0.29	0.00
Iran[M]	29.66	-22.87	-23.08	-19.63	0.23	0.02
Italy[M]	3.30	-3.20	0.00	-9.01	0.03	-0.10
Japan[M]	7.56	-7.03	0.00	-10.90	0.07	-0.19
Kazakhstan[X]	9.75	-8.88	-8.75	-33.89	0.09	0.00
Korea[M]	15.84	-13.68	0.00	-13.99	0.14	-0.29
Mexico[M]	17.30	-14.75	-13.04	-19.56	0.15	0.00
Moroco[M]	33.52	-25.10	-13.04	-25.46	0.25	0.00
Russia[X]	51.39	-33.94	-33.90	-45.83	0.34	0.00
Spain[M]	5.10	-4.86	0.00	-9.54	0.05	-0.15
Ukraine[X]	59.75	-37.40	-37.40	-20.77	0.37	0.00
U.S.[X]	22.79	-18.56	-18.46	-22.84	0.19	0.00
Africa (12)	27.13	-16.69	0.06	-25.68	2.19	0.48
America (8)	29.49	-24.32	-23.17	-26.22	1.80	0.37
Asia (17)	30.53	-15.62	-7.17	-25.60	3.24	-0.38
Europe (31)	20.35	-13.38	-13.84	-11.48	4.55	-1.43
Oceania (1)	3.50	-3.38	0.00	-20.39	0.03	-0.04
ROW (1)	19.23	-16.13	-13.04	-27.16	0.16	0.00
World	26.22	-15.36	-14.28	-18.80	17.03	-2.39

Table 8. Counterfactual Scenario 4.

	30% Export Tax by 19 Net Wheat Exporting Countries[A]					
	ΔP_i	ΔX_i	ΔX_{ii}	ΔX_{ij}	EV	ΔGR
Algeria[M]	36.24	-26.60	-13.04	-28.03	0.27	0.00
Argentina[X]	50.70	-33.64	-33.64	-24.44	0.34	0.00
Australia[X]	63.29	-38.76	-38.76	-13.05	0.39	0.00
Brazil[M]	38.62	-27.86	-13.04	-34.84	0.28	0.00
Canada[X]	48.98	-32.88	-32.90	-27.86	0.33	0.00
China[M]	30.17	-23.18	-23.08	-35.04	0.23	0.00
Egypt[M]	20.39	-16.93	-13.04	-31.53	0.17	0.00
France[X]	39.15	-28.14	-28.15	-24.74	0.28	0.00
Germany[X]	38.75	-27.93	-28.03	-26.20	0.28	0.02
India[X]	57.17	-36.37	-36.40	-34.51	0.36	0.00
Indonesia[M]	57.93	-36.68	-13.04	-36.68	0.37	0.00
Iran[M]	29.74	-22.92	-23.08	-20.44	0.23	0.02
Italy[M]	3.30	-3.20	0.00	-9.01	0.03	-0.10
Japan[M]	7.56	-7.03	0.00	-10.90	0.07	-0.19
Kazakhstan[X]	85.00	-45.95	-46.01	-33.89	0.46	0.00
Korea[M]	15.82	-13.66	0.00	-13.98	0.14	-0.29
Mexico[M]	20.71	-17.16	-13.04	-28.76	0.17	0.00
Moroco[M]	45.23	-31.14	-13.04	-31.68	0.31	0.00
Russia[X]	51.39	-33.94	-33.90	-45.88	0.34	0.00
Spain[M]	6.99	-6.53	0.00	-12.83	0.07	-0.14
Ukraine[X]	59.75	-37.40	-37.40	-28.81	0.37	0.00
U.S.[X]	38.76	-27.93	-27.87	-30.55	0.28	0.01
Africa (12)	36.12	-24.82	-16.23	-29.43	3.05	0.53
America (8)	46.29	-32.31	-32.67	-31.73	2.54	0.41
Asia (17)	39.54	-21.56	-15.54	-28.66	4.13	-0.38
Europe (31)	26.33	-16.98	-17.93	-13.15	5.60	-1.43
Oceania (1)	3.50	-3.38	0.00	-20.39	0.03	-0.04
ROW (1)	20.90	-17.29	-13.04	-32.44	0.17	0.00
World	36.11	-21.54	-21.45	-21.81	23.14	-2.23

Table 9. Counterfactual Scenario 5.

	Yield Recorver in 25 Net Wheat Exporting Countries[A]					
	ΔP_i	ΔX_i	ΔX_{ii}	ΔX_{ij}	EV	ΔGR
Algeria[M]	27.66	-21.67	-13.04	-22.58	0.22	0.00
Argentina[X]	30.00	-23.08	-23.08	-19.41	0.23	0.00
Australia[X]	30.00	-23.08	-23.08	-13.05	0.23	0.00
Brazil[M]	24.79	-19.86	-13.04	-23.08	0.20	0.00
Canada[X]	30.00	-23.08	-23.08	-23.07	0.23	0.00
China[M]	30.00	-23.08	-23.08	-23.07	0.23	0.00
Egypt[M]	17.85	-15.15	-13.04	-23.03	0.15	0.00
France[X]	29.99	-23.07	-23.08	-20.75	0.23	0.00
Germany[X]	29.80	-22.96	-23.08	-20.81	0.23	0.02
India[X]	30.00	-23.08	-23.08	-23.08	0.23	0.00
Indonesia[M]	29.99	-23.07	-13.04	-23.07	0.23	0.00
Iran[M]	29.31	-22.66	-23.08	-16.08	0.23	0.02
Italy[M]	0.00	0.00	0.00	0.00	0.00	-0.11
Japan[M]	0.00	0.00	0.00	0.00	0.00	-0.19
Kazakhstan[X]	30.00	-23.08	-23.08	-23.07	0.23	0.00
Korea[M]	0.00	0.00	0.00	0.00	0.00	-0.29
Mexico[M]	18.58	-15.67	-13.04	-23.08	0.16	0.00
Moroco[M]	29.41	-22.72	-13.04	-23.01	0.23	0.00
Russia[X]	30.00	-23.08	-23.08	-23.07	0.23	0.00
Spain[M]	2.05	-2.01	0.00	-3.95	0.02	-0.15
Ukraine[X]	30.00	-23.08	-23.08	-22.64	0.23	0.00
U.S.[X]	29.95	-23.05	-23.08	-21.89	0.23	0.01
Africa (12)	25.19	-19.70	-16.23	-21.57	2.37	0.54
America (8)	28.80	-21.23	-20.17	-22.97	1.75	0.42
Asia (17)	24.50	-16.29	-14.92	-17.91	3.00	-0.39
Europe (31)	15.90	-12.08	-13.58	-6.04	3.88	-1.48
Oceania (1)	0.00	0.00	0.00	0.00	0.00	-0.05
ROW (1)	17.79	-15.11	-13.04	-22.47	0.15	0.00
World	22.52	-15.53	-16.20	-13.37	16.44	-2.31

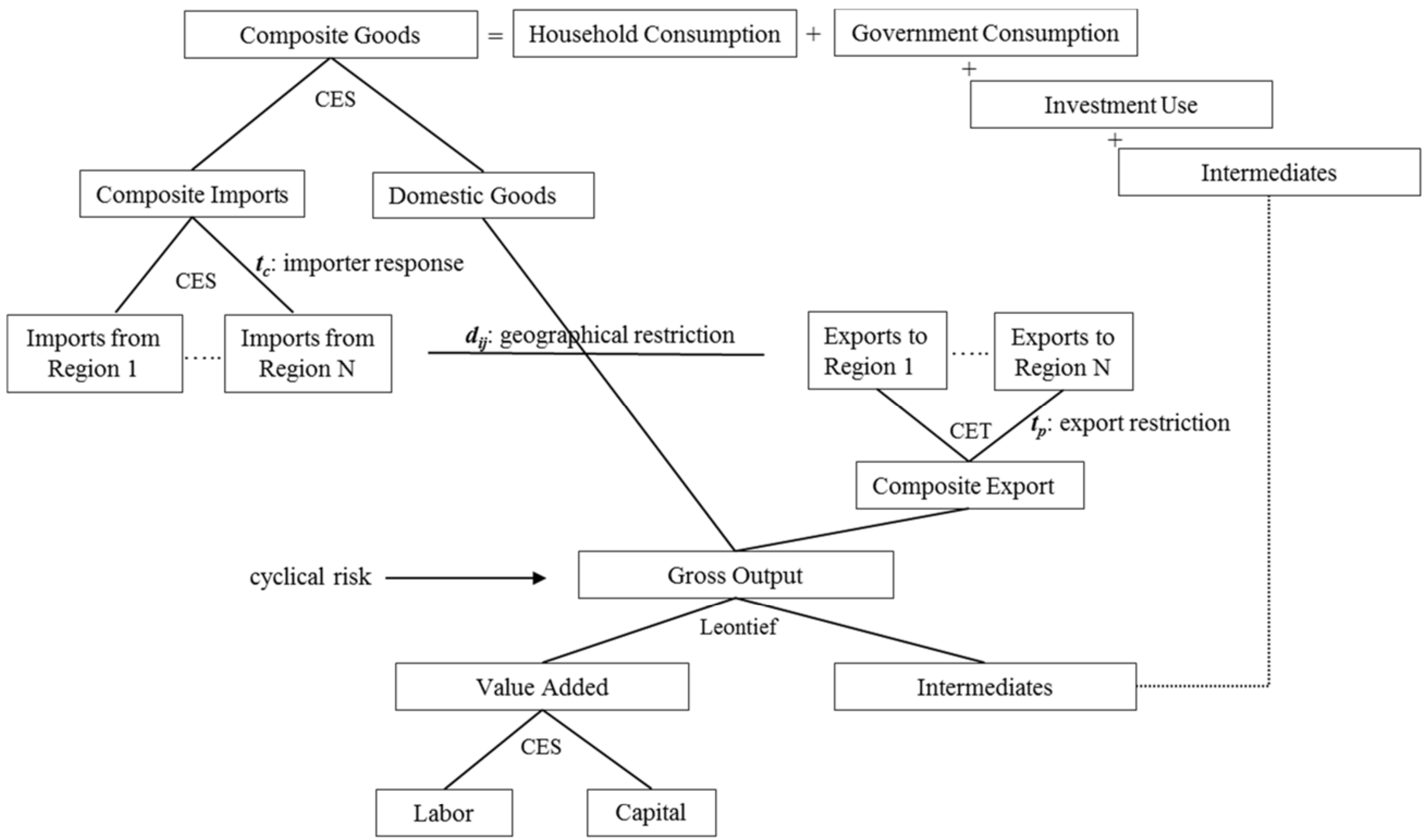

Figure 1. General Economic Structure. Note: CES/CET stands for constant elasticity of substitution/tranformation

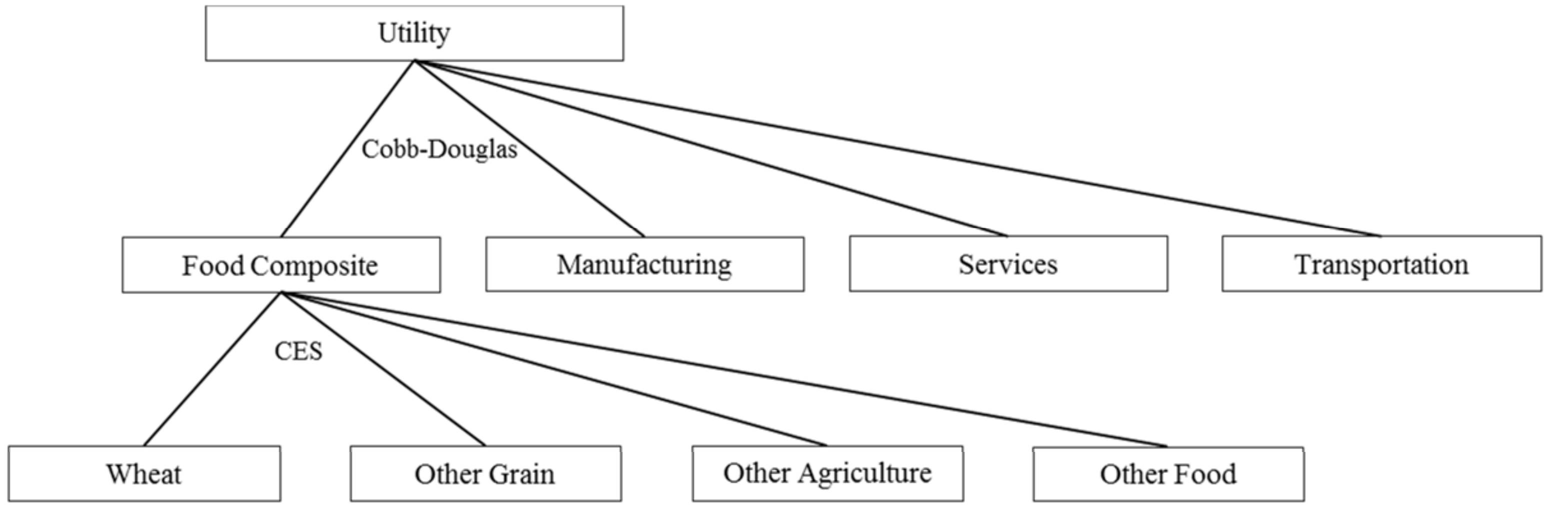

Figure 2. Utility Structure in Household Consumption. Note: CES stands for constant elasticity of substitution