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Trade Liberalization on the EU-US GMO Agreement : A Political Economy Approach

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Abstract

The EU and the US launched negotiations on a Transatlantic Trade and Investment Partnership (TTIP) in July 2013. Among the TTIP aims, there are negotiable terms under which the EU would import more genetically modified (GM) products and change its labeling regulations on GM Organisms (GMOs). This paper discusses a trade agreement of agricultural products between two countries, with different GM regulatory regimes from a political economy perspective. We find the negotiation equilibrium of the GMO Trade Agreement and compare it with a stricter trade policy. We find that if the trade agreement leads to a lenient GM regulation, lobbying intensifies. However, this effect is moderated if there are exports of non-GM products.

Keywords: Political Economy, GMOs, international trade

1. Introduction

After the Subprime mortgage crisis and the Euro crisis, many countries are now willing to develop new economic policies. The WTO negotiations and the Doha Round, however, have hardly moved forward. Thus, some countries have launched regional bilateral or multilateral trade agreements. The largest ones are the Trans-Pacific Partnership and the Transatlantic Trade and Investment Partnership (TTIP). The TTIP is an agreement between the European Union (EU) and the United States (US). The two parties launched the TTIP negotiations in July 2013. The agreement potentially offers significant benefits to the US and the EU's economies in terms of trade and growth. According to a report from the Centre for Economic Policy Research (2013), a trade agreement which eliminates tariffs and reduces non-tariff barriers could boost the US and the EU economic growth by more than $100 billion a year. Hence, both parties have an incentive to start bilateral negotiations. The TTIP aims, include negotiable terms under which the EU would import more Genetically Modified (GM) products and loosens its labeling regulations on GM Organisms (GMOs).

Currently, the GMO policy regimes differ between the EU and the US. The EU has strict regulations on GMOs, such as labeling and coexistence while the US does not require labels nor has specific coexistence rules(Wesseler and Kalaitzandonakes, 2011). Even though these two large economies have a divergence in GM food policies, they are important trade partners of each other. EU-US trade climbed to $787 billion in 2013,

double the level of 2000 (Transatlantic Economy 2014). After 2011, EU agricultural product sales on the US market kept on growing to over €15 billion in 2012, which is a 13% increase compared to 2011 (Agricultural and Rural Development data, EU Commission 2014). However, the EU imports only about 30 million tons a year of GM crops for animal consumption (EU Commission 2001). In contrast, in the US, 88 percent of corn, 94 percent of cotton and 93 percent of soybeans are GM crops (USDA ERS 2013). Even though we do not know the outcome of the negotiation, it offers a chance for collaboration between two different GM regulations.

Many scientists (Anderson, Rausser and Swinnen, 2013, Graff, Hochman and Zilberman, 2009, Qaim, 2009, Shao, Punt and Wesseler, 2013) argue that the GMO regulation approval process is a political rivalry between different interest groups. Some interest groups (such as biotech R&D firms, GM farmers and retailers) would be in favor of the agreement, whereas the interest groups who represent conventional agriculture (e.g. farmers, chemical producers) and environmentalists would prefer stringent GM regulations and would therefore oppose the agreement.

A GMO Trade Agreement (GTA) can be regarded as a starting point for a change in GM policy. The GTA negotiation may intensify the current GMO debate within the EU. In this study, we assess the effect of the negotiations on the lobbying efforts in the GMO debate in the country. We use a political economy model to describe a scenario where two countries with different GM regimes start negotiations over a GTA.

Many previous studies discuss FTA negotiations using a political economy approach. Grossman and Helpman (1995) describe a bilateral FTA negotiation and discuss the economic conditions of an FTA equilibrium outcome. Levy (1993) studies the interaction between multi-and bilateral FTA negotiations. He finds that bilateral negotiations can undermine political support for multilateral free trade because a bilateral FTA offers larger gains and reservation utility over the multilateral FTA. Many of these studies focus on aggregate welfare and simplify by assuming a single traded good. Later, Fajgelbaum, Grossman and Helpman (2011) developed a framework about consuming differentiated products. They provide a tool for studying welfare consequences of the trade and trade policy by differentiating consumers' by income and preferences on goods' quality and variety. Maggi and Rodriguez-Clare (1998) develop a small-country model to show that when factors are static in short term but mobile in long run, the government prefers a free-trade agreement because its payoff is less if it gets involved in a political game.

In this paper, we start the discussion from a social equilibrium point of view and then add the political process. The political process follows the Grossman and Helpman (1994) model. We focus our discussion on the bilateral GTA negotiation. The GTA negotiation will affect welfare under two different GM regulations. The domestic debate could intensify when the government decides to join the GTA. But we also show that simultaneous foreign exports could mitigate the domestic debate, because the profits from the foreign market can compensate the domestic loss of a less strict GM trade regulation

for conventional farmers. The paper departs from previous research on GMO regulations and international trade by i) solving for the possible economic equilibrium agreement and its conditions in the presence of "semi-differentiated" goods. ii) Addressing the welfare effects of entering a GTA negotiation. iii) The effect of non-GM exports on the lobbying efforts.

The paper proceeds as follows: section 2 discusses the political economy equilibrium in the country before launching the GTA negotiation. Section 3 introduces the bilateral GTA negotiation and the possible equilibria of the political game. We present the welfare consequences for the country and the effects on lobbying effort. In Section 5, we add exports to the model and show their effect on the lobbying effort. Section 6 summarizes the main findings and implications of the paper.

2. Preliminaries

We assume that there are two countries in the world, the domestic country and the foreign country. There is a difference in the regulation and acceptance of GM technology between the two countries, but otherwise they are symmetric in terms of economic structure. The two countries have different GM regulations that influence the GM firms' profits. There is a regulation compliance cost for the GM firm in each country. We also assume that the current GM regulation is the outcome of the domestic political game between interest groups.

The domestic country has stricter GM regulations, and the acceptance of GM food in the domestic country is relatively low. In contrast, there is less debate in the foreign country about agricultural GM technology, and the regulation is less strict. In the world market, both countries trade food products and numeraire goods with each other. The domestic GM regulation of either country is a measure of the protection of the GM trade. That is, when the domestic regulation is strict, there will be extra costs on the imported GM products[1]. We assume that the GM technology is an advanced safe agricultural technology that increases farm level production in comparison to conventional farming. The foreign country has a comparative advantage in GM food production in general in the bilateral trade due to less restrictive policies.

In the following discussion, we first focus on the domestic economy due to the symmetry.

2.1 The economy of the domestic country

There are two sectors, an agricultural food sector and a numeraire good (z) sector, in the economy. Labor $(L_i, i = G, N)$ is the only input for the numeraire sector with constant returns to scale. The food sector uses labor and conventional agricultural input. GM technology is an optional technology for the food processing firms. There are two representative firms in the food sector, a conventional and a GM producer. The GM firm has an additional investment in the GM technology but a larger output compare to the

[1] GM products include GM food products, food products with GM ingredients, GM feed, etc. In the paper, we mainly focus on the GM food products.

non-GM firm. If we denote x_G is the output of the GM food products and x_N is the output of the conventional food products, and let $x_G = g(L_G)$ and $x_N = f(L_N)$, we have $g' > f'$ according to our assumption. There is a regulation compliance cost θ added to the GM firm. If the GM regulation is strict, the cost of following the GM requirements is high for the firm. The GM firm prefers a larger θ while the non-GM firm prefers a lower θ. The profit function of two firms are:

$$\pi_G(\theta) = p_G x_G - c(q) - \theta$$

$$\pi_N = p_N x_N - c(q)$$

Where p_G and p_N are the prices of the GM and non-GM product, respectively. q is the conventional input for both firms. The marginal profit of the GM firm increases with decreasing in θ.

We normalize the total consumers into one, and divide them into three kinds. Fraction α represents consumers who only choose GM food products and owns the GM firm, fraction β consumes only conventional food products and owns the non-GM firm. The rest of the population $(1-\alpha-\beta)$ only cares about the food price rather than food varieties.

Individuals consume both numeraire goods and food products. But they can choose either GM food or conventional food according to their preferences. The utility function is $U^k = z + \sum_i u^k(x_i)$, where z is the consumption of numeraire goods, x_i is the

consumption of either conventional or GM goods for consumer $k=\alpha,\ \beta$,1-α-β, and $i=G,N$, where G denotes GM and N denotes conventional. $U^k(\cdot)$ is a quasi-concave function. The demand function for food products depends on food prices (p_i), that is, $d_i(p_i)$. Thus, the demand for numeraire is $z^k = I^k - \sum_i p_i d_i(p_i)$, where I^k is the net income of consumers in each group. When $k=\alpha,\ \beta$, it consists of labor income and any profit share from the firms deducted by the contribution share. When k=1-α-β, consumers only earn labor income. So the surplus of consuming food products is: $S_i^k(p_i) = u\left[d_i^k(p_i)\right] - p_i d_i^k(p_i)$.

One unit of the good requires one unit of labor, so total labor income equals labor supply L. Welfare of each group is given:

$$W_\alpha(\theta) = \alpha L + \alpha S^G + \pi^G(\theta)$$

$$W_\beta(\theta) = \beta L + \beta S^N + \pi^N(\theta)$$

$$W_{1-\alpha-\beta}(\theta) = (1-\alpha-\beta)L + (1-\alpha-\beta)\sum_{i\in G,N} S^i(\theta) \quad (1)$$

We can write the aggregate welfare as the sum of aggregate labor income, the total profits of the industry sector and aggregate consumer surplus of agricultural food products:

$$W(\theta) = L + \sum_{i\in G,N} \pi^i(\theta) + \sum_{i\in G,N} S^i(\theta) \quad (2)$$

In this setting, the welfare maximization policy of the domestic country can be found if we take the first order condition of equation (4) with respect to θ and set it equal to zero:

$$\frac{\partial W(\theta^*)}{\partial \theta} = \frac{\partial W_\alpha(\theta^*)}{\partial \theta} + \frac{\partial W_\beta(\theta^*)}{\partial \theta} + \frac{\partial W_{1-\alpha-\beta}(\theta^*)}{\partial \theta} = 0 \quad (3)$$

2.2 The Political Process

The formation of the GM regulation is regarded as an outcome of a political game between different interest groups. We suppose that there are two interest groups, the pro-GM group (PGM) and the anti-GM group (AGM), in the political game. Both of them aim to maximize the welfare of their own group by lobbying with the government to influence the agricultural biotechnology policy. Interest groups in each country make contributions to influence the government's decision. The contribution can be monetary, resources, votes or other factors that the government will take. Lobbying is costly to interest groups, which means that interest groups spend $(1+\lambda_k), k \in (\alpha, \beta)$ unit from their welfare for one unit contribution. Fraction $(1-\alpha-\beta)$ is the "free-rider" in the political game. λ_k is a nonnegative parameter that represents the lobbying efficiency of two groups. A higher λ_k means lobbying is relatively more costly for group k. We assume interest groups never make contributions higher than the groups' welfare, that is, $W_k - (1+\lambda_k)C_k \geq 0$, where C_k is the lobbying contribution from group *k.*

The lobbies announce a schedule of contributions $C_k(\theta)$ based on the possible policies; they announce what contributions they will make to the government for a better GM policy (θ) from their perspective. The government maximizes the sum of the weighted welfare plus the contributions of the respective groups. The timing of the political game in both

countries is as follows: the two interest groups announce their contribution schedules simultaneously to the government in the first stage. The government then chooses a GM policy that maximizes its payoff in the second stage. Therefore, the government payoff function can be written as:

$$G(\theta) = aW(\theta) + C_{\alpha}(\theta) + C_{\beta}(\theta) \tag{4}$$

where $a(0 < a < 1)$ is a weight parameter, indicating relative importance of welfare in the policy making process.

If contribution schedules are locally truthful, the optimal contribution $C_k^*(\theta)$ of each group is determined by (Shao et al. 2013):

$$\frac{\partial C_k^*(\theta)}{\partial \theta} = \frac{1}{(1+\lambda_k)} \frac{\partial W_k(\theta)}{\partial \theta} \quad \text{for} \quad k = \alpha, \beta \tag{5}$$

Since the government maximizes its own payoff rather than the social welfare, the politically optimal GM policy is different from equation (3):

$$\frac{\partial G(\theta)}{\partial \theta} = a\frac{\partial W(\theta)}{\partial \theta} + \frac{\partial C_{\alpha}(\theta)}{\partial \theta} + \frac{\partial C_{\beta}(\theta)}{\partial \theta} = 0 \tag{6}$$

Substituting (5) into (6) gives:

$$\frac{\partial G(\theta)}{\partial \theta} = \left(\frac{1}{1+\lambda_{\alpha}} + a\right)\frac{\partial W_{\alpha}(\theta)}{\partial \theta} + \left(\frac{1}{1+\lambda_{\beta}} + a\right)\frac{\partial W_{\beta}(\theta)}{\partial \theta} + a\frac{\partial W_{1-\alpha-\beta}(\theta)}{\partial \theta} = 0 \tag{7}$$

Comparing (7) with (3), we see that the GM policy under the political structure is different from the one when only welfare is considered. The politically determined GM policy is a distortion from the social optimum, because the parameters (e.g. $\left(\frac{1}{1+\lambda_{\alpha}}+a\right)$) in front of the marginal welfare of each group are different in equation (7) compared to equation (3). This is of course, due to the lobbying effort.

Since the two countries are large players in the world the market, the trade flow of food products between them is large. But different GM regulations impede the increment of the bilateral agricultural trade flow. So they both have incentive to negotiate a GTA when there is an opportunity.

2.3 The GM Trade Policy

The domestic and the foreign country trade both conventional and GM food products in our model. However, the domestic country only exports non-GM goods to the foreign country and imports only few GM goods due to the strict GM regulations. Put differently, the strict domestic GM policy influences the GM trade policy, and this generates high import cost.

However, to see the policy effects more clearly, we assume that the domestic country only imports GM food products from the foreign country in the basic model first and then add export to the model.

In the model, the incumbent government formulates both the domestic GM policy and the trade policy. We limit the governments' policy only to imposing GM regulations on imported goods, and exclude the possibility that each government imposes other trade instruments in the bilateral trade. So, there is a regulation cost added to the imported GM goods. Lapan and Moschini (2004) point out that regulation costs imposed on GM imposts can be regarded as a tariff on the GM product, with the tariff revenue dissipated through the regulation costs. GM labelling regulations are Non-tariff Barriers (NTBs) in the international trade (Kreipe, 2010). We denote t as the unit GM regulation costs on the imported goods, and t is measured as Tariff Equivalents (TEs) of NTBs (Ferrantino, 2006, Linkins and Arce, 1994, Winchester, 2009).

Countries that have strict GM regulations generally have a strict trade policy on GM imports, such as the European countries and some African countries (Paarlberg, 2010). Therefore, in this preliminary analysis, we assume that the domestic has a strict GM policy and a strict GM trade regulation. Put differently, a stricter GM regulation implies a high GM import cost measured as a TE. We assume that the policy θ translates into the specific TE $t = b\theta^{-1}$, where b is an nonnegative arbitrary number and $\frac{\partial \theta}{\partial t} = -\frac{b}{t^2} < 0$. The tariff equivalence assumption allows us to rewrite all equations as a function of tariff equivalence t instead of the domestic GM policy θ. For example, $W(\theta) = W(t)$, and $\frac{\partial W(t)}{\partial t} = \frac{\partial W}{\partial \theta}\frac{\partial \theta}{\partial t} = -\left(\frac{b}{t^2}\right)\frac{\partial W}{\partial \theta} < 0$. The first order condition of equation (2) rewritten as a

function of tariff equivalent form then gives the socially optimal regulations on GM imports for the domestic country.

We denote the world price of food products as p^* and fix the tradable numeraire goods' price to unity. Domestic consumers then pay an import price for GM food $p_G = p^* + t$. Since the two countries are large players in the world food market, the change of GM import policy and associated tariff equivalent, will influence the world price of food products, as well as the domestic price. The total consumption of GM food in the domestic country is $(\theta x + m)$. The net imports of GM food products for the domestic country is $m = d(p_G) - \theta x$.

Rewriting the government payoff function as: $G = aW(t) + C_\alpha(t) + C_\beta(t)$. The politically optimal GM regulation t_0 before an agreement is made is determined by:

$$\frac{dG}{dt} = a\frac{\partial W(t)}{\partial t} + \frac{\partial C_\alpha(t)}{\partial t} + \frac{\partial C_\beta(t)}{\partial t} = 0 \qquad (8)$$

In above equation, parameter a represents the weight the government gives to social welfare in the lobbying game. It also implies how much the government will listen to the interest groups $(1-a)$ in the policy making process.

3. The Bilateral GTA Negotiation

We suppose the incumbent governments have set an initial TE (t_0) and try to negotiate an agricultural GTA with the other country. The GTA has a promising perspective for both

countries on the premises of minimizing TEs, relaxing GM regulations and increasing trade flows. The interest groups also have an incentive to revise their contribution schedules in the face of a GTA because the lobby that is currently relatively worse-off in the domestic GM lobbying game has an opportunity to change its status in the trade policy game. Hence, when there is a new policy under discussion, lobby groups have incentives to renew and revise their contributions in order to influence the government's decisions. Both countries have incentive to negotiate for a GTA to increase their welfare through increases in trade. However, loosening the domestic GM policy may hurt the non-GM producers and consumers. In addition, the GM firm will also face more intensive competition from abroad. We will discuss the main players in the game from the domestic point of view and describe why they have an incentive to reconsider their contribution schedules.

3.1 Players

Pro-GM Lobby. In the domestic lobbying game, PGM is the lobby that is relatively worse-off. The current strict GM policy decreases the welfare of the GM lobby. The GM firm cannot use as much GM technology inputs as it likes. Thus, the GM output and profits are lower in the domestic country. The GTA negotiation will bring about another lobbying game. PGM then has a chance to lobby for a less strict domestic GM policy. Consumers belonging to this group will benefit from the lower GM price. Even though there are more consumers who dislike GM products (fraction β is large in the domestic country), its lower price attracts more indifferent consumers (fraction $(1-\alpha-\beta)$) to consume GM food.

Since we assume that the demand of food products only depends on their prices, lower GM TEs will increase imports and decrease the domestic food price, but the compliance costs are also reduced. Therefore, the GM lobby has incentive to revise its contribution schedule in the GTA game.

Anti-GM lobby. AGM is currently the group that is relatively better off in the lobbying game. Conventional food has a higher production cost and price. It has no advantages to those consumers who are indifferent between GM or non-GM food products. If the GM policy is loosened, the non-GM firm may lose its market share in the domestic food market because the price difference between GM and non-GM increases due to the increased imports and increased local production of GM food, attracting marginal consumers to GM food. So, the AGM has an incentive to revise its contribution schedule and lobby with the government to terminate the GTA negotiation.

The Incumbent Government. A concluded GTA offers lower prices and more commodities in the market and this increase domestic welfare. Since welfare is an argument in the government's payoff function this provides an incentive to start the negotiations. Moreover the lobbies now offer new contribution schedules and thus the government has the opportunity to elicit larger contributions than before, also increasing its payoff.

3.2 The Unilateral Stance

The two countries negotiate a GTA, but we discuss the domestic government's decision first. The process is different from the domestic lobbying game. In the first stage, the lobbying groups offer their contribution schedules, which is the same as before. But the government will choose a set of contribution pairs, and decide to pursue or reject the agreement in the second stage.

Winters (1987) argues that the negotiation of NTBs reduction can be analyzed with the techniques of a tariff negotiation. He defines the costs and benefits from a NTBs negotiation as follows: the domestic country's "benefits" of a concession in TE equal to the reduction of regulation costs of the foreign country, especially in a two-country model. Countries value their negotiation stances subject to the gains from regulatory change. Following Herberg (1990), who points out that the NTB will have a direct effect on the trade volume and an indirect effect on the price, and the rent from the NTB change is equally distributed among consumers. We define the TE rents from the NTB reduction as: $t(\Delta m)$, where Δm is the import volume change through the negotiation. It is an *ex ante* value of the negotiation stances. Therefore, if we use A, B to denote the pre-GTA and GTA negotiation conditions, the welfare of each group after a concluded negotiation:

$$W_{\alpha}^{B}(t) = \alpha L + \alpha S^{GB} + \pi^{GB}(t) + \alpha t(m^{B} - m^{A})$$

$$W_{\beta}^{B}(t) = \beta L + \beta S^{NB} + \pi^{NB}(t) + \beta t(m^{B} - m^{A})$$

$$W_{1-\alpha-\beta}^{B}(t) = (1-\alpha-\beta)L + (1-\alpha-\beta)\sum_{i\in G,N} S^{iB}(t) + (1-\alpha-\beta)t(m^{B} - m^{A}) \quad (9)$$

and

$$W^B(t) = L + \sum_{i \in G,N} \pi^{iB}(t) + \sum_{i \in G,N} S^{iB}(t) + t(m^B - m^A) \tag{10}$$

We denote the contribution schedule of an interest group as $C_{kA}(t)$ and $C_{kB}(t)$ for the contributions under non-GTA and GTA negotiations, respectively. The government then maximizes its payoff by taking contributions into consideration. Since the government payoff is consist of the aggregate social welfare and contribution income, it pursues the GTA only if the change of its payoff after GTA is positive, that is,

$$\begin{aligned} \Delta G &= a\Delta W + \sum_{k \in \alpha,\beta} \Delta C_k \\ &= a(W^B - W^A) + \left[\left(C_\alpha^B - C_\alpha^A \right) + \left(C_\beta^B - C_\beta^A \right) \right] \geq 0 \end{aligned} \tag{11}$$

The government will pursue for a GTA only if it gets positive payoffs, otherwise it will reject the GTA. A unilateral stance refers to positions that the government will choose in response to the domestic interest groups' equilibrium behavior. We denote $\{t_e\}$ as the set of unilateral stances, where $e \in \{D, F\}$ for the domestic country and the foreign country. Following Grossman and Helpman (1995), we define a unilateral stance as:

The government will choose a unilateral stance $\{t_e\}$ *if there exists a set of contributions* $\{C_k^A(t_e), C_k^B(t_e)\}$*, one for each lobby k , before the negotiations such that:*

(a) $C_k^j(t_e) \geq 0$ *for* $j = A, B$ *and for all* k *;*

(b) $C_k^j(t_e) \leq \max\left[0, W_k^j(t_e) - (1 + \lambda_k^j) C_k^j(t_e)\right]$*;*

(c) $\{t_e\}$ *satisfies* $\left\{a\Delta W^j + \sum_k \Delta C_k^j \geq 0\right\}$ *;*

(d) for lobby k *, there exists no other contributions* $\left(C_k^j\right)^O \geq 0$ *and no* $\{t_e^O\}$ *such that:*

(i) $a\Delta W^j(t_e^O) + \sum_k \Delta\left(C_k^j\right)^O \geq 0$ *and*

(ii) $W_k^j - (1+\lambda_k^j)\left(C_k^j\right)^O > W_k^j - (1+\lambda_k^j)C_k^j.$

where $\left(C_k^j\right)^O$ and t_e^O represent "other" contributions and TE choices, respectively. We find this unilateral stance by using backward induction. It is the set of positions (t_e) for the domestic government in the GTA negotiation that guarantees a positive payoff increase. Any other position will decrease the government's payoff to some extent. The contribution schedules of lobbying groups are unique and maximize their welfare in the political game. Any other contribution schedules will induce a welfare loss for each group.

Similarly, the foreign country has the same political process and should have a unilateral stance of GM food product exports for the GTA negotiation. But the AGM is the relatively worse-off group in the political game in the foreign country. If the lobbies in the foreign country anticipate that their government will pursue the agreement, they will lobby with their government for their preferred GM trade policy in the negotiation.

3.3 The Bilateral Equilibrium

Similarly to Grossman and Helpman (1995) definition 2, a GTA is an equilibrium agreement if and only if t_e is a unilateral stance in both countries. If the domestic

government is willing to pursue an GTA negotiation, we can find the optimal unilateral regime is $\bar{t}_e$, which determined by

$$\frac{\partial \Delta G}{\partial t} = a\frac{\partial \Delta W(\bar{t}_e)}{\partial t} + \left[\frac{\partial \Delta C_\alpha(\bar{t}_e)}{\partial t} + \frac{\partial \Delta C_\beta(\bar{t}_e)}{\partial t}\right] = 0 \tag{12}$$

But if the government does not pursue a GTA, the optimal tariff will be the same as what we discussed in section 2.3. Our definition gives the unilateral stance as a range of choices that constitute a positive ΔG. The optimal unilateral stance is $\bar{t}_D$ that maximizes the domestic government's payoff in the GTA negotiation. However, depending on the shapes of the governments increased payoffs, there may be more than one intersections of two positive payoff curves. Each gives two governments a different payoff pairs. Therefore, to make a higher payoff during the negotiation, governments need to: $\min\left|t^* - \bar{t}_e\right|$, where t^* is the bilateral GTA equilibrium.

Since both governments aim at positive payoffs, we define the change of the governments' payoff as:

$$\Delta G_D(t) = a_D \Delta W_D^j(t) + \left[\Delta C_{\alpha D}^j(t) + \Delta C_{\beta D}^j(t)\right] \tag{13}$$

$$\Delta G_F(t) = a_F \Delta W_F^j(t) + \left[\Delta C_{\alpha F}^j(t) + \Delta C_{\beta F}^j(t)\right] \tag{14}$$

Since the government will pursue a payoff increment during the GTA negotiation, we only need discuss the relations between ΔG and t in the first quadrant. However, there will be many situations for the optimal unilateral stance $(\bar{t}_e)$ and the bilateral equilibrium (t^*).

The unknowns are: 1) the shape of the positive government payoff curve; 2) the distances of the overlaps for both the domestic and foreign feasible set of outcomes (e.g. totally, partly, or no overlaps). But we can explain the logic of a GTA negotiation by a possible case.

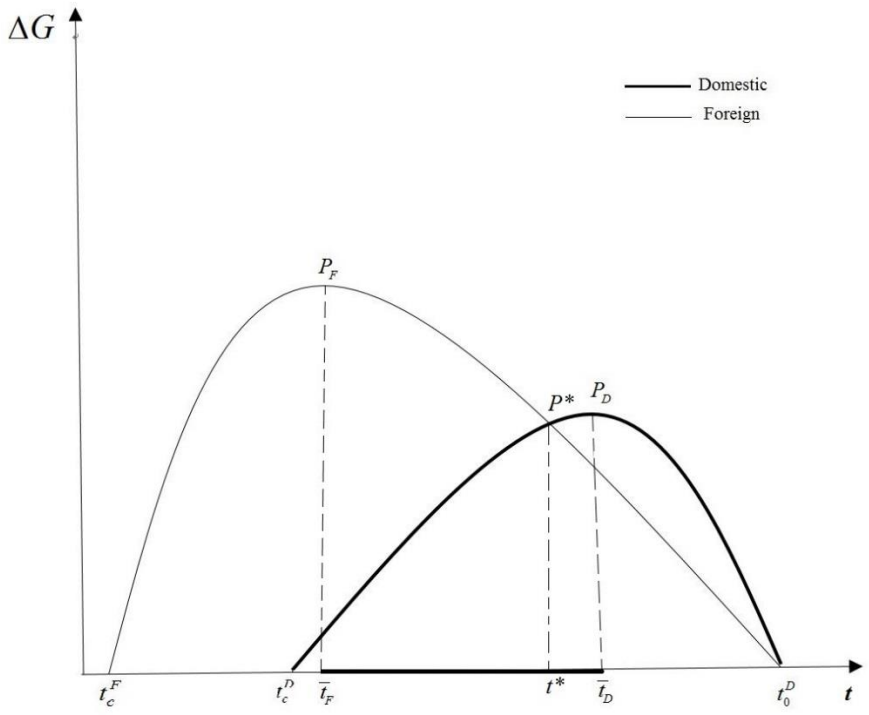

Figure 1 A Possible GTA Solution

Figure 1 gives a possible situation that demonstrate the difference between unilateral stances and the GTA solution. In order to see the solution clearly, we normalize the government payoff to the same scale of ΔG and t. Since the negotiation is about the NTB reduction, the starting point of the regulation cost is high. t_0^D is the initial GM regulation imposed on the GM imports. It is the starting point for both governments' increased payoff functions, and at t_0^D, $\Delta G_e = 0$. From the critical point t_0^D to t_c^D is the feasible set of outcomes for the domestic country, and from the critical point t_0^D to t_c^F is the feasible set of outcomes for

the foreign country. P_D and P_F denotes the optimal unilateral stances payoffs for the domestic and the foreign countries, respectively. The optimal import TEs are $\bar{t}_D$ and $\bar{t}_F$ for each country to maximize governments' payoff.

If two countries successfully make the agreement, the Nash Bargaining solution of the GTA negotiation should lie in the overlaps of the feasible sets. In figure 1's case, the overlap distance is from t_0^D to t_c^D. However, the distance from t_0^D to $\bar{t}_D$ will not be the solution set, because the government payoffs for both countries are still increasing. Similarly, the distances from $\bar{t}_F$ to t_c^D will not be the solution sets, because the payoff are decreasing for both countries in the sets. This also consistent with $\left(\min\left|t^* - \bar{t}_e\right|\right)$. Therefore, the possible solution (t^*) will lie in the set from t_0^F to $\bar{t}_F$. For example, the bilateral equilibrium is t^* in figure 1, and government will get a positive payoff at point P^*.

In other words, if there is a Nash Bargaining solution t^* in the GTA negotiation, it satisfies

$$\max_t\left[(u_D(t^*)-u_D(t_0))(u_F(t^*)-u_F(t_0))\right]=\max_t\left[\left(\Delta G_D\right)\left(\Delta G_F\right)\right] \quad (15)$$

4. The GTA Effects on the Domestic Country

In this section, we will discuss the effects of the optimal unilateral stance of the government instead of the GTA equilibrium effects, because the optimal unilateral stance describes the true political competition in the country.

If two governments can successfully negotiate an agreement, they both receive an incremental payoff through the GTA negotiation. The marginal benefit from the new GM regulation is greater than the pre-GTA one to the government, that is, $\frac{\partial G^B}{\partial t} - \frac{\partial G^A}{\partial t} > 0$.

Since we assume $t = b\theta^{-1}$, we rewrite equation (1) as a function of t:

$$W_\alpha(t) = \alpha L + \alpha S^G + \pi^G$$

$$W_\beta(t) = \beta L + \beta S^G + \pi^G$$

$$W_{1-\alpha-\beta}(t) = (1-\alpha-\beta)\left(L + \sum_{i=G,N} S^i\right) \tag{16}$$

Taking partial derivatives with respect to t:

$$\frac{\partial W_\alpha(t)}{\partial t} = \alpha S_t^G + \pi_t^G$$

$$\frac{\partial W_\beta(t)}{\partial t} = \beta S_t^N + \pi_t^N$$

$$\frac{\partial W_{1-\alpha-\beta}(t)}{\partial t} = (1-\alpha-\beta)\left(\sum_{i=G,\mathrm{N}} S_t^i\right) \tag{17}$$

Also, rewriting equation (7) as a function of t :

$$\frac{\partial G(t)}{\partial t} = \left(\frac{1}{1+\lambda_\alpha} + a\right)\frac{\partial W_\alpha(t)}{\partial t} + \left(\frac{1}{1+\lambda_\beta} + a\right)\frac{\partial W_\beta(t)}{\partial t} + a\frac{\partial W_{1-\alpha-\beta}(t)}{\partial t} = 0 \tag{18}$$

Substituting (17) into (18)

$$\frac{\partial G^A(t)}{\partial t} = \left(\frac{1}{1+\lambda_\alpha} + a\right)\pi_t^G + \left(\frac{1}{1+\lambda_\beta} + a\right)\pi_t^N + \varphi\left(\sum\nolimits_i S_t^i\right) \tag{19}$$

where $\varphi = \left(a + \frac{\alpha}{1+\lambda_\alpha} + \frac{\beta}{1+\lambda_\beta}\right)$

We apply the same procedure to the GTA negotiation situations from equation (9), and get

$$\frac{\partial G^B(t)}{\partial t} = \left(\frac{1}{1+\lambda_\alpha} + a\right)\pi_{tD}^G + \left(\frac{1}{1+\lambda_\beta} + a\right)\pi_{tD}^N + \varphi\left[\left(m^B - m^A\right) + \sum_{i=G,N} S_{tD}^i\right] \tag{20}$$

Therefore, we have

$$\begin{aligned}\frac{\partial G^B}{\partial t} - \frac{\partial G^A}{\partial t} &= \left(\frac{1}{1+\lambda_\alpha} + a\right)(\pi_{tD}^G - \pi_t^G) + \left(\frac{1}{1+\lambda_\beta} + a\right)(\pi_{tD}^N - \pi_t^N) \\ &+ \varphi\left[(m^B - m^A) + (\sum_{i=G,N} S_{tD}^i - \sum_{i=G,N} S_t^i)\right] > 0\end{aligned} \tag{21}$$

where $\pi_{tD}^G = \frac{\partial \pi_B}{\partial t_D}$ is the marginal effect of the optimal domestic unilateral stance on the GM profit after the GTA negotiation. $\pi_t^G = \frac{\partial \pi_A}{\partial t_0}$ is the marginal effect of the original GM regulation on the GM profit before the GTA negotiation. S_{tD}^i are the marginal effects of the domestic GTA regulation on the aggregate consumer surplus after the negotiation.

A less strict GM regulation decreases the domestic GM price via an increase in GM imports. However, the cost of GM production stay the same and the GM firm's profits decrease. The marginal change of the regulation costs to the domestic GM profit is smaller under the GTA than under pre-GTA. Thus, the first term on the RHS in equation (21) is negative. For the

second term in equation (21), a decrease of the GM price will induce an increase in GM consumption from the $(1-\alpha-\beta)$ group, and a decrease consumption of the non-GM food. The price of the conventional food then decreases, which brings a profit decrease for the non-GM firm. Thus, the second term is negative as well. The last term of equation (21) is positive, because a lower regulation cost increases the GM imports and increases the aggregate consumer surplus. If the domestic government signs the GTA agreement, equation (21) will be positive. So, we have

$$\left(\frac{1}{1+\lambda_\alpha}+a\right)(\pi_{tD}^G-\pi_t^G)+\left(\frac{1}{1+\lambda_\beta}+a\right)(\pi_{tD}^N-\pi_t^N)>-\varphi\left[(m^B-m^A)+(\sum_{i=G,N}S_{tD}^i-\sum_{i=G,N}S_t^i)\right]$$

Therefore, we can write a condition for the GTA agreement from the welfare point of view:

The domestic government will sign a GTA agreement if and only if the marginal loss of the domestic food industry from the equilibrium policy is less than the marginal gain of social welfare for the rest of the consumers.

A GTA with a lower GM import cost has effects on:

Pro-GM lobby. GM consumers will benefit from a lower GM price. We rewrite equation (5) as a function of the GM regulation

$$\frac{\partial W_k(t)}{\partial t}=(1+\lambda_k)\frac{\partial C_k(t)}{\partial t} \quad \text{for} \quad k=\alpha,\beta \tag{22}$$

and compare the marginal welfare change before and after the GTA negotiation:

$$\frac{\partial W_\alpha^B}{\partial t}-\frac{\partial W_\alpha^A}{\partial t}=\alpha\underbrace{(m^B-m^A)}_{>0}+\alpha\underbrace{(S_{tD}^G-S_t^G)}_{>0}+\underbrace{(\pi_{tD}^G-\pi_t^G)}_{<0} \tag{23}$$

Since the PGM is the relatively worse-off in the domestic GM policy game, it would like to lobby for a policy change through the GTA negotiation. Even though the PGM have a loss in profits, the expected revenue would be greater in following periods if the GTA negotiation is successful. More people will choose GM food after the price decreases. An increasing GM demand requires a larger supply. Thus, policy support for GM production would be possible then. By equation (22), we also have

$$\frac{\partial W_\alpha^B}{\partial t}-\frac{\partial W_\alpha^A}{\partial t}=(1+\lambda_\alpha^B)\frac{\partial C_\alpha^{tD}}{\partial t}-(1+\lambda_\alpha^A)\frac{\partial C_\alpha^t}{\partial t} \tag{24}$$

According to above discussion, we can find that larger GM imports will also give incentives to the PGM. The PGM would like to update its contribution schedule. Therefore, its lobbying could be more efficient (i.e. $\lambda_\alpha^B<\lambda_\alpha^A$) for same marginal welfare gain in the GTA negotiation .

Anti-GM lobby. We compare the marginal regulation cost change on welfare with the situation under pre-negotiation and GTA welfare of the AGM:

$$\frac{\partial W_\beta^B}{\partial t}-\frac{\partial W_\beta^A}{\partial t}=\beta\underbrace{(m^B-m^A)}_{>0}+\beta\underbrace{(S_{tD}^N-S_t^N)}_{<0}+\underbrace{(\pi_{tD}^N-\pi_t^N)}_{<0} \tag{25}$$

We know that the AGM and the non-GM food consumption are large. From equation (25) we can see that if the GM import is small, there will be only small changes to the GM prices. Fewer indifferent consumers will change to consume GM food. So the loss of the AGM from importing GM food is small. The AGM then has less incentive for the regulation cost change. In contrast, if the GM import is large and there is a large decrease in import cost, a lower GM price will induce an increasing consumption of GM food. It induces a larger welfare loss for the AGM. Similarly, we have

$$\frac{\partial W_{\beta}^{B}}{\partial t}-\frac{\partial W_{\beta}^{A}}{\partial t}=(1+\lambda_{\beta}^{B})\frac{\partial C_{\beta}^{tD}}{\partial t}-(1+\lambda_{\beta}^{A})\frac{\partial C_{\beta}^{t}}{\partial t} \tag{26}$$

From above discussion, the optimal contribution level will be larger than the pre-GTA contribution. Here, we assume that in comparison to the pre-GTA condition, GM imports are large, and both interest groups therefore have stronger incentives to lobby to the government. Thus, equation (23) and (25) are more likely to be positive under a large GM import assumption. The two interest groups would spend more on lobbying than before. The increase in lobbying costs shows that the domestic GM debate will become more fierce than under the pre-GTA condition.

If we compare equation (24) to (26), we find that the contribution change of the PGM is larger than the contribution change of the AGM. Possible reasons could be found from equation (23) and (25): 1) the AGM is very large (i.e. $\alpha \ll \beta$), therefore the marginal loss of its consumer surplus from a lower import cost is larger than the marginal consumer gain of

the PGM. So, a large increasing contribution will be paid for welfare increase in the GTA lobbying game for the AGM. 2) As the government enters the GTA negotiation, the lobbying efficiency decreases for the AGM, that is, $\lambda_\beta^B > \lambda_\beta^A$. The AGM needs to spend more money on lobbying, which also decreases its marginal welfare gain from lobbying.

Indifferent group. Since a large GM import will bring a price decrease, consumers who are indifferent to either GM or non-GM food will choose the lower priced food, and will benefit from the GTA.

Government. More open trade policy will bring a welfare increase to the country. As we discussed above, both interest groups have a stronger incentive for lobbying in the first stage of the GTA game. The government payoff then will increase after it joins the GTA negotiation.

However, if the government rejects the offer during the negotiation, the GM import cost will stay the same as before. Conventional food still take the most part of the food market, and the GM lobby will not gain from the lobbying. Since both interest groups have paid for lobbying, their welfare decreases if the negotiation breaks down.

5. GTA with Exports to the Foreign Country

In the previous section, we assume the domestic country only imports GM food products from the foreign country. Now we discuss the situation that when the foreign country

imports conventional food from the domestic country. We denote the export gains to the non-GM firm in the domestic country with E.

If the non-GM firm exports part of its food production, its profits change. The influence of the import GM policy also changes. Before earning E, the total demand of non-GM products $d((1-\theta)x)$ decreases when the GM import costs decreases. This causes a decrease of the non-GM price, which leads to a profit decrease. However, if the firm can export its "residual" non-GM food products, the non-GM firm does not have to decrease its price and earns E instead. We assume E is not influenced by the GM import policy. Thus, we have the non-GM profit function after it gets E: $\pi^E = \left(\pi^{NB} + E\right) > \pi^{NA} > \pi^{NB}$.

We take partial derivatives of different profits with respect to the GM import costs:

$\frac{\partial \pi^E}{\partial t} < \frac{\partial \pi^{NB}}{\partial t}$. The marginal effect of GTA import costs on the non-GM profits is small when the firm exports non-GM products than before, because a part of its profits $\left(E\right)$ is not influenced by the GM import cost. Therefore, $\frac{\partial \pi^E}{\partial t} < \frac{\partial \pi^{NB}}{\partial t} < \frac{\partial \pi^{NA}}{\partial t}$.

Now we rewrite equation (25),

$$\frac{\partial W_\beta^E}{\partial t} - \frac{\partial W_\beta^B}{\partial t} = \beta \underbrace{(m^B - m^B)}_{=0} + \beta \underbrace{(S_{tD}^E - S_{tD}^N)}_{=0} + \underbrace{(\pi_{tD}^E - \pi_{tD}^N)}_{<0} \tag{27}$$

In the above equation, the GM imports do not change. The consumption of non-GM food products under the GTA import regulation does not change if the firm exports non-GM

products. So, the marginal effects of the GTA import costs to non-GM consumer surplus stays the same. $\left(\pi_{tD}^{E}-\pi_{tD}^{N}\right)<0$ because the loss from decreasing GM import cost is compensated by the foreign profits of the non-GM firm. Therefore, the marginal welfare loss from the GM trade policy change is smaller after the non-GM firm has foreign exports. By rewriting equation (26), we have

$$\frac{\partial W_{\beta}^{E}}{\partial t}-\frac{\partial W_{\beta}^{B}}{\partial t}=(1+\lambda_{\beta}^{E})\frac{\partial C_{\beta}^{E}}{\partial t}-(1+\lambda_{\beta}^{B})\frac{\partial C_{\beta}^{tD}}{\partial t} \tag{28}$$

Therefore, the optimal lobbying schedule will be lower for the AGM without foreign exports. The domestic GM debate thus will be less fierce than before. Since we assume that $\frac{\partial \theta}{\partial t}<0$, the domestic GM regulation is more likely to be less strict in the future.

We conclude our findings that:

When the domestic country only allows the GM imports, a GTA negotiation on GM imports will intensify the domestic GM debate. A welfare increase for the pro-GM group and a welfare loss for the anti-GM group from a decreasing GM import regulation will induce higher contributions by both groups. Lobbying cost of the anti-GM group will be higher than lobbying cost of the pro-GM group under large GM imports. However, the domestic GM debate will be less intensive if there are non-GM exports, because the welfare loss from a less strict GM import policy to the anti-GM group can be compensated by export earnings.

6. Conclusion

The paper investigates the welfare effects of a trade agreement between two countries, two goods (GM and non-GM good), two regulatory standards (high in the domestic and low in the foreign country) and two lobby groups. We show the political process of the domestic GM policy and trade policy, and compare the equilibria before and after a trade agreement. Since the GM regulations are not the same in the two countries, a lower GM import cost will not necessarily benefit all consumers. Analytical results show that the overall non-GM consumer surplus decreases as the import costs of GM products decreases and hence the domestic price for GM products. Lower GM import costs will induce a more intensive domestic GM debate (measured by the size of lobbying contributions) about GM regulations for both lobby groups. The pro-GM lobby group as well as the anti-GM lobby group, have an incentive to increase their lobbying activities. If the trade agreement also provides opportunities to export GM products by the domestic country, the anti-GM lobby group will receive additional compensation which will decrease the tension of the debate in the country.

In the TTIP negotiation, GMOs are one of the important negotiation issue. In addition to other benefits, the EU can benefit by trading conventional agricultural products with the US. Our results show the possibility for a less strict GM policy in the EU if a successful TTIP agreement exists. Even though a free-trade agreement is still far, an open trade policy of GM products will increase welfare in both countries.

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