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Abstract

Sanitary and phytosanitary (SPS) measures are important policy instruments to regulate food safety and to protect the domestic ecosystem from biological invasions. However, these measures may also be used to protect domestic producers from international competition. The World Trade Organization's (WTO) Agreement on the Application of Sanitary and Phytosanitary Measures (the SPS Agreement) was established in 1995 to prevent member countries from using SPS measures discretionarily and arbitrarily. Whereas the SPS Agreement is mainly based on the risk analysis approach, economists have criticized it for lacking economic considerations in regulating SPS measures. Despite these criticisms, I show that the SPS Agreement would contribute to establishing economically sound discipline for SPS measures by reducing the scope of the use of SPS measures for disguised protectionist purposes. However, it is not entirely free from protectionist use of SPS measures. Potential problems also arise from scientific uncertainty.

Keywords: sanitary and phytosanitary measures; quarantine; food safety; biological invasion; disguised protectionism; risk analysis; scientific principle.

JEL classification: F13; F18; Q17.

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1 Introduction

Regulating food safety in the domestic food market is an important role of the government. As international movements of goods and people are growing, protecting the domestic ecological system from the introduction of non-indigenous or "exotic" species and pests, which are called "biological invasions," is also an important policy issue. Facing these issues, sanitary and phytosanitary (SPS) measures are necessary to protect human, animal, and plant life or health from diseases, pests, and contaminants (Roberts, 1998).[1] However, these measures may also be used to protect domestic producers from international competition. As tariffs and other forms of classical trade barriers are progressively dismantled through multilateral, regional, and bilateral negotiations over trade liberalization, the temptation to use SPS measures for protectionist purposes becomes stronger.

There are a number of examples of trade disputes over SPS measures being potentially used for such disguised protectionist purposes. A famous example is the dispute over hormone-treated beef between the United States (U.S.) and the European Communities (EC). In 1980s, the EC banned the use of growth-promoting hormones in cattle and imports of meat and meat products from animals that had been supplemented with growth-promoting hormones. In 1996, the U.S. and Canada appealed to the Dispute Settlement Body of the World Trade Organization (WTO). In 1997, the WTO dispute settlement Panel ruled against the EC as the import ban was not justified (Roberts, 1998). Other examples include the dispute between the U.S. and Japan over Japan's phytosanitary measures on imports of U.S. apples[2] and the dispute between Canada and

[1] SPS measures are defined as measures that "protect human, animal, or plant life and health within the territory of the Member from risks related to diseases, pests, and disease-carrying or -causing organisms, as well as additives, contaminants, toxins or disease-causing organisms in food, beverages, or feedstuffs" (Roberts, 1998: 382). Roberts (1998) points out that SPS measures are defined with respect to the regulatory goal of a measure rather than the policy instrument itself. Thus, SPS measures cover any policy instruments to affect degrees of trade restriction, such as complete import bans, product and PPM standards, labelling for informing the potential allergenicity of products.

[2] Japan restricted imports of U.S. apples because Japan was concerned with the spread of fire blight, a bacterial disease that affects apple trees and other plants in the rose family. However, the WTO dispute settlement Panel issued its report in which the panel found that Japan's phytosanitary measures were inconsistent with Japan's WTO obligations.

Australia over Australia's ban on imports of Canadian fresh, chilled and frozen salmon.[3]

The Agreement on the Application of Sanitary and Phytosanitary Measures (the SPS Agreement) of the WTO, which was entered into force in January 1995, prevents members of the WTO from using SPS measures discretionarily and arbitrarily. The novelty of the SPS Agreement in GATT/WTO disciplines is to stipulate a *scientific basis* for policies related to SPS. Thus, even though a policy is implemented according to the *principle of non-discrimination* (that is, Most-Favoured-Nation (MFN) and National Treatment (NT) principles of GATT), it may be judged to violate the SPS Agreement if such a policy lacks scientific basis. Under the SPS Agreement, a scientifically "rational relationship" is required between policy measures and their intended goals. The requirement of scientific justification is expected to contribute to mitigating disguised protectionism.

The SPS Agreement also requires harmonization of SPS policy of members to international standards and minimization of negative effects of SPS measures on trade. On the other hand, the SPS Agreement respects members' sovereignty over the choice of their own acceptable level of risk, or the appropriate level of protection (ALOP), which can be more stringent than international standards, as long as a sufficient scientific justification is demonstrated.[4] Even setting the ALOP at "zero risk" can be allowed.

Economists have criticized the SPS Agreements for its lacking economic considerations in regulating SPS measures. Calvin and Krissoff (1998) argue that the SPS Agreement, which is rooted more in the risk analysis approach, focuses only on losses to producers and ignores costs and benefits resulting from SPS measures, which can be measured by the economic cost-benefit analysis. James and Anderson (1998) criticize that SPS policy assessment, under the SPS Agreement, is "about where environmental policy assessment

[3]In 1975, Australia introduced a quarantine measure requiring salmon products to be heat-treated for certain prescribed durations and temperatures prior to importation. The reason was to prevent the introduction of pathogens that could be responsible for various fish diseases. In 2000, a WTO panel found that Australia's measures affecting imports of Canadian salmon were inconsistent with Australia's WTO obligations.

[4]For example, Australia, Japan, Mexico, and the U.S. inspect some import goods at the point of export in trading partner countries to reduce their risks, whereas the United Kingdom (UK) inspect at the point of delivery in most cases. Although the inspection costs are much higher in the former system, it is accepted as appropriate to the risks faced, and reduces subsequent control costs of diseases and pests (Mumford, 2002).

was two or three decades ago" (James and Anderson, 1998: 426), looking only at direct effects and using command-and-control measures. The SPS Agreement pays "virtually no attention to the impact of SPS trade restrictions on consumer prices" (James and Anderson, 1998: 426).

The main purpose of this paper is to examine the role of the SPS Agreement in developing the international trade regime of agricultural and food products. In particular, this paper tries to investigate how the SPS Agreement can or cannot successfully deter the use of SPS measures for disguised protectionist purposes.

In order to answer the above questions, I use a simple two-sector, two-country perfectly competitive general equilibrium trade model developed by Bagwell and Staiger (1999, 2001). Governments can use two types of policy instruments: tariffs and SPS measures. The use of tariffs is restricted by international agreements, which correspond to GATT/WTO disciplines. The SPS Agreement is captured as a set of restrictions on SPS measures. In order to clarify the role of the SPS Agreement, I compare the equilibrium under the SPS Agreement with the equilibrium without the SPS Agreement.

The main findings of the paper are as follows. Unlike the criticisms by economists for lacking economic considerations, I demonstrate that the SPS Agreement can play a role of mitigating disguised protectionism and improving welfare in international trade of agricultural and food products. Requiring scientific basis is effective to lead SPS policy to the economically sound direction.

However, science for SPS risk analysis involves uncertainty (Powell, 1997; Christoforou, 2000). The academic community may fail to reach a concensus in this area, as a number of opposing, but equally plausible views, may exist. Due to this uncertainty, the SPS Agreement may fail to prevent SPS measures from being used for protectionism purposes.

There are a number of studies related to this paper. First of all, this paper uses the framework developed by Bagwell and Staiger (1999, 2001), who analyze the role of GATT/WTO from an economic point of view. In particular, Bagwell and Staiger (2001) extend the framework of Bagwell and Staiger (1999) to examine the interaction

between tariff policy that is directly restricted by GATT/WTO and domestic policy regarding labour and environmental standards. They show that when the terms-of-trade effect is the only cross-border externality, the current GATT/WTO rules could enable governments to achieve efficient policy combinations of trade and domestic policies with tariff negotiations alone, provided that the market access commitments negotiated in the WTO are not eroded by unilateral choices of domestic labour and environmental standards. They demonstrate that the right to bring the "nonviolation" complaints, which is provided in GATT Article XXIII, is the key to ensuring that governments achieve efficient trade and domestic policy outcomes with tariff negotiations alone. Their result implies that GATT/WTO rules need not be broadened to directly handle the issues of labour and environmental standards in order to achieve a globally efficient outcome. In this paper, I extend their analysis to clarify the role of the SPS Agreement. Similar to Bagwell and Staiger (2001), Copeland (1990) explores the interaction between negotiable and non-negotiable trade barriers. He shows that trade negotiations contain loopholes which can be exploited by protectionist governments, but are nevertheless welfare-improving.[5] Ederington (2001a) demonstrates that the issue raised by Copeland (1990) can be solved by allowing environmental duties. That is, if countries are allowed to set trade policy conditional on the environmental policy of other countries, a fully efficient outcome can be achieved even if countries set their environmental policies unilaterally.

The linkage between trade and nontrade issues in the context of self-enforcing international agreements has been analyzed by Ederington (2001b, 2002) and Limão (2005). Unlike Copeland (1990), Ederington (2001b) investigates cooperation over two negotiable instruments of protection. He focuses on the differential treatment of domestic policies and tariffs in GATT/WTO rules. In GATT/WTO rules, the use of domestic policies as a "disguised" trade barrier is prohibited, while tariff protection is only required not to exceed any "binding levels" that member countries may agree on and to be nondiscriminatory. In the framework of an infinitely-repeated game in which

[5]Copeland (1989) also examines negotiation over two instruments of protection, namely tariffs and quotas. He shows that the set of efficient equilibria is essentially identical when either tariffs or quotas, but not both, are negotiated. He also shows that a trade-eliminating war will not occur unless bargaining over tariffs is inefficient.

any deviation in either trade or domestic policy triggers retaliation in both trade and domestic policies, he shows that differential treatment is efficient if supply and demand functions are approximately linear in local prices, because there is no gain from distorting domestic policy. Since trade policy is the most efficient means of pursuing terms-of-trade gains, it is also the most efficient means of countering the temptation to deviate from cooperation. Thus, under the limited enforcement power that prevents implementation of a fully efficient set of trade and domestic policies, an agreement that requires countries to cooperate fully over domestic policy and to adjust tariffs to satisfy constraints is self-enforcing.

Ederington (2002) compares linkage and nonlinkage of trade and domestic policies in self-enforcing agreements. In a "linked agreement," any deviation in either trade or domestic policies is punished by infinite reversion to a Nash equilibrium in both policies, whereas in a "nonlinked agreement" punishment is restricted to the policy in which the provision is violated. It is commonly viewed that policy linkage strengthens the punishment to deviation. However, he shows that a nonlinked agreement can support the same most-cooperative equilibrium as a linked agreement, which implies that linkage does not necessarily enforce more cooperation. The main reason is that the tariff is the most efficient instrument to address the terms-of-trade effect, which is the only cross-border externality in his model.

Limão (2005) analyzes whether linkage of trade and nontrade policies promotes better cooperation in both policies when there is cross-border nonpecuniary externality as well as the terms-of-trade externality. In the context of self-enforcing agreements, he shows that if trade and domestic policies are strategic complements, linkage can sustain more cooperation in both policies than nonlinkage. When two policies are strategic complements, a country incurs an extra cost when it deviates jointly, which does not exist if it deviates only in one policy. Consequently, linkage lowers an incentive to deviate in any given policy and hence it creates enforcement. He demonstrates that cross-border negative externality is essential for policies to be strategic complements.

Some recent studies examine international agreements from the standpoint of

incomplete contract (Battigalli and Maggi, 2003; Horn, Maggi, and Staiger, 2006). Although this approach would be potentially important to understand the role of the SPS Agreement, that is not the focus of this paper.

This paper is also related to the literature on biological invasion (Horan *et al.*, 2002; Costello and McAusland, 2003; McAusland and Costello, 2004; Knowler and Barbier, 2005), though the focus is different.

Empirical studies on the economic effects of SPS measures include Calvin and Krissoff (1998), James and Anderson (1998), Otsuki, Wilson, and Sewadeh (2001a, b), Wilson, Otsuki, and Majumdar (2003), and Yue, Beghin, and Jensen (2006). For example, Otsuki, Wilson, and Sewadeh (2001a, b) examine the trade impact of an EC regulation announced in 1998 that reduced the maximum permissible level of a certain type of aflatoxin (a toxic substance) in food to a lower level than international standards specified by the Codex Alimentarius. Their study shows that EU standards, which would reduce health risk by approximately 1.4 deaths per billion a year, would reduce exports of cereals, dried fruits and nuts from African countries by 64 per cent or US$670 million, compared with regulations based on the Codex standards.

The remainder of the paper is organized in the following way. Section 2 briefly discusses the background and the main features of the SPS Agreement. Section 3 illustrates the structure of the SPS Agreement from an economic point of view. Section 4 examines the economic effect of the SPS Agreement in the framework of general equilibrium. Section 5 provides some concluding remarks.

2 Background

2.1 Before the SPS Agreement

Prior to the SPS Agreement, the original General Agreement on Tariffs and Trade (GATT) Articles, primarily Article XX, and the 1979 Tokyo Round Agreement on Technical Barriers to Trade, which is known as the *Standards Code*, established multilateral disciplines on the use of SPS measures (Roberts, 1998). However, the

consensus view was that GATT and the Standards Code were not enough to deter disruptions of trade in agricultural and food products.

A typical example to show failures of the pre-SPS Agreement legal disciplines is the unresolved dispute between the U.S. and the EC over the EC's ban on imports of hormone-treated meat and meat products during the 1980s. In March 1987, the U.S. raised the issue of the EC ban under the Standards Code. After six months of fruitless bilateral negotiations, the U.S. requested the establishment of a technical experts group to evaluate the scientific basis for the ban. This request was blocked by the EC, which contended that the use of hormonal growth promotants in beef production was a process and production method (PPM) rather than a product characteristic and hence did not violate the Standards Code. The EC prohibited the import of meat from animals that had been administered growth hormones but did not refer to the import prohibition of meat containing growth hormones (Vogel, 1995, Chapter 5; Roberts, 1998).

2.2 The SPS Agreement

The SPS Agreement was negotiated during the Uruguay Round and entered into force in January 1995. It created new WTO disciplines on permissible trade-restricting measures related to protection of human, animal, and plant life or health from risks.[6] The Technical Barriers to Trade Agreement (TBT Agreement) of the WTO also contains language that refers to protection of human health and the environment. The TBT Agreement covers "all technical regulations and conformity assessment procedures," (Roberts, 1998: 383) except for SPS measures defined by the SPS Agreement. "The objective of a measure is thus crucial to the determination whether it is subject to the disciplines in the TBT or SPS Agreement" (Roberts, 1998: 383).

The main provisions of the SPS Agreement are as follows. Article 2 (Basic Rights and Obligations) claims that members have the right to take SPS measures necessary for the protection of human, animal, or plant life or health and stipulates that any SPS

[6]Roberts (1998) points out that animals and plants in the definition include natural fauna and flora as well as commercial livestock and crops. Thus, the disciplines of the SPS Agreement apply to measures intended to protect the natural environment from the risks associated from harmful exotic species.

measure shall be "applied only to the extent necessary" to the protection, "based on scientific principles" and "not maintained without sufficient scientific evidence" (Article 2.2).

Article 3 (Harmonization) states that members are encouraged to base their SPS measures on international standards, where they exist (Article 3.1).[7] SPS measures which conform to international standards "shall be deemed to be necessary to protect human, animal, or plant life and health, and presumed to be consistent with the relevant provisions" (Article 3.2) of the SPS Agreement and of GATT 1994. However, members can adopt a measure to provide a higher level of SPS protection than that provided by an existing international standard "if there is a scientific justification" (Article 3.3).

Article 4 (Equivalence) states that an importing country must recognize an SPS measure, which differs from its own, as equivalent to its own if the exporting country's measure provides the same level of SPS protection.

Article 5 (Assessment of Risk and Appropriate Level of SPS Protection) requires that any SPS measures be based on a risk assessment, taking into account "risk assessment techniques developed by the relevant international organizations" (Article 5.1); Article 5.5 requires internal consistency in ALOP, avoiding "arbitrary or unjustifiable distinctions in the levels it considers to be appropriate in different situations, if such distinctions result in discrimination or a disguised restriction on international trade"; Article 5.6 stipulates that SPS measures are "not more trade-restrictive than required" to achieve their ALOP; Article 5.7 states that "if relevant scientific evidence is insufficient," members may adopt SPS measures on a provisional basis.

Article 7 (Transparency) and Annex B state that members are obliged to ensure that

[7]The SPS Agreement makes specific reference to three international standard setting agencies (Annex A). For food safety, it is the "standards, guidelines and recommendations established by the Codex Alimentarius Commission relating to food additives, veterinary drug and pesticide residues, contaminants, methods of analysis and sampling, and codes and guidelines of hygienic practice" that are relevant. For animal health and zoonoses, "the standards, guidelines and recommendations developed under the auspices of the International Office of Epizootics" (or the Office International des Epizzoties: OIE) apply. For plant health it is those developed "under the auspices of the Secretariat of the International Plant Protection Convention" (IPPC) in cooperation with its regional organizations. For any matters not covered by the Codex, the OIE or the IPPC, the SPS Committee has the authority to identify "other relevant international organizations open for membership to all Members."

all SPS measures, and proposals for change, are notified in a transparent manner and to establish a single national enquiry point which is "responsible for the provision of answers to all reasonable questions from interested Members."

2.3 Agri-food trade disputes

For the subsequent analysis of the role of the SPS Agreement, it would be important to look at the cases involving agriculture and food products, in which the WTO Dispute Settlement Body (DSB) found articles of the SPS Agreement were violated. Here, I look at four major cases.

In the *EC-hormones* dispute, the WTO Appellate Body (the report was released on January 16, 1998) found that the EC's import ban was not based on a risk assessment in violation of Article 5.1 and that the EC did not provide scientific evidence to support a higher level of protection than the Codex international standards in violation of Article 3.3

In the *Japan-Agricultural Products II* dispute complaint by the U.S., the WTO Appellate Body (the report was released on February 22, 1999) found that Japan's quarantine measures affecting imports of certain agricultural products were not based on sufficient scientific evidence in violation of Article 2.2 nor based on a risk assessment in violation of Article 5.1.

In the *Australia-Salmon* dispute complaint by Canada, the WTO Panel (Article 21.5 Panel Report was released on February 18, 2000) found that Australia's import ban of fresh, chilled, and frozen salmon was not based on sufficient scientific evidence in violation of Article 2.2 nor based on a risk assessment in violation of Article 5.1, and was not least trade-restrictive in violation of Article 5.6.

In the *Japan-Apples* dispute complaint by the U.S., the WTO Panel (Article 21.5 Panel Report was released on June 23, 2005) found that Japan's import restrictions on U.S. apples were not based on sufficient scientific evidence in violation of Article 2.2 nor based on a risk assessment in violation of Article 5.1, and were not least trade-restrictive in violation of Article 5.6.

In summary, all of the four cases violated Article 5.1 (risk assessment) and three out of the four cases violated Article 2.2 (scientific principles). Moreover, two cases violated Article 5.6 (least trade-restrictive).

3 The structure of the SPS Agreement

In this section, I illustrate the structure of the SPS Agreement from an economic point of view. In particular, I show how the usual economic analysis of price and quantity is transformed into food risk in the evaluation of SPS policy under the SPS Agreement.

Consider that a country imports good x, or food, which is subject to SPS policy. Let D^d, S^d, and S^f be domestic demand for, domestic supply of, and import supply of good x, respectively. Let p^w and p be world and domestic price of good x, respectively.

Good x may contain some "hazard," which is a "biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect" (Codex, 2003: 51). Thus, a possible contamination of a hazard in good x causes a health risk to consumers. In this situation, some SPS policy is required to achieve a certain level of sanitary or phytosanitary protection (which means the protection of human, animal or plant life or health), or *SPS protection*. I assume that the SPS protection level that is attained by some SPS policy is measured by the corresponding risk level R. The smaller R lower the risk, i.e., $R = 0$ means zero risk. The SPS protection level in this country depends on the total amount of hazard intake. Suppose that consumers in this country take the total amount of H_x of hazard by consuming good x. Then, the risk level R can be expressed as a function of H_x, $R(H_x)$. Let h_x be per unit hazard intake. Then, $H_x = h_x \times x$ holds.

Figure 1 depicts the relationship among food consumption, hazard intake, and risk. The risk level R is measured along the upper side of the vertical axis. The right-hand-side of the horizontal axis measures the level of hazard intake H_x. The first quadrant shows the relationship between hazard intake and risk. The upward-sloping curve is the function $R(H_x)$.[8] Since the lower side of the vertical axis measures quantity of food

[8] Although an example of $R''(H_x) > 0$ is drawn in Figure 1, this is not necessarily the case.

consumption and production, the fourth quadrant shows the relationship between the amount of food consumption and hazard intake. The slope of the line in the fourth quadrant is per unit hazard intake h_x. This line could be rotated by the implementation of SPS measures. Moreover, the food price is measured along the left-hand-side of the horizontal axis. Thus, the third quadrant shows the usual relationship between price and quantity. The domestic demand and supply curves are depicted. The supply from abroad is given by a straight line. The implementation of SPS measures could shift the domestic supply and the foreign supply. It may also shift the domestic demand, because the implementation of SPS measures may alter consumers' assessment of food safety.

In this way, under the SPS Agreement an SPS policy is assessed by transforming the market outcome (i.e., a combination of price and quantity) into the risk level through taking hazard intake into account.

The relationship between the SPS protection level implied by international standards and the ALOP of the country is also depicted in Figure 1. In this figure, hazard intake under international standards and the corresponding risk level are indicated as $H_x = \bar{H}$ and $R = \bar{R}$, respectively. The acceptable level of risk chosen by the government of the country is indicated as "ALOP." Here, I consider a case in which the country chooses a more stringent ALOP than $\bar{R}$. $H_x = H^b$ is the level of hazard intake to attain the ALOP. In this figure, I show an example of excessive SPS measures. In the fourth quadrant, a line labelled as "Without SPS" depicts the case of no SPS measure being implemented. On the other hand, a line labelled as "With SPS" depicts the case of an SPS measure being implemented. Thus, without SPS measure, the domestic consumption is $x = x^n$, resulting in hazard intake of $H_x = H^n$. The attained risk level is $R = R^n$, which is higher than the international standard $R = \bar{R}$. If an introduced SPS measure rotates down the line in the fourth quadrant to the line labelled as "With SPS", the domestic consumption is decreased to $x = x^s$ and the corresponding hazard intake is decreased to $H_x = H^s$. This level of hazard intake achieves the risk level of $R = R^s$, which is lower than ALOP. This kind of an excessive SPS policy is considered to violate the SPS Agreement.

4 A general equilibrium analysis

In the previous section, I analyze the structure of the SPS Agreement in the framework of partial equilibrium. In this section, I extend the analysis to a model of general equilibrium, so that the role of the SPS Agreement in international trade in food is further examined.

4.1 The basic framework

I use the two-sector, two-country perfectly competitive general equilibrium trade model developed by Bagwell and Staiger (1999, 2001). There are two countries: home and foreign. Variables of the foreign country are indicated by an asterisk ($*$). There are two goods: x and y. All markets are perfectly competitive. Let x be the natural import good of the home country and y be the natural import of the foreign country. Let $p \equiv p_x/p_y$ and $p^* \equiv p_x^*/p_y^*$ be local relative prices in the home and foreign countries, respectively. Let t and t^* be ad valorem import tariffs imposed by the home and foreign governments, respectively. Define $\tau \equiv 1 + t$ and $\tau^* \equiv 1 + t^*$. Then, I have $p = \tau p^w \equiv p(\tau, p^w)$ and $p^* = p^w/\tau^* \equiv p^*(\tau^*, p^w)$, where $p^w \equiv p_x^*/p_y$ is the world relative price. Note that the home country's terms of trade are measured by $1/p^w$ and the foreign country's terms of trade are measured by p^w.

I assume that both goods are potentially affected by SPS measures.[9] In order to focus on the situation in which trade disputes occur in the real world, I only consider SPS measures with regard to import goods.[10] Let S be a set of SPS measures. Let s_x and s_y^* be SPS measures imposed by the home and foreign governments with regard to their import good, respectively, where $s_x, s_y^* \in S$.

A country's SPS measures could potentially affect both its import demand and the

[9]For example, in the case of hormone beef dispute in the period of the pre-Uruguay Round, when a ban imposed by the EC on imports of hormone-treated beef went into force in 1989, the U.S. implemented retaliatory measures in the form of 100 per cent duties on some EC products, such as beef, tomatoes, and fruit juices.

[10]Some SPS measures are also employed towards export goods. However, trade disputes involving SPS measures usually occur when importing countries impose more stringent SPS measures than exporting countries do. Thus, it is not interesting from a practical perspective to analyze SPS measures with regard to exporting goods. I assume that SPS measures with regard to export goods are set at some basic level.

other country's export supply. For example, Japan allows imports of beef from the U.S. and Canada only from cattle aged 20 months or younger in order to address the issue of bovine spongiform encephalopathy (BSE). This type of SPS measure affects import demand. On the other hand, Japan introduced new standards on residue of pesticide, feed additives, and veterinary drugs in May 2006. The new standards could particularly affect Japan's imports of food from China. This type of SPS measure not only affects Japan's import demand but also could affect China's export supply. Actually, SPS measures affecting export supply and those affecting import demand have quite different effects. Here, I focus on the SPS measures that affect import demand.

For the home country, imports of x are represented as $M_x(s_x, p(\tau, p^w), p^w)$ and exports of y are denoted as $E_y(p(\tau, p^w), p^w)$. Foreign imports of y, M_y^* and foreign exports of x, E_x^* are defined analogously. In these import demand and export supply functions of the home and foreign country, s_x and s_y^* act as shift parameters. From the conditions of balanced trade, I have

$$p^w M_x(s_x, p(\tau, p^w), p^w) = E_y(p(\tau, p^w), p^w), \tag{1}$$

$$M_y^*(s_y^*, p^*(\tau^*, p^w), p^w) = p^w E_x^*(p^*(\tau^*, p^w), p^w). \tag{2}$$

The equilibrium world price $\tilde{p}^w(\tau, s_x, \tau^*, s_y^*)$ is determined by the x-market-clearing condition:

$$M_x(s_x, p(\tau, \tilde{p}^w), \tilde{p}^w) = E_x^*(p^*(\tau^*, \tilde{p}^w), \tilde{p}^w), \tag{3}$$

with market clearing for y. I assume that the Marshall-Lerner stability conditions are satisfied, so that an inward shift of the home (respectively, foreign) import demand curve will result in a lower (respectively, higher) equilibrium world price. Following Bagwell and Staiger (1999, 2001), I also assume that $dp/d\tau > 0 > dp^*/d\tau^*$ to avoid the Metzler paradox and $\partial\tilde{p}^w/\partial\tau < 0 < \partial\tilde{p}^w/\partial\tau^*$ to avoid the Lerner paradox.

Furthermore, it will be reasonable to assume that an increase in SPS measures reduces import demand, that is,

$$\frac{\partial M_x(s_x, p(\tau, p^w), p^w)}{\partial s_x} < 0, \qquad \text{and} \qquad \frac{\partial M_y^*(s_y^*, p^*(\tau^*, p^w), p^w)}{\partial s_y^*} < 0. \tag{4}$$

These assumptions together with the stability assumptions imply

$$\frac{\partial \tilde{p}^w(\tau, s_x, \tau^*, s_y^*)}{\partial s_x} < 0, \qquad \text{and} \qquad \frac{\partial \tilde{p}^w(\tau, s_x, \tau^*, s_y^*)}{\partial s_y^*} > 0. \tag{5}$$

4.2 Social welfare and SPS protection level from risks

Following Bagwell and Staiger (1999, 2001), I represent social welfare of the home and foreign country by general functions $W(s_x, p(\tau, \tilde{p}^w), \tilde{p}^w)$ and $W^*(s_y^*, p(\tau^*, \tilde{p}^w), \tilde{p}^w)$, respectively. As in Bagwell and Staiger (1999, 2001), I assume that, holding local prices and SPS measures fixed, an improvement in terms of trade increases social welfare of the country, that is,

$$\partial W(s_x, p, \tilde{p}^w)/\partial p^w < 0 \qquad \text{and} \qquad \partial W^*(s_y^*, p^*, \tilde{p}^w)/\partial p^w > 0. \tag{6}$$

On the other hand, the acceptable level of risk or the *SPS protection level from risk to human, animal or plant life or health* that will be achieved by implementing an SPS measure in the home country is denoted as $R \in [0, R^{Max}]$. A higher value of R means a higher risk and $R = 0$ means risk free. The relationship between s_x and R is represented by a function $R = f(s_x)$, which is assumed to be non-increasing in s_x. Similarly, the SPS protection level in the foreign country is denoted as $R^* = f(s_y^*)$.

4.3 Efficient policy choices

Efficient policy choices are identical to those shown by Bagwell and Staiger (2001). That is, any efficient policies $(\tau^E, s_x^E, \tau^{*E}, s_y^{*E})$ solve

$$\max_{\tau, s_x, \tau^*, s_y^*} \; W(s_x, p(\tau, \tilde{p}^w), \tilde{p}^w) \tag{7}$$

$$\text{subject to} \qquad W^*(s_y^*, p(\tau^*, \tilde{p}^w), \tilde{p}^w) \geq \tilde{W}^{*E},$$

where $\tilde{W}^{*E} \equiv W^*(s_y^{*E}, p(\tau^{*E}, \tilde{p}^{wE}), \tilde{p}^{wE})$ and $\tilde{p}^{wE} \equiv \tilde{p}^w(\tau^E, s_x^E, \tau^{*E}, s_y^{*E})$. The first-order-conditions (FOCs) are given by

$$W_s \left(\frac{1}{\partial \tilde{p}^w / \partial s_x} \right) = W_p \left(\frac{\tilde{p}^w}{\partial \tilde{p}^w / \partial \tau} \right), \tag{8}$$

$$W^*_{s_y^*} \left(\frac{1}{\partial \tilde{p}^w / \partial s_y^*} \right) = W^*_{p^*} \left(\frac{-p^*/\tau^*}{\partial \tilde{p}^w / \partial \tau^*} \right), \tag{9}$$

and

$$(1 - AW_p)(1 - A^*W^*_{p^*}) = 1, \tag{10}$$

where subscripts mean partial derivatives and $A \equiv (1 - \tau\lambda)/(W_p + \lambda W_{p^w})$ and $A^* \equiv (1 - \lambda^*/\tau^*)/(W^*_{p^*} + \lambda^* W^*_{p^w})$, where

$$\lambda \equiv \frac{\partial \tilde{p}^w/\partial\tau}{dp/d\tau} < 0 \quad \text{and} \quad \lambda^* \equiv \frac{\partial \tilde{p}^w/\partial\tau^*}{dp^*/d\tau^*} < 0.$$

See Bagwell and Staiger (2001) for detailed discussion on those FOCs.

The only thing that Bagwell and Staiger (2001) did not do is to define the *efficient SPS protection level*, R^E and R^{*E}, which is given by

$$R^E = f(s^E_x) \qquad \text{and} \qquad R^{*E} = f(s^{*E}_y). \tag{11}$$

4.4 GATT/WTO disciplines with the SPS Agreement

I now turn to the case in which the SPS Agreement is entered into force. In this case, in addition to the tariff negotiation, choices of SPS measures are also restricted by the SPS Agreement.

First of all, the SPS Agreement requires each country to set its own ALOP. Let $\bar{R}$ and $\bar{R}^*$ be ALOPs of the home and foreign country, respectively. The SPS Agreement requires harmonization of ALOPs to international standards. Let $\bar{R}^w_x$ and $\bar{R}^w_y$ be the SPS protection levels with regard to x and y, respectively, set by the relevant international organizations, such as the Codex, the OIE, and IPPC. Then, the SPS Agreement requires $\bar{R} \geq \bar{R}^w_x$ and $\bar{R}^* \geq \bar{R}^w_y$. However, it also allows ALOPs to be more stringent than $\bar{R}^w_x$ or $\bar{R}^w_y$, if there is a scientific justification.

Secondly, the SPS Agreement requires scientific basis and appropriate risk analysis for SPS measures. This implies that each country is responsible for demonstrating "rational relationship" between ALOPs and SPS measures. I define the following three cases: (a) If $\bar{R} > R = f(s)$, it is said to be *overprotective*; (b) If $\bar{R} = R = f(s)$, it is said to be *just protective*; (c) If $\bar{R} < R = f(s)$, it is said to be *underprotective*. Case (a) means that the actual SPS protection level resulting from implementing an SPS measure s is higher than the ALOP set by the government. Case (c) is the opposite case. Case (b)

means that an SPS measure s is just enough to achieve the ALOP. The SPS Agreement requires that (b) is the case.

Finally, the SPS Agreement requires SPS measures to be least trade-restrictive. This implies that if there exist $s'_x, s''_x \in S$ such that $R' = f(s'_x)$ and $R'' = f(s''_x)$ and $R' = R'' \equiv \hat{R}$, then the home country has to choose s'_x such that $M_x(s'_x, p, p^w) \geq M_x(s''_x, p, p^w)$ for all s''_x such that $\hat{R} = f(s''_x)$. A similar rule applies to the foreign country.

Now, I am ready to prove the first result regarding the economic effects of the SPS Agreement. Let $(\bar{\tau}, \bar{\tau}^*, s^u_x, s^{*u}_y)$ be a combination of policies in Nash equilibrium without the SPS Agreement. Denote $R^u = f(s^u_x)$ and $R^{*u} = f(s^{*u}_y)$. Then, the following proposition is obtained.

Proposition 1 *Assume that there is a negotiated pair of tariff bindings $(\bar{\tau}, \bar{\tau}^*)$. Suppose that $\bar{R}$ and $\bar{R}^*$ conform to $\bar{R}^w_x$ and $\bar{R}^w_y$.*

(i) Consider $\bar{R}^w_x$ and $\bar{R}^w_y$ such that $R^u < \bar{R}^w_x \leq R^E$ and $R^{*u} < \bar{R}^w_y \leq R^{*E}$. If $dW/d\tau^* < 0$ and $dW^*/d\tau < 0$ hold at the non-cooperative choices of SPS measures, then the SPS Agreement, which induces reciprocal reductions in s_x and s^*_y from (s^u_x, s^{*u}_y), improves social welfare of both countries, compared to the case without an SPS Agreement;

(ii) If $(\bar{\tau}, \bar{\tau}^*) = (\tau^E, \tau^{*E})$ and $\bar{R}^w_x = R^E$ and $\bar{R}^w_y = R^{*E}$ hold, the SPS Agreement together with tariff negotiations achieves efficient outcomes.

Proof. See Appendix. ∎

Proposition 1 demonstrates that the SPS Agreement actually has a positive economic effect, provided that at the equilibrium point without SPS Agreement each country would be hurt by a unilateral increase in its trading partner's tariff. The SPS Agreement reduces SPS measures that would be otherwise set at higher level for manipulating terms of trade, contributes to a freer trade, and improves welfare in the world, compared to the case without an SPS Agreement.

The next result, however, show that the SPS Agreement in the current form is not enough to guarantee an efficiency gain.

Proposition 2 *Given a negotiated pair of tariff bindings* $(\bar{\tau}, \bar{\tau}^*)$*, if* $\bar{R}_x^w$ *and* $\bar{R}_y^w$ *such that* $R^u < \bar{R}_x^w \leq R^E$ *and* $R^{*u} < \bar{R}_y^w \leq R^{*E}$*, a country has an incentive to set its ALOP more stringent than* $\bar{R}_x^w$ *or* $\bar{R}_y^w$*, or to implement an overprotective SPS measure.*

Proof. See Appendix. ∎

This proposition shows that a country has an incentive to unilaterally increase its actual SPS protection level from international standards. There are two ways to achieve this: the first option is to set its ALOP higher than international standards; the second option is to make its ALOP conform to international standards but implement SPS measures that will realize a higher level of SPS protection than the ALOP. Although the second option is prevented by the SPS Agreement, the first option may be feasible under the SPS Agreement.

Article 3.3 of the SPS Agreement allows each country to set its ALOP higher than $\bar{R}^w$ as long as a scientific justification is provided. However, the state of science for SPS risk assessment is highly uncertain (Powell, 1997).[11] The Appellate Body of the WTO Dispute Settlement Body in the case of hormone beef dispute argued that the scientific evidence to support a particular SPS measures is not necessarily based on the "mainstream" scientific opinion (Pauwelyn, 1999). Governments can base their SPS measures on "a divergent opinion coming from qualified and respected sources" (WTO, 1998). It would be sufficient for a country to demonstrate a "rational relationship" between the SPS measure and the risks it mitigates in order to justify a particular SPS measure (Roberts, 1998). "The Appellate Body clarified that even minority opinions could provide this 'rational relationship' " (Pauwelyn, 1999: p. 649). This implies that various ALOPs and SPS measures can be justified by different scientific evidence.[12] Thus, scientific uncertainty might be exploited by disguised protectionism.

[11] This is particularly true for biological stressors. Powell (1997) argues that "there may be large, irreducible uncertainties in predicting the effects of biological stressors" (p. 5) because, unlike chemical stressors, biological organisms grow, reproduce, disperse both actively and passively, interact with ecosystems in ways that are hard to predict, and evolve largely randomly (Simberloff and Alexander, 1994).

[12] Christoforou (2000) argues potential procedural issues at the Dispute Settlement Body (DSB) of the WTO when science-based trade disputes are dealt with. He points out that the procedural rules of the DSB may contribute to multiple or biased views over scientific information.

5 Concluding Remarks

In this paper, I have analyzed the role of the SPS Agreement of the WTO, which is aimed at preventing WTO members from using SPS measures discretionarily and arbitrarily, from an economic point of view. The SPS Agreement relies mainly on the risk analysis paradigm, which is based on scientific justification, rather than the economic paradigm. For that reason, economists have often criticized the SPS Agreement for lacking economic sense.

The analysis in this paper, however, has demonstrated that the SPS Agreement could play a role of improving social welfare in the world. As long as the SPS protection levels are set at some proper levels by the relevant international organizations, the SPS Agreement induces reciprocal reductions in SPS measures of both countries from their unilaterally optimal levels, leading to an improvement in economic welfare of both countries.

However, a potential drawback of the SPS Agreement arises from its reliance on the risk analysis paradigm. Science involves uncertainty. Owing to the uncertainty of science, the SPS Agreement leaves room for countries to use SPS measures for disguised protectionist purposes or they may become an obstacle to implementation of welfare-improving SPS measures.

Appendix: Proofs of Propositions

Proof of Proposition 1. (i) Let s_x^w and s_y^{*w} be SPS measures satisfying $\bar{R}_x^w = f(s_x^w)$ and $\bar{R}_y^w = f(s_y^{*w})$, respectively. Then, although s_x^w and s_y^{*w} may not be uniquely determined, under the SPS Agreement $s_x^w < s_x^u$ and $s_y^{*w} < s_y^{*u}$ must hold for any s_x^w and s_y^{*w} such that $\bar{R}_x^w = f(s_x^w)$ and $\bar{R}_y^w = f(s_y^{*w})$. Since $(\bar{\tau}, \bar{\tau}^*)$ is binding, governments cannot increase tariffs in response to decreases in s_x and s_y^*.

Given the partner country's SPS measure, the best-responses of the home and foreign government are respectively defined by the the FOCs:

$$W_s \left(\frac{1}{\partial \tilde{p}^w / \partial s_x} \right) = -\left(\tau W_p + W_{p^w} \right); \tag{A1}$$

$$W_{s_y^*}^* \left(\frac{1}{\partial \tilde{p}^w / \partial s_y^*} \right) = -\left(\frac{1}{\tau^*} W_{p^*}^* + W_{p^w}^* \right). \tag{A2}$$

Let $s_x^{BR}(s_y^*; \bar{\tau}, \bar{\tau}^*)$ and $s_y^{*BR}(s_x; \bar{\tau}, \bar{\tau}^*)$ be the best-responses of the home and foreign country, respectively, which satisfy (A1) and (A2), respectively. By assumption (6), the following inequalities hold:

$$\begin{aligned} \tilde{p}^w(\bar{\tau}, s_x^{BR}(s_y^{*w}), \bar{\tau}^*, s_y^{*w}) &\leq \tilde{p}^w(\bar{\tau}, s_x^w, \bar{\tau}^*, s_y^{*w}); \\ \tilde{p}^w(\bar{\tau}, s_x^w, \bar{\tau}^*, s_y^{*BR}(s_x^w)) &\geq \tilde{p}^w(\bar{\tau}, s_x^w, \bar{\tau}^*, s_y^{*w}). \end{aligned}$$

Then, from (5) these inequalities imply that $s_x^{BR}(s_y^{*w}) \geq s_x^w$ and $s_y^{*BR}(s_x^w) \geq s_y^{*w}$. At the point where s_x and s_y^* satisfy (A1) and (A2), respectively, a marginal change in s_x (respectively, s_y^*) has no first-order impact on W (respectively, W^*). The impacts of a change in the partner country's SPS measure on domestic welfare are given by

$$\frac{dW}{ds_y^*} = \left(\tau W_p + W_{p^w} \right) \frac{\partial \tilde{p}^w}{\partial s_y^*}, \qquad \text{and} \qquad \frac{dW^*}{ds_x} = \left(\frac{1}{\tau^*} W_{p^*}^* + W_{p^w}^* \right) \frac{\partial \tilde{p}^w}{\partial s_x}.$$

Since

$$\frac{dW}{d\tau^*} = \left(\tau W_p + W_{p^w} \right) \frac{\partial \tilde{p}^w}{\partial \tau^*}, \qquad \text{and} \qquad \frac{dW^*}{d\tau} = \left(\frac{1}{\tau^*} W_{p^*}^* + W_{p^w}^* \right) \frac{\partial \tilde{p}^w}{\partial \tau},$$

the assumptions of $dW/d\tau^* < 0$ and $dW^*/d\tau < 0$ with assumption of $\partial \tilde{p}^w / \partial \tau < 0 < \partial \tilde{p}^w / \partial \tau^*$ implies that $(\tau W_p + W_{p^w}) < 0$ and $(W_{p^*}^*/\tau^* + W_{p^w}^*) > 0$. Then, from (5) $dW/ds^* < 0$ and $dW^*/ds < 0$ hold, which establishes the intended result.

(ii) If $(\bar{\tau}, \bar{\tau}^*) = (\tau^E, \tau^{*E})$ and $\bar{R}_x^w = R^E$ and $\bar{R}_y^w = R^{*E}$ hold, then $s_x \leq s_x^E$ and $s_y^* \leq s_y^{*E}$ must hold. By Article 5.6 of the SPS Agreement, s_x and s_y^* must satisfy respectively the following restrictions:

$$M_x(s_x, p(\tau^E, \hat{p}^w), \hat{p}^w) \geq M_x^E, \tag{A3}$$

$$M_y^*(s_y^*, p^*(\tau^{*E}, \hat{p}^w), \hat{p}^w) \geq M_y^{*E}, \tag{A4}$$

where M_x^E and M_y^{*E} denote home and foreign import volumes associated with a combination of the efficient policies $(\tau^E, s_x^E, \tau^{*E}, s_y^{*E})$. Then, conditions (1) through (3) together with stability assumptions imply that (A3) and (A4) can be rewritten as

$$\hat{p}^w(\tau^E, s_x, \tau^{*E}, s_y^*) \geq \tilde{p}^{wE}, \tag{A5}$$

$$\hat{p}^w(\tau^E, s_x, \tau^{*E}, s_y^*) \leq \tilde{p}^{wE}, \tag{A6}$$

respectively, where $\tilde{p}^{wE}$ denotes the equilibrium world price associated with a combination of the efficient policies $(\tau^E, s_x^E, \tau^{*E}, s_y^{*E})$. Under assumption (6), for a given s_y^*, the home government will choose s_x such that $\hat{p}^w(\tau^E, s_x, \tau^{*E}, s_y^*) = \tilde{p}^{wE}$. Similarly, for a given s_x, the foreign government will choose s_y^* such that $\hat{p}^w(\tau^E, s_x, \tau^{*E}, s_y^*) = \tilde{p}^{wE}$. This implies that the combination of (s_x, s_y^*) in Nash equilibrium is (s_x^E, s_y^{*E}). ∎

Proof of Proposition 2. Given $(\bar{\tau}, \bar{\tau}^*)$ and $\bar{R}^* = \bar{R}_y^w$, if the home government sets $\bar{R} < \bar{R}_x^w$, under the assumption (4) an SPS measure that corresponds to $\bar{R} = f(s_x)$ yields

$$M_x(s_x, p(\bar{\tau}, \tilde{p}^w(\bar{\tau}, s_x, \bar{\tau}^*, s_y^{*w})), \tilde{p}^w(\bar{\tau}, s_x, \bar{\tau}^*, s_y^{*w})) < M_x(s_x^w, p(\bar{\tau}, \tilde{p}^{wR}), \tilde{p}^{wR}), \tag{A7}$$

where $\tilde{p}^{wR} \equiv \tilde{p}^w(\bar{\tau}, s_x^w, \bar{\tau}^*, s_y^{*w})$. Then, under the stability assumptions, (A7) implies that

$$\tilde{p}^w(\bar{\tau}, s_x, \bar{\tau}^*, s_y^{*w}) < \tilde{p}^{wR}.$$

Thus, under assumption (6),

$$W(s_x, p(\bar{\tau}, \tilde{p}^w), \tilde{p}^w) > W(s_x^w, p(\bar{\tau}, \tilde{p}^{wR}), \tilde{p}^{wR})$$

holds. When $\bar{R} = \bar{R}_x^w$, an overprotective s_x, which yields $f(s_x) < \bar{R}$ produces the same result. The case of the foreign country is proved in an analogous way. ∎

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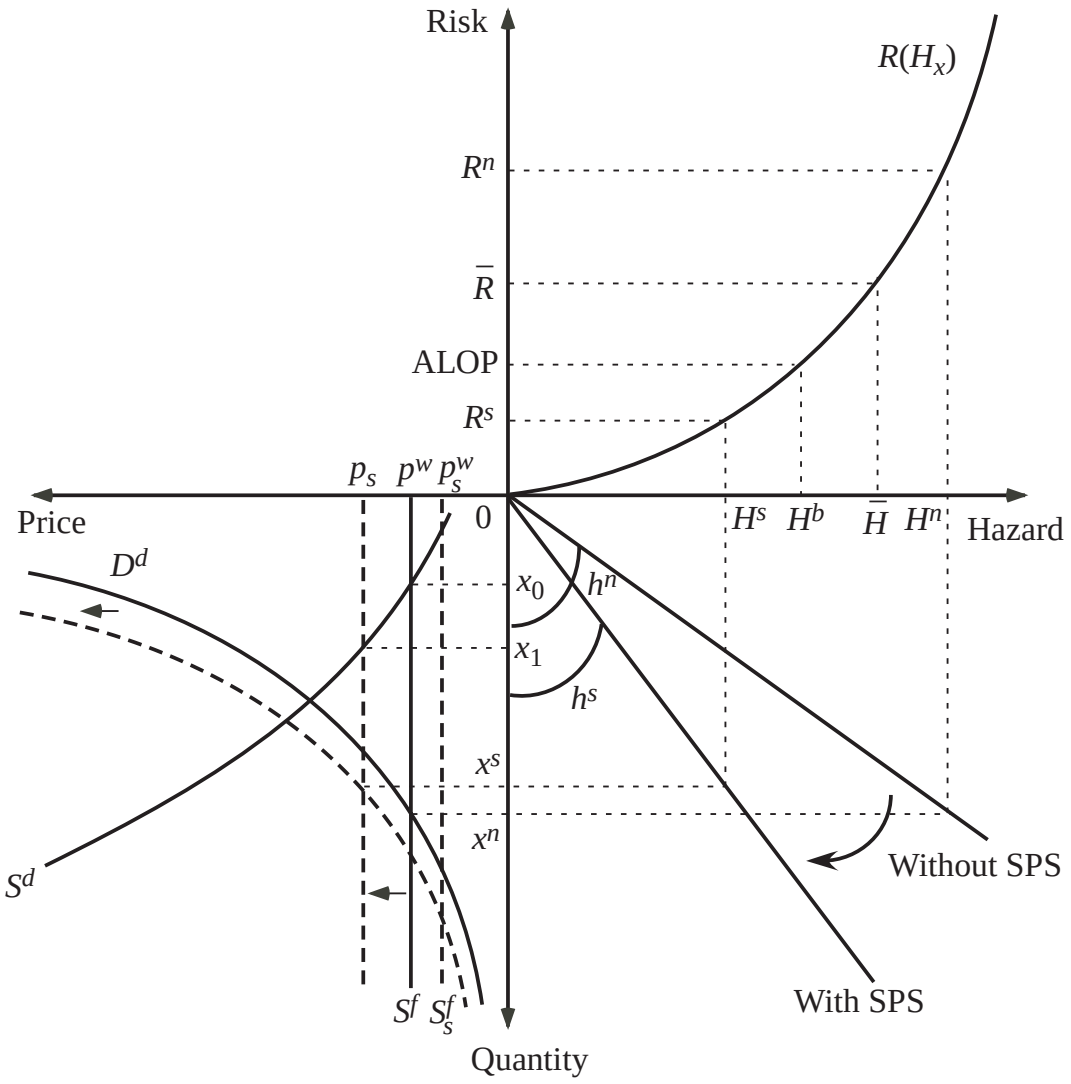

Figure 1: Food consumption, hazard, and risk