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A Partial Equilibrium Framework

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Abstract

This contribution provides a cost-benefit analysis in a partial equilibrium framework to investigate the welfare consequences of a prohibitive regulatory non-tariff measure (NTM) in the form of a sanitary and phytosanitary (SPS) measure aimed at a foreign product with perceived negative characteristics. Two groups of consumers are distinguished: one that is indifferent to the foreign product's negative attributes, and another that is concerned about them. Different scenarios concerning the welfare gains from the introduction of an NTM are explored. The results depend on consumer awareness and information policies pursued by the government of the importing country or group of countries. The theoretical model is illustrated with data on the production and importation of prepared poultry in the EU. This paper focusses on the recent Dispute Settlement (DS) case 607 at the World Trade Organization (WTO) that was initiated by Brazil in November 2021 to consult with the EU on restrictive measures imposed on the importation of prepared and preserved poultry. These restrictions are in line with the comprehensive and restrictive programme legislated by the EU to combat salmonella spp. The findings suggest that the consumer surplus may be reduced after the imposition of prohibitive SPS measures because the market structure changes from a duopoly to a monopoly. However, when the perceived harm of the bad product increases and the portion of the concerned population in society regarding the bad product increases, the change in the consumer surplus also increases.

Keywords: welfare, trade policy, non-tariff measures, technical barriers to trade, dispute settlement

JEL classification: D61, F13

CONTENTS

TABLES AND FIGURES

1. Introduction

Since the General Agreement on Tariffs and Trade (GATT) took effect in 1948, tariffs on trade between World Trade Organization (WTO) members have fallen. However, non-tariff measures (NTMs) have received worldwide attention as their use has been on the rise. While WTO agreements allow member countries to impose regulatory measures such as regulatory NTMs, some of these NTMs have raised Specific Trade Concerns (STCs) at WTO committees and have led to Dispute Settlement (DS) cases at the WTO. While the DS mechanism is currently not fully functional due to political reasons, one of the most recent DS cases of regulatory NTMs is DS607[1], requested by Brazil in November 2021 concerning the measures imposed by the European Union (EU) on imports of certain poultry meat preparations from Brazil. This paper focusses on this specific DS case. The paper first analyses imports of prepared or preserved turkey to the EU from Brazil and regulatory measures imposed by the EU on the domestic production and the importation of these goods. The regulatory measure is embedded within sanitary and phytosanitary (SPS) measures intended to protect human health from microbiological hazards and to control for salmonella and other specified food-borne zoonotic diseases. Secondly, the paper provides a cost-benefit analysis by illustrating a partial equilibrium framework to assess the welfare implications of the measures imposed by the EU. The conceptual framework distinguishes between the paternalistic behaviour of EU regulations and consumer awareness and concerns regarding harm from salmonella.

According to the Multi-Agency Support Team (MAST)[2] classification of May 2019 (UNCTAD, 2019), NTMs include 16 categories, of which the first and second are those most frequently notified by WTO members. These two most frequently used measures described by MAST are SPS measures and technical barriers to trade (TBT). SPS measures are those that are applied with the aim of: protecting human or animal life from risks arising from additives, contaminants, toxins, or disease-causing organisms in their food; protecting human life from plant- or animal-carried diseases; protecting animal or plant life from pests, diseases or disease-causing organisms; preventing or limiting other damage to a country from the entry, establishment or spread of pests; or protecting biodiversity. SPS measures include those taken to protect the health of fish and wild fauna, as well as forests and wild flora. TBTs are ‘measures referring to technical regulations, and procedures for assessing conformity with technical regulations and standards, excluding measures covered by the SPS Agreement’.

These measures have attracted worldwide attention: the World Trade Report (WTO, 2012) specifically discusses them and analyses their impact on international trade flows. They have been very effective instruments for governments in pursuing different motivations. Therefore, they are considered as

1 https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds607_e.htm

2 As of July 2008, MAST comprises the following institutional members: the Food and Agriculture Organization of the United Nations (FAO), the International Monetary Fund (IMF), the Organization for Economic Cooperation and Development’s (OECD) Trade and Agriculture Directorate, the United Nations Conference on Trade and Development (UNCTAD), the United Nations Industrial Development Organization (UNIDO), the World Bank (WB), the World Trade Organization (WTO), and the International Trade Centre UNCTAD/WTO (ITC). Observers: the European Commission (EC), the United States International Trade Commission (USITC), and the United States Department of Agriculture (USDA). UNCTAD and the World Bank jointly coordinate MAST. MAST reports to the Group of Eminent Persons, which is convened by the director general of UNCTAD.

ambiguous trade policy measures (Gründler and Hillman, 2021). According to the WTO report, there may be three reasons for imposing these regulatory measures. First, an NTM may address a public welfare policy issue rather than an economic issue: it may concern the protection of human health or safety, animal or plant life or health, or the environment. For instance, as part of a TBT or SPS measure, a foreign product that could potentially have a harmful effect on consumers may be banned from importation because consumers are not well informed about the damaging attributes of the product. In other words, an NTM policy is imposed with the aim of protecting consumer welfare in the domestic society.

Secondly, from an economic perspective, an NTM might focus on increasing social welfare by correcting market failures without engaging in trade discrimination. Increased market efficiency and an improvement in information available to market agents through the employment of certain technical regulations such as labelling products, offers a good example of a government's economic motivations for using NTMs. It may be the case that both producer surplus and consumer welfare are improved by the imposition of new regulations. Since the government has not introduced import tariffs, there is no revenue accruing to it.

Thirdly, NTMs can be purely politically motivated: they may seek to hamper free trade to support special interest groups, without increasing consumer welfare. This leads to protectionism in the interests of domestic industry. This type of motivation is described as 'protection for sale' in the literature (Grossman and Helpman, 1992; Goldbe and Maggi, 1997). The change in social welfare is determined by adding together the change in the surplus of domestic producers and government gains induced through the support of the lobbying industry and taking into account consumer welfare losses. In such a framework, the government would assign a lower weight to the final element, resulting in positive social welfare change.

The first two reasons demonstrate good faith on the part of a government and receive support in the WTO agreements; but the third may unnecessarily hamper trade and violate the articles related to NTMs. In other words, special interest groups that lobby governments might persuade them to break international rules and impose protectionist measures, which could lead to a corrupt environment. TBT, SPS and other WTO agreements cover logical frameworks for the imposition of NTMs to avoid this. They provide WTO members with justifiable authority to implement their own standards and regulations, provided they are not discriminatory. For example, a government might claim to be using an NTM to protect the health of its citizens, while in fact it may be protecting its own economy or industry at the expense of domestic consumers or other countries.

In general, new standards and regulations imposed in the context of NTMs are followed by various determining factors that can have quite a substantial impact on international trade. Economic considerations, protectionism, technological progress, health, and environmental issues are powerful motivations for imposing NTMs. Moreover, due to their complexity, these measures have different consequences across countries and products (Disdier et al., 2008; Bao and Qiu, 2010, 2012; Winchester et al., 2012; Blyde, 2022). When the government of a country imposes a new regulation, foreign industries need to adapt to that regulation to gain permission to export to that country. This should increase the quality of imported goods (Ghodsi and Stehrer, 2022; Ghodsi, 2022; Fałkowski et al., 2019; Curzi et al., 2020; Fiankor et al., 2021; Yue, 2021). This happens when domestic industry also produces in line with the new regulations. But if the products of a foreign industry are not in line with the new regulations, their export to the country in question will be halted until those products comply with the new regulations. If it does not make economic sense for a foreign industry to modify its production procedure,

it will simply lose one of its markets. In that case, it will often ask its own government to take legitimate action under international law and WTO agreements. However, it can take quite a long time to convince the government that has introduced the new standards to reverse its policy – or even to comply with current agreements if those have been violated.

During this interim period the market structure becomes less competitive, and those consumers who are indifferent to, or unaware of, the negative characteristics of a product that is manufactured in line with outdated regulations will subjectively feel a negative effect. On the one hand, if the NTM is imposed 'correctly' (i.e., the regulation will benefit their health or wellbeing), consumers will gain (they will be protected from bad products or will enjoy higher safety standards), although they will have to pay a higher price, as the market becomes less competitive. In this situation the net gains or losses need to be quantified. On the other hand, if the NTM is not justified, consumers will bear a net loss, as they must pay a higher price without enjoying better quality. Moreover, when consumers are not willing to pay higher prices for the better quality that derives from the new regulations, they divert their demand to other, cheaper products. Therefore, it is crucial to take into consideration the preferences of consumers when imposing a trade policy instrument such as a regulatory NTM. In other words, a trade policy might be ineffective (or even counterproductive) if consumer preferences are ignored.

Governments that act in good faith generally provide scientific and justifiable reasons for the introduction of TBTs and SPSs. Paternalistic governments try to protect their populations from outdated standards and regulations that would allow the import of harmful products. Thus, the new standards and regulations which are the focus of the NTM seek to increase the quality of life for consumers. However, regardless of the median voter theorem, governments might not heed the true wishes of their domestic consumers. In fact, this paternalistic attitude does not allow consumers to choose the characteristics of a product for themselves: the decision is made for them. Some consumers do not care about the damaging properties of products; and some are simply unaware of them. Nevertheless, governments take the decision to impose new quality standards whether or not the policy is in line with international agreements.

If, as a government might claim, consumers are unaware of the harmful nature of a foreign product, they cannot take into account the damaging effects when deciding on their preferences. For instance, if a consumer does not know (or care) about the potential damage from poultry that is raised and cultivated in a non-hygienic environment, then his/her utility increases with the consumption of any type of poultry – simply because his/her utility is an increasing function of consuming any type of poultry – and this satisfaction is higher than any anticipated objective future harm from the harmful product with salmonella. Given the consumer's overestimation of utility, the government is concerned about the damage to health and considers the following issues: first, and most importantly, a harmful product might cause death; a price cannot be put on that loss, and it cannot even be evaluated (i.e., its cost to society approaches infinity). Secondly, if the product causes illness that requires treatment, the costs of that treatment can be measured by the government and be accounted for as another negative effect of the bad product. Thirdly, a person in society is one of the main factors of production, and his/her absence due to illness (or death) decreases the total welfare of society. A figure can be put on this loss: average labour productivity relative to the GDP of that society during the period of absence caused by the negative attributes of the product. According to the European Food Safety Authority (EFSA)[3], over 91,000 salmonellosis cases are reported each year in the EU with an overall economic burden of EUR 3bn per year. As noted by Ehuwa et al.

[3] https://www.efsa.europa.eu/en/topics/topic/salmonella

(2021), the number of cases has decreased from 200,000 per year before 2004 in the 15 EU member states to 91,000 in the 28 member states recently. This is mainly because the EU has implemented one of the most successful and stringent salmonella programs in the world with legislation of numerous regulations over the years. Therefore, in this paper, a specific scenario is constructed which assumes that a government can rationally evaluate the damaging consequences of the bad product on which a prohibitive NTM is imposed. Then, it can show that the damage is economically greater than consumers' welfare losses from a prohibitive NTM. The paper will expand on this.

This paper thus provides a theoretical framework for analysing and quantifying the welfare changes in the EU if it imposes a prohibitive NTM; consumers are assigned either to one group that is indifferent to the properties of a product or to another group that is concerned about them. The analysis is separated into two scenarios, depending on whether or not consumers are aware of the harmful effects of the foreign product. First, this enables us to more effectively judge the paternalistic behaviour of the government. Second, if most domestic consumers are concerned about the harmful properties of the foreign product, then NTMs can act with more justification in the context of international regulations and WTO agreements.

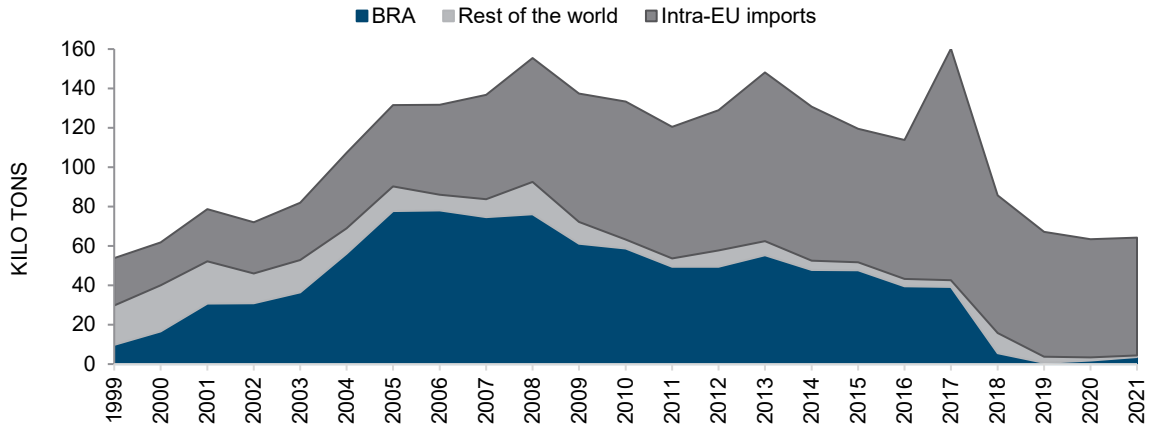
The ongoing DS case on Measures Concerning the Importation of Certain Poultry Meat Preparations from Brazil is examined to illustrate the application of the framework. The findings of this study suggest that the implications of trade policy are closely related to consumer preferences and market structure. Disclosure of information by the government can play a vital role in the consequences of the trade policy instrument. Moreover, the framework presented here provides a measurement of the damage that may be caused by the product that is the target of the regulatory NTM.

The remainder of the paper is as follows: anecdotal facts about EU's programme to control salmonella, import relations with Brazil, and a literature review are provided in section two. In the third section, the basic analysis of the theoretical model is presented. The application of the model using data related to the DS607 investigation requested by Brazil will be illustrated in the fourth section. Finally, a summary of findings, conclusions and possible extensions of the model will be discussed in section five.

2. Anecdotal facts and literature review

In November 2021, Brazil requested consultation (DS607) with the EU within the framework of the Dispute Settlement Mechanism with respect to certain regulatory measures imposed by the EU on the importation of salted poultry meat and turkey meat with pepper. Figure 1 shows the EU's import volumes of prepared or preserved turkey (with HS code 160231) by trading partners in kilo tons during the period 1999-2021. As observed, Brazil was the largest exporter of these products to the EU. During the period 2001-2008, import volumes from Brazil were even larger than intra-EU[4] imports. However, as the average price of the product imported from Brazil was much lower than the average price of the intra-EU imported product (see Figure 3), the value of intra-EU imports was almost always higher than import values from Brazil, except in 2005 (see Figure 2). This indicates that Brazil had a competitive advantage in this sector.

Figure 1 / EU's import volumes of prepared or preserved turkey (HS 160231) by trading partner in kilo tons - 1999-2021

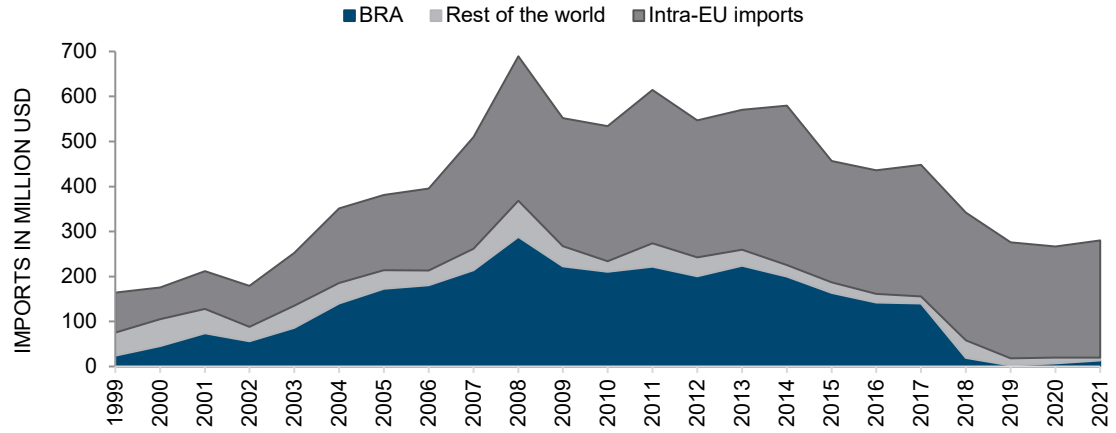


Source: WITS, UN COMTRADE, author's elaboration.

However, as observed in both figures 1 and 2, imports of prepared or preserved turkey from Brazil have decreased substantially from more than 78 kilo tons in 2006 to 6 kilo tons in 2018, subsequently dropping to a very insignificant level of 0.65 kilo tons in 2019. This is while intra-EU imports have been relatively stable with an annual average of 69 kilo tons that peaked in 2017 at 118 kilo tons. Intra-EU import volumes of prepared turkey relative to extra-EU imports rose from 0.53 kilo tons in 2006 to 13.73 in 2021, which may be a sign of protectionism related to trade regulations.

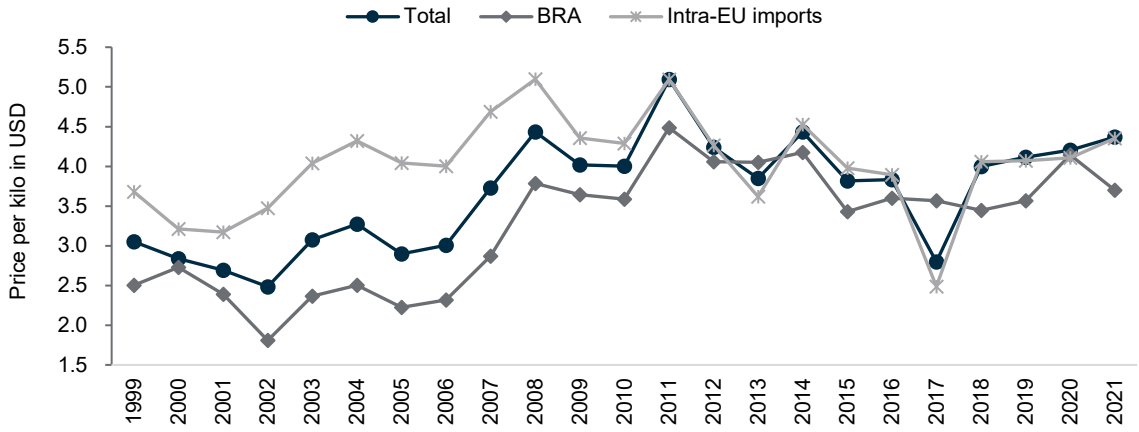
[4] The evolutionary accession of 27 members of the EU is considered in this paper.

Figure 2 / EU's import values of prepared or preserved turkey (160231) by trading partner in million USD 1999-2021



Source: WITS, UN COMTRADE, author's elaboration.

Figure 3 / EU's average import price of prepared or preserved turkey (160231) by trading partner 1999-2021 in USD



Source: WITS, UN COMTRADE, author's elaboration.

It is important to note that Brazil is also a major exporter of prepared or preserved chicken or fowls of the species Gallus domesticus (with HS code 160232) as Figure B1 in Appendix B shows. The EU's import volumes of prepared chicken from Brazil peaked at 166 kilo tons in 2011 and since then they have gradually declined to only 25 kilo tons in 2020. In 2020 other major exporters of these products to the EU were Thailand with more than 55 kilo tons, the UK with 38.5 kilo tons, and China with 15.8 kilo tons, all countries that are included in the rest of the world. Intra-EU import volumes of prepared chicken relative to extra-EU imports grew from 1.33 kilo tons in 2011 to 4.13 in 2021, which may be a sign of protectionism related to trade regulations. However, extra-EU imports of prepared chicken never dropped to insignificant lows as was the case for prepared turkey. Therefore, in this paper, the welfare cost-benefit of the prohibitive SPS measures that have led to almost full stoppage of importation of prepared and preserved turkey is analysed, while the theoretical framework could be similarly applied to the importation of prepared and preserved chicken from Brazil.

2.1. THE EU'S EVOLVING PROGRAMME TO COMBAT SALMONELLA-RELATED DISEASES

The major reason behind such a reduction in Brazilian exports of prepared poultry to the EU could have been the imposition of stringent regulations through SPS measures. Regulations adopted and mandated by the EU to protect human health and safety against specified zoonoses and zoonotic agents in animals and products of animal origin date back to the Directive of the Council of European Communities on 17 December 1992 (92/117/EEC[5]) on protection against zoonosis that is the transmission of diseases from animals to humans. Later many other regulations came into force to regulate the market following further scientific research findings and further inspections and testing.

On 17 November 2003, the European Parliament and the Council of Europe introduced regulation 2160/2003[6] on the control of salmonella specifically as one of the zoonotic agents. This regulation specifies measures at plant level and requires third countries to apply similar measures when exporting to the EU. The regulation mandates that 'With effect from 84 months after entry into force of this Regulation [i.e., its publication date], fresh poultry meat from animals listed in Annex I may not be placed on the market for human consumption unless it meets the following criterion: Salmonella: absence in 25 grams.' This means that by December 2010, the market for fresh poultry in the EU should have been substantially free of salmonella. This regulation is also cited in eight SPS measures imposed by the EU during the period 2007-2011 that amended some criteria on the import of poultry and poultry products.

In November 2005, the European Commission introduced microbiological criteria for foodstuffs within regulation 2073/2005[7]. This regulation mandates detailed specification and guidelines on the acceptability of foodstuffs, their manufacturing, handling, and distribution via certain testing criteria. The regulation covers ready-to-eat foodstuffs (like prepared or salted poultry), fresh meat and products, milk and dairy, eggs, fishery, and vegetables. This regulation also obliges suppliers to provide information on packaging, and whether the prepared food needs to be heated and cooked in order to be safe for consumers' health. These regulations specified rules for both poultry meat and poultry meat preparations. They also apply to imported goods from third countries since they went in force on 1 January 2006. This regulation is also cited in five SPS measures imposed by the EU during the period 2007-2012 that amended some of the criteria for the import of poultry, poultry products, and reptiles containing salmonella.

The EU's common organisation of the agricultural market was established in October 2007 with regulation 1234/2007[8] of the Council of Europe. This regulation was cited in six TBTs imposed by the EU during the period 2009-2012 and in seven STCs raised on TBTs imposed by the EU in 2012. In June 2008, detailed rules were set out within regulation 543/2008[9] mandated by the European Commission for the marketing standards of poultry meat, also specifying inspections of imported goods.

To achieve a salmonella-free market, data were collected from broilers across the EU following European Commission regulation 2005/636/EC[10] in 2005, which was also cited in an SPS measure imposed by the

5 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31992L0117

6 https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex:32003R2160

7 https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32005R2073

8 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32007R1234

9 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008R0543

10 https://eur-lex.europa.eu/eli/dec/2005/636

EU in 2020. Then, in a new regulation, 646/2007[11] from the European Commission, collected data were used, a few earlier regulations were repealed or amended, and it was envisaged that by the end of 2011, the maximum percentage of broiler flocks of gallus remaining positive with *Salmonella enteritidis* and *Salmonella typhimurium* on the EU market should be reduced to 1% or less. Similarly, European Commission regulation 584/2008[12] from 2008 envisaged that by the end of 2012, fattening turkey flocks remaining positive with *Salmonella enteritidis* and *Salmonella typhimurium* in the EU should be reduced to 1% or less. This regulation was cited in an SPS measure imposed by the EU in 2008.

To amend earlier regulations that envisaged a salmonella-free market in the EU by 2012, the European Commission introduced regulation 1086/2011[13] that noted that according to earlier surveys, the salmonella prevalence in flocks of broilers was still high. Furthermore, Commission regulation 1190/2012[14] was introduced in December 2012 to amend earlier regulations with new detailed criteria for reducing *Salmonella Enteritidis* and *Salmonella Typhimurium* in flocks of turkeys. Therefore, the envisaged plans were not yet achieved. However, referring to the EFSA's study that approximately 80% of human salmonellosis cases are caused by *Salmonella enteritidis* and *Salmonella typhimurium*, the regulation recommended new testing criteria for only these two serotypes and their control at previous stages of poultry production, only for fresh poultry meat. However, as mentioned above, all other types of foodstuffs including both prepared and fresh poultry were to be tested for all types of salmonella agents according to regulation 2073/2005. The new regulation in 2011 did not loosen the testing criteria for prepared meat. One reason for this might have been that although the labelling of the prepared meat should inform the consumer about cooking and heating the product, the consumer may still use the prepared meat without heating, which may increase the risk of infection, while fresh meat is always cooked. However, citing these three regulations (2160/2003, 2073/2005, 1086/2011) in the document[15] submitted by Brazil to the WTO requesting the DS case, it is argued that fresh meat and prepared meat are similar products and less stringent regulations for one should not be implemented.

2.2. RAISING STCS AT THE WTO BY BRAZIL

Figure B2 in Appendix B illustrates the EU's import volumes of poultry meat and edible poultry offal (HS 0207) by trading partners in kilo tons during the period 1999-2021. As observed, the EU's imports of poultry meat peaked at 260 kilo tons in 2005. It seems that due to stringent regulations, imports of poultry meat from Brazil have also been gradually reduced to just 26 kilo tons in 2021. This has occurred while intra-EU imports or imports from other countries such as Ukraine or the UK have increased. However, the major focus of DS607 is on prepared and preserved poultry meat. As was discussed above, imports of prepared turkey from Brazil fell to an insignificant level since 2018.

As the description of an STC raised by Brazil on the SPS measure imposed by the EU indicates, in November 2017 the issue of differences in regulations on poultry meat versus prepared meat was discussed in the WTO's SPS committee. The EU acknowledged that the differences in the new regulations were based on the findings of a scientific committee in the form of veterinary measures relating to the

11 https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32007R0646

12 https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32008R0584

13 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32011R1086

14 https://eur-lex.europa.eu/legal-content/de/TXT/?uri=CELEX%3A32012R1190

15 https://docs.wto.org/dol2fe/Pages/SS/directdoc.aspx?filename=q:/WT/DS/607-1.pdf&Open=True

public health effects of salmonella in foodstuffs. However, Brazil argued that "food safety specifications for salted poultry meat should be the same as those applied to fresh poultry meat since their intrinsic characteristics relevant to microbial food safety were virtually identical. In addition, both products were uncooked, had similar muscle fibre structure and were not intended for immediate human consumption." In fact, according to Hunag and Hwang (2012), ready-to-eat foodstuffs are "a group of food products that are pre-cleaned, precooked, mostly packaged and ready for consumption without prior preparation or cooking". The EU's results of inspections of prepared turkey imported from Brazil points to the fact that the preparation procedure in Brazil or transportation storage (Akbar and Anal, 2015) has led to negative results, both of which led to the lack of credibility of exporters. Nevertheless, since these regulations also applied to domestic production, the EU argued that imports were not treated with discrimination.

The measure description of another STC raised by Brazil in July 2018 on the SPS imposed by the EU explains that European Commission regulation 2018/700[16] amended the list of Brazilian firms exporting poultry meat and preparations to the EU and removed many of them from the list of authorised establishments[17]. This came after several inspections by the EU of imported goods from Brazil found the presence of salmonella among a significant number of imported samples. This is despite pre-export testing and the fact that according to previous arrangements, the EU's auditing system "relied on guarantees provided by the competent authorities of the exporting country that the exports met the level of sanitary protection set by the European Union". Since these involved Brazilian authorities who approved laboratory test results, it became an alleged case of fraud that could harm confidence in the Brazilian official system. Therefore, the EU's delisting of those firms was argued as a proportionate measure. Furthermore, more frequent border inspections were envisaged. These have led to a substantial drop in imports from Brazil as discussed above.

As the concerns raised by Brazil in the SPS committee meeting of the WTO were discussed on several occasions but were not resolved, in November 2021 Brazil requested consultation with the EU within the Dispute Settlement Mechanism.

2.3. LITERATURE REVIEW AND PAPER'S CONTRIBUTION

To quantify the welfare implications of NTMs, a cost-benefit analysis can be conducted in a partial equilibrium framework. Paarlberg and Lee (1998) used a numerical partial equilibrium approach to investigate the linkages between products at risk of transmitting Foot and Mouth Disease that were imported to the US and the level of protectionism. They simply modelled consumer and producer surplus changes, and a government that maximised welfare by assigning the optimal tariff. Then they calculated the output losses after the outbreak of the disease by assigning a probability to its risk.

The consequences of liberalised trade are twofold for the people of any given society. First, the inflow of products from the international market to a country can potentially threaten its domestic industry. As a result, the job market in the domestic industry would shrink (or at least require labour market adjustments). Secondly, the import of a variety of products with lower prices and higher quality would increase the satisfaction and welfare of consumers. Baker (2003) constructed a theoretical framework to relate earning power to consumption attitude, to explain the popularity of free trade among developing

[16] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018R0700

[17] https://ec.europa.eu/food/safety/biological-safety/food-hygiene/non-eu-countries-authorised-establishments_en

Latin American countries. He provided survey results showing why consumers are interested in the benefits of consumption rather than being concerned about earning power in the job market. In a common microeconomic model, he argues that people work and try to earn, which can be translated as a cost to their leisure. On the other hand, as citizens they try to enjoy and get the most satisfaction out of their leisure time, and they prefer to have a variety of inexpensive bundles of products of high quality. Baker (2003) claimed that this was a reasonable explanation for the pursuit of free trade even in developing countries with high job-market volatility.

Kono (2006) analysed the role of democracy and autocracy in trade policies. His main argument was that democratic governments try to respond to mass public preference for liberal trade policies. Consumers benefit from the variety of products and low prices that are a result of liberal trade. Nevertheless, in all governments there are pressures from industrial interest groups seeking protection. The authorities prefer to address liberalisation with transparent policies, such as tariff reduction. However, there are less transparent policy options available to satisfy special interest groups, one of which is the NTM.

According to Kono (2006) the impact of tariffs can be determined by the degree of pass-through effects. Core NTMs consist of price control measures (such as antidumping) and quantity measures (such as quotas and voluntary export restrictions), which are rather more complex in nature than direct tariffs. Although the impacts of core NTMs are related to prices and quantities, consumers who lack either the expertise or the time for analysis cannot easily evaluate the impact of such policy instruments. Regulatory NTMs are generally regulations on technical issues and standards, which have an impact not only on the quantities and prices of imports, but also on the quality of products that feature in consumer preferences. Thus, the effects of these regulatory measures are even more difficult for consumers to evaluate than the previous two instruments (i.e., core NTMs and quantity measures).

When the political opposition wants to criticise the trade policies of those in power, they can inform people about the negative impacts of high tariffs on consumer welfare in the form of simple price changes. However, a reduction in tariffs can also be seen to threaten jobs. It becomes more difficult for them to explain why, for instance, a voluntary export restriction on 250,000 car units increases the price. Informing people about the costs and benefits of regulatory NTMs would be even harder. Besides, political groups in charge know how their competitors try to challenge their actions and policies by providing information to the population in various ways. In autocracies there is no powerful opponent to try and keep people informed; in democracies, people tend to be better informed, but there is great variation in the information about different types of policy instruments. That may explain why governments, even in the most democratic countries, try to implement opaque and complex trade policies instead of simple tariffs (Kono, 2006). Hence, the public's general knowledge, consumer awareness, related government policies and the provision of information by NGOs might all matter.

According to Baba (1997), it is costly to inform voters and consumers in general. For instance, in election campaigns for the presidency or parliament, candidates try to give voters information to gain their support. But these campaigns are quite costly and are often supported by special interest groups. Other methods of informing consumers, such as media advertising, are also costly. Thus, to have informed consumers who seek liberal trade, there needs to be support from lobbying groups or else from taxing consumers themselves. Governments can easily and relatively cheaply inform society about simple, transparent policy instruments, such as tariffs; but they may conceal the role of opaque and complex ones, such as regulatory NTMs, because of the high cost of providing information.

In a survey conducted by Godínez-Oviedo et al. (2019) in a central region of Mexico, it was found that there was very little consumer awareness or knowledge regarding salmonella spp. In fact, only around 17% of the 1,199 people surveyed had any self-perception regarding salmonella. However, a survey conducted by Henke et al. (2020) on 1008 consumers in Germany showed that only 2.8% of them had never heard of salmonella before. Furthermore, 77.3% had heard about salmonella and knew how to protect themselves, which means only 22.7% of consumers in their sample did not know how to protect themselves against salmonella. This comparison between Germany and Mexico indicates how the EU's programmes in combating salmonella-related diseases have also led to information being provided to consumers.

Some studies in the literature established theoretical frameworks to analyse the costs and benefits of a prohibitive NTM. Van Tongeren et al. (2009) constructed a modular partial equilibrium framework that focused on demand and supply relationships. Changes in social welfare were analysed for three different scenarios: prohibitive standards that completely bring the market into autarky, free trade, and mandatory labelling that provides consumers with comprehensive information about the goods. Using these three scenarios, the effects on consumers and producers were investigated, as were the effects of global common externalities.

Beghin et al. (2012) provided a framework like that of van Tongeren et al. (2009). They considered two scenarios featuring consumers who were informed and uninformed about the negative characteristics of foreign products. They found that in certain circumstances prohibitive standards can increase international welfare. When consumers are unaware of the negative attributes of a product, only the foreign producer's welfare decreases slightly; meanwhile, domestic producers and consumers gain from the regulations. When consumers are thoroughly informed, all these agents gain from the new standards.

This research contributes to the literature and to the papers by Beghin et al. (2012) and van Tongeren et al. (2009) with some additional modifications. Here, in one scenario it is assumed that consumers are aware of the negative characteristics of the product, but they may be either indifferent or concerned. The papers above assume that informed consumers are also concerned consumers. This assumption is relaxed in this paper. In the second scenario, it is assumed that consumers are not aware of the damaging effects, and the government imposes a regulatory NTM to increase their welfare objectively. Furthermore, the paternalistic behaviour of the government, the human cost and burden on society are also considered in this paper. As noted earlier, the annual economic cost of salmonellosis in the EU was estimated by EFSA to be around EUR 3bn.

Furthermore, NTMs are strictly prohibitive: they halt the import of those foreign products with the perceived negative attributes until foreign production procedures improve. This is also what happened in the case of importation of prepared turkey to the EU from Brazil, which is under consultation within the Dispute Settlement Mechanism of the WTO as DS case 607. The market structure in this model differs from the previous research: here, under free trade, the home country has a duopolistic market (like the framework of Brander and Spencer, 1985). Oligopolistic competition instead of perfect competition can provide a clearer situation between two industries at home and abroad. The findings of this paper can clarify a government's motivation for imposing NTMs and its implementation of an information policy. In fact, whenever the data are available for other cases, the analytical framework discussed in the following shows whether or not the government is increasing consumer welfare through restrictive measures that target public issues.

3. Presentation of the model

It is assumed that there are two countries, Home country (H) and Foreign country (F), and that the foreign product contains some characteristics that might cause harm to human health. Here it is simply assumed that the foreign government has a different evaluation of potential risk. The foreign industry or government does not know (or care) about these negative characteristics. And the foreign industry manufactures a product of lower quality[18] than the domestic industry. Some domestic consumers might be concerned about these negative attributes and reflect their concerns in their preferences. A domestic government that tries to protect its population against potential damage from the foreign product imposes a prohibitive NTM that raises the standard of the product. Let us assume that the domestic industry has already been producing in line with the new standards. Foreign producers now need to comply with the new regulations if they are to export to the home market. This takes time. In this model we attempt to analyse domestic welfare changes after the imposition of an NTM, during the time that the foreign product is not imported into the home market because of its lower quality and before the foreign industry complies with the new standards.

The supply side of the market is an oligopolistic Cournot competition between the industries of the two countries[19] before the prohibitive NTM. It is also assumed that the cost of transportation is included in the cost of the final good imported from the foreign supplier. Industries maximise their output with respect to a quadratic cost function in output. Considering N individuals in each society and $Q(p) = \sum_{i=1}^{N} q_i\,(p)$, where $q_i(p)$ and $Q(p)$ are, respectively, the demand of individual i, and the total demand at Home; the profit for this industry in each country is:

$$\pi_j = p(Q)q_j - c_{1j}q_j - \frac{1}{2}c_{2j}q_j^2 - K_j \text{ , for } j = \{H, F\} \qquad (1)$$

where c_{1j} and c_{2j} are the variable cost parameters, and K_j is the sunk cost related to market entry for each industry.

On the demand side it is assumed that consumers are unable to distinguish between the good and bad products. This is exactly why the authorities make regular inspections at the border, to prevent entry of bad products on the market. Even if, according to the rules of origin, consumers know where the product comes from, because of the uncertainty related to the intermediate goods employed in production they cannot distinguish between good and bad products. Thus, products are not differentiable. However, it is

[18] In this model, the low quality of products is assumed to directly affect an individual consumer after consumption. These are not negative externalities associated with the consumption or production of others affecting another individual.

[19] It is simply assumed that there exists one industry in each country; each industry acts as a monopoly in autarky even if it comprises various firms (think of a cartel). The rationale for the selection of such a market structure is simply to show the possibility of government support for the home industry, which can be easier to observe here than a perfect competition. One can argue that although firms within the same industry in the EU or in Brazil are competing in very close to perfect competition, the industries between the two countries are competing in duopolistic competition. Given this assumption, the real data is used to calibrate the model. However, it is also assumed that there is no additional welfare loss due to any potential lobbying of the domestic industry with its government to impose more stringent NTMs.

assumed that the good product is produced domestically, without any negative characteristics, while the bad product is produced abroad and has some negative attributes.

In the following subsections, two scenarios are analysed. In the first, it is assumed that consumers are aware of the harm that could be caused by a product on the market (let us assume that the media and scientists have informed consumers that there is a specific product with certain harmful effects). Now, consumers are divided into two groups: a proportion of society (η) is indifferent to those characteristics; the rest of the population is concerned about the perceived damage from the foreign product and take this into account when making a decision. Consumers can rationally allocate their budget in line with the demand for a product. Given undifferentiated products, they can assign a probability to their ending up with the foreign (bad) or domestic (good) product.

In the second scenario, it is assumed that society is not aware of the harm from the foreign product, and that only the government knows about its attributes. Thus, it can be considered that all consumers are indifferent to the characteristics of the foreign product. The government is fully aware of the danger of the imported goods and considers them in the utility of all consumers objectively.

3.1. SCENARIO A

In this scenario, consumers are aware of the harm that could be caused by one of the products on the market that is presumably imported from a country with less stringent regulations. After the restrictive NTM is imposed to prevent the importation of the bad product, consumers can be informed in case I of this scenario that the bad product does not exist anymore, or they can remain uninformed about it in case II. Case II of this scenario measures subjective welfare, while Case IIB of this scenario measures objective welfare. Since consumers do not know whether or not the product they consume is the one with negative or positive characteristics, they cannot include the two types of product in their preferences exclusively. In other words, they cannot distinguish between the good and bad products, even though they know their origins. Hence, foreign and home goods are mixed in one single market. What they include in their preferences is simply one type of good (q_i) with mixed characteristics. Assume that with probability τ the consumer gets the foreign product, and with probability $(1-\tau)$ she gets the domestic product. Considering quadratic preferences of the good and an additive numeraire, the utility function of each domestic consumer $i = \{1, \dots, N\}$ is as follows:

$$U_i(q_i, w_i) = \tau\left(aq_i - \overline{b}\, q_i^2/2 - I_i r q_i + w_i\right) + (1-\tau)\left(aq_i - \overline{b}\, q_i^2/2 + w_i\right) \quad (2)$$

Here w_i is the numeraire good, the term $aq_i - \overline{b}\, q_i^2/2$ is the satisfaction of consumer *i* from consuming quantity q_i. rq_i is the perceived damage from the product for every concerned consumer, which might be the focus of the technical policy or new regulations. To have positive demand, it is simply assumed that $r < a$. Term I_i represents the concerned knowledge of the consumer regarding the harmfulness of the product. Therefore, if the good is not perceived by the consumer to be harmful, this term will be equal to zero. Conversely, if $I_i = 1$, it means that the consumer will be concerned about the negative properties of the good. Hence, term $I_i r q_i$ captures the impact of harm and the concern about consuming this good felt by the representative consumer.

$\eta = N_1/N$ is the proportion of the population indifferent to the negative characteristics of the good. It means that $I_i r q_i = 0$ for $i \in [1, N_1]$. The rest of society is concerned about the damaging effect of the product, which comprises the proportion $1 - \eta = 1 - (N_1/N)$. Thus, for $i \in [N_1 + 1, N]$, $I_i r q_i > 0$.

The demand function for each consumer can be derived by utility maximisation, subject to a budget constraint. Total demand in society is simply the sum of the demand functions of the two groups. The total demand schedule is truncated where price is equal to $a - \tau r$. In fact, above this price, only indifferent consumers demand good q_i, while concerned consumers demand nothing because of the perception of high negative effects. Therefore, the total inverse demand by society is given by:[20]

$$p_A^D(Q, r) = \begin{cases} a - \dfrac{b}{\eta} Q, 0 \le Q \le \dfrac{\tau r \eta}{b} \\ a - \tau r(1 - \eta) - bQ, Q \ge \dfrac{\tau r \eta}{b} \end{cases} \quad (3)$$

The concerned consumers assign a value τ to the probability of getting the foreign variety of the product. Although they cannot distinguish between the two products, they have access to statistical data and consider the ratio of the imported products (with bad characteristics) relative to the total consumption of the product (with two types of characteristics) in the market to be τ. This allows us to simply assume that $\tau = q_F/(q_F + q_H)$. Firms in both countries maximise their profits in a duopolistic market subject to the inverse demand function (3), and they consider the value of τ to be determined by pre-NTM patterns. It is further assumed that both industries are symmetric, and their cost parameters are identical ($c_{1H} = c_{1F} = c_1$; $c_{2H} = c_{2F} = c_2$; $K_H = K_F = K$). Therefore, it is clearly observed that both industries supply the same amount of product in the market, and thus $\tau = 1/2$. Considering these assumptions and deriving the Cournot (Nash) Equilibrium for the Best Response (BR) functions of the two industries, before imposition of the restrictive NTM, the total quantity supplied in the oligopolistic market (Q_{AO}) will be:[21]

$$Q_{AO} = \begin{cases} \dfrac{2\eta(a - c_1)}{3b + c_2\eta}, a - \dfrac{r}{2} \le p \le a \\ \dfrac{2\left(a - \frac{r}{2}(1 - \eta) - c_1\right)}{3b + c_2}, 0 \le p \le a - \dfrac{r}{2} \end{cases} \quad (4)$$

The equilibrium price in this duopoly (P_{AO}) will be:

$$P_{AO} = \begin{cases} a - \dfrac{2b(a - c_1)}{3b + c_2\eta}, 0 \le Q \le \dfrac{r\eta}{2b} \\ a - \dfrac{r}{2}(1 - \eta) - \dfrac{2b\left(a - \frac{r}{2}(1 - \eta) - c_1\right)}{3b + c_2}, Q \ge \dfrac{r\eta}{2b} \end{cases} \quad (5)$$

[20] Calculations can be found in Appendix 1.

[21] These are not closed solutions but analytical solutions. A pure strategy Nash Equilibrium may not exist. For the proof of existence refer to Appendix 2. However, the simulation in the next section is based on the existence of pure strategy Nash Equilibrium.

Consumer welfare in this oligopoly before new regulations (CS_{AO}) will be as follows:[22]

$$CS_{AO} = \int_0^{Q_{AO}} (p_A^D(Q,r) - P_{AO})dQ$$
$$= \begin{cases} 2b\eta\left[\frac{(a-c_1)}{3b+c_2\eta}\right]^2, a-\frac{r}{2} \le p \le a \\ \frac{b}{2}\left[\frac{2\left(a-\frac{r}{2}(1-\eta)-c_1\right)}{3b+c_2}\right]^2 + \frac{r^2\eta(1-\eta)}{8b}, 0 \le p \le a-\frac{r}{2} \end{cases} \quad (6)$$

Now consider an NTM policy that completely prohibits the import of goods from abroad. Simply assume that it is a high sunk cost imposed on the foreign firm that induces exit from the home market for a long period of time. The market goes to autarky and a single monopoly supplies the product domestically. As noted in the beginning of this scenario, there may be two cases regarding the information provided by the new NTM; these will be presented next.

There are numerous standards and regulations that are publicly available on government-affiliated websites, but many are not advertised. For instance, as noted earlier, salmonella is controlled and restricted in the EU market by regulations and standards. These have long been addressed and advertised in the media domestically and also internationally. Such policies that affect consumers' safety and health on the one hand and production and international trade on the other attract the attention of the media, and consequently of consumers. However, there are many other qualitative standards and regulations that are not highlighted by the media, and so consumers miss out on the information. One such example is EU Commission Regulation No. 2257/94, which lays down restrictions on the import of bent bananas and curved cucumbers. The regulation was issued on 16 September 1994 and came into force on 1 January 1995. Even though some major EU members, such as France, Italy, and Spain, benefited economically from this protectionist measure, others, including Britain and Ireland, voted to reform the rules. The interesting point is that such a regulation had been in place in Austria since 1967, yet Austrians were not aware of it until the EU regulation was ridiculed in the media.[23,24] The regulation was finally repealed in 2009, as it was creating an unnecessary barrier to trade. Whether or not a government is willing to inform its consumers by providing extensive advertising in the media, is the focus of the post-NTM case scenarios presented next.

Case I: Complete information on the existence of a foreign product after NTM

Again, it is worth noting that in this scenario, consumers are aware of the harm that could be caused by one of the products on the market that is presumably imported from a country with less stringent regulations. After the restrictive NTM is imposed to prevent the importation of the bad product, consumers are informed in Case I of this scenario that the bad product no longer exists on the market.

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22 Since the demand is truncated where $p = a - \frac{r}{2}$, the calculation of CS below this price is:
$$CS_{AO} = \int_{a-\tau r}^{a} \left(\frac{\eta(a-p)}{b}\right)dp + \int_{P_{AO}}^{a-\tau r} \left(\frac{a-\tau r(1-\eta)-p}{b}\right)dp$$

23 http://www.telegraph.co.uk/news/worldnews/europe/2453204/Bent-banana-and-curved-cucumber-rules-dropped-by-EU.html

24 http://ec.europa.eu/austria/documents/_1341_gurken.pdf

When a government informs the producer and all consumers that there is no product with harmful characteristics on the market, concerned consumers feel certain about their safety and assign a probability $(1-\tau)=1$ to the chances of receiving the home product. In other words, their expected utility (2) will be reduced to only the second term on the right-hand side. There will be no more disutility rq in the preferences of consumers. The domestic industry becomes monopolistic and maximises its profit subject to inverse total demand on the part of society $p_{AI}^{D}(Q,r)=a-bQ$. The equilibrium price (P_{AMI}) and quantity (Q_{AMI}) supplied by the home monopolist will be:

$$P_{AMI}=a-\frac{ab-bc_{1H}}{2b+c_{2H}}\;;\;Q_{AMI}=\frac{a-c_{1H}}{2b+c_{2H}} \tag{7}$$

Total consumer surplus in this case (CS_{AMI}) will be as follows:

$$CS_{AMI}=\int_{0}^{Q_{AMI}}(p_{AI}^{D}(Q,r)-P_{AMI})dQ=\frac{b}{2}\left(\frac{a-c_{1H}}{2b+c_{2H}}\right)^{2} \tag{8}$$

Case II: No information on the existence of the foreign product after NTM

Again, it is worth noting that in this scenario, consumers are aware of the harm that could be caused by one of the products on the market that is presumably imported from a country with less stringent regulations. After the restrictive NTM is imposed to prevent the importation of the bad product, consumers are not informed by the government in Case II of this scenario that the bad product no longer exists on the market. Therefore, the objective welfare of society is discussed here. Assume that a government informs the domestic producer, but not consumers, about the new regulations, so that consumers believe that the supply of foreign products is still mixed with the home product on the domestic market. As explained before, there have been some examples whereby the government has not informed other countries or the WTO about the new measure. The government does not inform *anybody* (except a special interest group) – not even its own citizens – about the new measures and policies. Even though this rarely happens, it raises STCs that are likely to lead to trade disputes in the WTO (Ghodsi and Michalek, 2016). According to Baba (1997), informing voters and consumers generally is costly. Not only may the government be reluctant to inform the WTO about its new policy instrument, but it may also be concerned about consumers learning of less liberal trade.

In this case, consumers do not have information regarding the characteristics of products after the imposition of an NTM. Moreover, in the short run, the data on importation and consumption of the product is not published, and consumers cannot gain access to statistics to assign a correct value to τ. Therefore, the inverse aggregate demand function remains equivalent to that in equation (3). Profit maximisation of the home industry, acting as a monopolist, yields the analytical solution for total supply (Q_{AMII}) as follows:

$$Q_{AMII}=\begin{cases}\dfrac{a\eta-c_{1H}\eta}{2b+c_{2H}\eta}\,,a-\dfrac{r}{2}\leq p\leq a\\[2ex]\dfrac{a-\frac{r}{2}(1-\eta)-c_{1H}}{2b+c_{2H}},0\leq p\leq a-\dfrac{r}{2}\end{cases} \tag{9}$$

The equilibrium price in this case (P_{AMII}) will be as follows:

$$P_{AMII} = \begin{cases} a - \dfrac{ab - bc_{1H}}{2b + c_{2H}\eta}, 0 \le Q \le \dfrac{r\eta}{2b} \\ a - \dfrac{r}{2}(1-\eta) - b\dfrac{a - \frac{r}{2}(1-\eta) - c_{1H}}{2b + c_{2H}}, Q \ge \dfrac{r\eta}{2b} \end{cases} \quad (10)$$

The total subjective consumer surplus in this case (CS_{AMII}) will be as follows:[25]

$$CS_{AMII} = \int_0^{Q_{AMII}} (p_A^D(Q,r) - P_{AMII})dQ$$

$$= \begin{cases} \dfrac{b\eta}{2}\left[\dfrac{a - c_{1H}}{2b + c_{2H}\eta}\right]^2, a - \dfrac{r}{2} \le p \le a \\ \dfrac{b}{2}\left[\dfrac{a - \frac{r}{2}(1-\eta) - c_{1H}}{2b + c_{2H}}\right]^2 + \dfrac{r^2\eta(1-\eta)}{8b}, 0 \le p \le a - \dfrac{r}{2} \end{cases} \quad (11)$$

Case IIB: Objective welfare without information on the existence of the bad product after NTM

Again, it is worth noting that in this scenario, consumers are aware of the harm that could be caused by one of the products on the market that is presumably imported from a country with less stringent regulations. After the restrictive NTM is imposed to prevent the importation of the bad product, the consumers are not informed by the government in Case IIB of this scenario that the bad product no longer exists on the market. The reason for choosing a different name for this case is only for clarity of arguments and simulation results. However, the reality is different, and consumers are no longer subject to any harmful effects from the bad product ($r = 0$). In the calculation of subjective welfare of consumers (11), the negative effect of the foreign product is included mainly in the second line where both groups of consumers show demand. Hence, to calculate the objective surplus in case IIB, this damaging effect must be excluded. In other words, $\tau r Q(1-\eta)$ should be added to the second line of equation (11), while the first line will remain unchanged, as it is the demand of unconcerned consumers.

In the above case scenarios, the impact of the NTM on the welfare of consumers (ΔCS_A) can be evaluated by simply deducting consumer welfare after NTM (CS_{AM}) from consumer welfare before (CS_{AO}). Domestic producer surplus changes are simply the difference between the home industry's profits in a monopoly and its profit under an oligopoly in each case. Since the foreign market is not the focus of the modelling here, it is simply assumed that the foreign producer is out of the home market after the NTM, and its welfare losses will be its profit in a duopoly before NTM, excluding sunk fixed costs (K_F).

[25] Since the demand is truncated where $p \le a - \frac{r}{2}$, the calculation of CA below this price is:

$$CS_{AMII} = \int_{a-\tau r}^{a} \left(\frac{\eta(a-p)}{b}\right)dp + \int_{P_{AMII}}^{a-\tau r} \left(\frac{a - \tau r(1-\eta) - p}{b}\right)dp$$

3.2. SCENARIO B

This scenario focuses on the paternalistic behaviour of a government when consumers are not aware of the harm of bad (foreign) products. Consumers therefore cannot take into account the negative effects in their preferences. On the other hand, a government can provide scientific evidence for measuring the harm of a foreign product on society. In this scenario, it is assumed that a government can rationally measure these negative effects of the bad product produced abroad (r) and can objectively calculate social welfare.

The EFSA estimates the overall economic burden of Salmonella spp. to be around EUR 3bn per year with 91,000 cases. Given that the total demand of prepared or preserved turkey was estimated at around 574[26] kilo tons in 2019 in the EU27, the estimated r could reach EUR 5.22 per kilo if all products are treated as bad products. When a smaller portion of products are known by the government to be harmful, then the estimated value of r should increase proportionately so that the elimination of those products from the market could yield the same welfare as if they were consumed without harm.

To analyse the impact of an NTM on society's welfare in this scenario, it is simply assumed that all consumers are indifferent to, or unaware of, the negative characteristics of the product. Before imposition of the NTM, the two industries are competing in a duopoly, and it does not matter whether the origins of the products are identifiable or not. However, asymmetry of industries is assumed in this scenario. After maximising industry profits and finding the Nash Equilibrium in Cournot competition, the total quantity supplied in the oligopoly in Scenario B (Q_{BO}) will be:

$$Q_{BO} = \frac{(a - c_{1H})(b + c_{2F}) + (a - c_{1F})(b + c_{2H})}{(2b + c_{2H})(2b + c_{2F}) - b^2} \tag{12}$$

The equilibrium price in this duopoly (P_{BO}) will be:

$$P_{BO} = a - b\frac{(a - c_{1H})(b + c_{2F}) + (a - c_{1F})(b + c_{2H})}{(2b + c_{2H})(2b + c_{2F}) - b^2} \tag{13}$$

Considering consumer utility objectively in the eyes of the government, the consumer surplus before NTM (CS_{BO}) will be the area below the inverse demand function $p_B^D(Q, r) = a - r - bQ$, and above the equilibrium price in a duopoly:

$$CS_{CO} = \int_0^{Q_{CO}} (p_B^D(Q, r) - P_{BO})dQ$$

$$= \frac{b}{2}\left(\frac{(a - c_{1H})(b + c_{2F}) + (a - c_{1F})(b + c_{2H})}{(2b + c_{2H})(2b + c_{2F}) - b^2}\right)^2 - \frac{r}{2}\left(\frac{(a - c_{1H})(b + c_{2F}) + (a - c_{1F})(b + c_{2H})}{(2b + c_{2H})(2b + c_{2F}) - b^2}\right) \tag{14}$$

where the second term on the right-hand side of equation (14) is the total negative effect caused by consumption of the foreign product. After imposition of an NTM, quantities and prices in the monopoly of domestic producer (Q_{BM}, P_{BM}) will be the same as equation (7), and consumer welfare changes (CS_{BM})

[26] Read below in next chapter how this is estimated.

will be equal to equation (8). Hence, the consumer welfare changes measured by government (ΔCS_B) are as follows:

$$\Delta CS_B = \frac{b}{2}\left(\frac{a-c_{1H}}{2b+c_{2H}}\right)^2 - \frac{b}{2}\left(\frac{(a-c_{1H})(b+c_{2F})+(a-c_{1F})(b+c_{2H})}{(2b+c_{2H})(2b+c_{2F})-b^2}\right)^2 + \frac{r}{2}\left(\frac{(a-c_{1H})(b+c_{2F})+(a-c_{1F})(b+c_{2H})}{(2b+c_{2H})(2b+c_{2F})-b^2}\right) \quad (15)$$

A government imposing a prohibitive NTM in this scenario is trying in good faith to improve consumer welfare in society, as well as pursuing a public policy aimed at health and safety. To justify its motivations within international regulatory frameworks, it should be proved that consumer welfare would increase after new measures ($CS_{BM} > CS_{BO}$) were introduced. In other words, a government should provide scientific reasons showing that the negative effects related to the consumption of foreign product r are such that the NTM prohibiting the product will not decrease the consumer welfare of society, even after the structure of the market is changed to become monopolistic. In fact, the harmful attributes of a foreign product should have a greater impact on consumers than the inefficiencies associated with a monopoly.[27] A damaging effect of a foreign product r that renders objective consumer welfare before and after the imposition of NTM equal can be a good benchmark for acknowledging that the government was justified in imposing the NTM. Thus, an r that yields non-negative changes in consumer surplus after NTM ($\Delta CS_B \geq 0$) can be calculated as follows:

$$\Delta CS_B \geq 0 \Rightarrow r \geq b\left(Q_{BO} - \frac{Q_{BM}^2}{Q_{BO}}\right) = b\left(\frac{Q_{BO}^2 - Q_{BM}^2}{Q_{BO}}\right) \quad (16)$$

If the government declares and proves that the foreign product has a negative effect r that satisfies condition (16), it is actually acting in good faith to improve consumer welfare and the health of its citizens. Thus, r has to cross a certain threshold for the NTM to be justified.

[27] As discussed earlier in the introduction, an extreme case of such harm is the death of a consumer, which cannot be explicitly measured in economic terms.

4. Illustration and application of model

As illustrated in Figure 1, Brazil has been the largest exporter of prepared and preserved poultry to the EU. Imports of prepared poultry have been interrupted by the EU's regulations. As stated earlier, Brazil has raised two STCs on SPS measures imposed by the EU in the WTO's SPS committee meetings. Furthermore, Brazil also initiated consultation with the EU in the Dispute Settlement Mechanism of the WTO in November 2021. In this section, the theoretical model illustrated in the previous section is calibrated using data on the production and importation of prepared turkey from Brazil to the EU.[28]

Table 1 / Data used in the model in EU27

Variable	Description	Data
$P \times q_{H1013}$	Production value of meat and poultry meat products (NACE 1013) in 2019 - million euro [a]	88,018.7
$P \times M_{H1013}^{Total}$	EU's total import value of meat and poultry meat products (NACE 1013) in 2019 - million euro [b]	10,279.82
$P \times M_{H1013}^{EU}$	Intra-EU import value of meat and poultry meat products (NACE 1013) in 2019 - million euro [b]	9,186.04
$\frac{P \times M_{H1013}^{Total}}{P \times q_{H1013}}$	Import to production ratio of meat and poultry meat products (NACE 1013) in 2019	11.68%
$M_{H160231}^{Total}$	EU's total import volume of prepared or preserve turkey (HS 160231) in 2019 – kilo tons [b]	67.11
$q_H = q_{H160231}$	Estimated production of domestic prepared turkey in 2019 - kilo tons	574.65
$q_H = q_{H160231}$	Estimated production of domestic prepared turkey in 2006 - kilo tons	436.87
$q_F = M_{H160231}^{BRA}$	Import of prepared turkey from Brazil to the EU at its peak in 2006 - kilo tons [b]	78
$q_{H'} = M_{H160231}^{EU}$	Intra-EU import of prepared turkey in 2006 - kilo tons [b]	45.59
$P = P_{160231}$	Average import price of prepared turkey per kilo (USD) [b]	3.01
$P_F = P_{160231}^{BRA}$	Average import price of prepared turkey from Brazil in 2006 per kilo (USD) [b]	2.32
$P_H = P_{160231}^{EU}$	Average intra-EU import price of prepared turkey in 2006 per kilo (USD) [b]	4.00
ε_D	Own-price (import price) elasticity of demand [c]	-2.143811
ε_S	Own-price (export price) elasticity of supply faced by EU [d]	1.20469
r	Benchmark per-kilo damage of product (in USD) [e]	1.88
τ	Probability of getting foreign product	0.5
$1 - \eta$	Proportion of society concerned about the damaging effect of salmonella [f]	77.3%

Sources of data are in the following notes:
a: Eurostat annual detailed enterprise statistics for industry (NACE Rev. 2, B-E)
b: WITS – UN COMTRADE
c: Import demand elasticity faced by the EU from Nicita et al. (2018).
d: Export supply elasticity faced by the EU from Nicita et al. (2018).
e: Perception of per unit damage of product is from the experiment by Beghin et al. (2012).
f: Portion of surveyed Germans who heard of salmonella and knew how to protect themselves in the survey by Henke et al. (2020).

[28] The simulation is undertaken only to show the application of the theoretical framework. Therefore, it is assumed that the real-world data provided for the analysis are only a proxy for parameterisation, and not an accurate replicate of the model in reality. It is later shown how changes in the model's parameters affect the welfare outcomes of the model.

After Brazil and the US, the EU27 is the largest exporter of poultry products and for a long time the EU has had a trade surplus in poultry[29]. As mentioned before, Brazil was the major supplier of poultry and poultry products to the EU and many of its producers have been officially[30] listed as authorised exporters of poultry meat and poultry preparations to the EU. As one category of poultry goods exported to the EU, Brazil was exporting on average 60 kilo tons of prepared turkey (with HS code 160231) per year to the EU during the period 2005-2016, which peaked at about 78 kilo tons in 2006 before the EU's regulations intensified. Based on the results of an auditory inspection carried out in April 2017 by the EU, test results revealed the presence of salmonella in the imported prepared meat; these results were confirmed after pre-export tests by Brazilian authorities. This led to the elimination of many Brazilian establishments from the EU's authorised list and imports dropped to 5.6 kilo tons in 2018 and to a negligible 0.65 kilo tons in 2019.

To illustrate the model that was presented in the previous section using the data on prepared poultry, one also needs to have information on production quantities in the EU (i.e. the home country). However, there is no statistical data provided on the production value or volume of prepared or preserved poultry. Here this value is approximated using two different sources. One source is the detailed trade statistics of prepared poultry (and meat and poultry meat) imported by EU member states compiled from WITS or UN COMTRADE. Using this data, the total import value and volumes of the EU27 from the world and from other EU members have been compiled. The second source is the amount of production in NACE sector 1013 in the category 'Production of meat and poultry meat products' compiled from Eurostat. Using this trade data one can calculate the ratio of imports (or exports) to total production. Then, using this ratio and the trade statistics from the first source, the production value and volume of the home country (EU) is calculated. To compile the trade data for NACE sector 1013, a concordance table of 16 products at the six-digit level of the Harmonized System (HS) has been created. This concordance relates 16 HS six-digit products with one NACE four-digit sector 1013 using the EU COMEXT trade data provided by Eurostat. Then, aggregating the trade statistics of these 16 products gives us the total trade in NACE sector 1013. Table 1 presents the data gathered from these different sources.

Let us assume that the authorities in the EU found a negative attribute in the prepared turkey imported from Brazil, as in the case explained above. Then, some consumers might become concerned about the foreign products imported into the EU and would prefer intra-EU imported prepared turkey rather than that imported from Brazil. Thus, they perceive a negative impact from the consumption of prepared turkey imported from Brazil, even though it is difficult to distinguish domestic products from foreign products. On the other hand, some consumers remain indifferent: they do not regard Brazilian prepared turkey in a worse light than that prepared in the EU. In other words, they trust the quality of the meat produced in Brazil. The EU's authorities also try to ensure the health of the domestic market by monitoring domestic production. Even though there is no evidence that the foreign prepared turkey is of bad quality as reported by Brazilian authorities before the inspection in April 2017, the EU halts the imports of prepared turkey to the EU by imposing a restrictive SPS measure.

Regarding the negative characteristics of the foreign product, the survey results of Beghin et al. (2012) will be used in the analysis.[31] In their experiment, consumers were asked to indicate their willingness to pay for shrimp before and after receiving information regarding the shrimp's potential to cause harm.

[29] https://ec.europa.eu/info/food-farming-fisheries/farming/facts-and-figures/markets/outlook/medium-term_en

[30] https://ec.europa.eu/food/safety/biological-safety/food-hygiene/non-eu-countries-authorised-establishments_en

[31] Although their survey was for the consumption and import of shrimp to the EU, here it is assumed that consumers behave similarly in the US regarding consumption of another category of food, like red meat.

The average difference between the two prices determines the perceived negative effect of the harm of the product. The authors found the effect to be 47% of the price of the harmless product. Based on this experiment and considering the average intra-EU import price of prepared turkey per kilo to be around USD 4 (the maximum price in the market in 2006), the perceived negative characteristics of the bad product would be equal to USD 1.88.

Table 2 / Calculated parameters of the model on the production and importation of prepared turkey in EU27 in 2006

Variable	Calculation	Description	Value
b	$b = -P/(\varepsilon_D Q)$	Slope of demand in scenario A [a]	0.0113393245
b	$b = -P/(\varepsilon_D Q)$	Slope of demand in scenario B [b]	0.0027223567
a	$a = (bQ) + P$	Demand intercept in scenario A [a]	4.40683027
a	$a = (bQ) + P$	Demand intercept in scenario B [b]	4.40683027
c_2	$c_2 = P/\left(\varepsilon_S \frac{Q}{2}\right)$	Cost parameter 2 of two symmetrical industries in Scenario A	0.04035788
c_1	$c_1 = \left(c_2 \frac{Q}{2}\right) - P$	Cost parameter 1 of two symmetrical industries in Scenario A	-0.51059636
c_{2H}	$c_{2H} = P_H/(\varepsilon_S q_H)$	Cost parameter 2 of home industry in Scenario B	0.0076069643
c_{1H}	$c_{1H} = (c_{2H} q_H) - P_H$	Cost parameter 1 of home industry in Scenario B	-0.680250543
c_{2F}	$c_{2F} = P_F/(\varepsilon_S q_F)$	Cost parameter 2 of foreign industry in Scenario B	0.024646032
c_{1F}	$c_{1F} = (c_{2F} q_F) - P_F$	Cost parameter 1 of foreign industry in Scenario B	-0.393613224

Source: own calculations.
a: Total production is equal to imports from Brazil plus intra-EU trade, i.e., 124 kilo tons
b: Total production is equal to imports from Brazil plus estimated EU's production, i.e., 515 kilo tons

To calibrate the parameters, it is assumed that the data illustrates a situation in which consumers have not yet received any information regarding harmfulness of a foreign product from the media. To calculate the cost parameters using supply elasticities, it is assumed that the market in the EU, as represented by the data, is in perfect competition between many domestic producers in EU industry and between many Brazilian producers in its industry. However, as noted in footnote 19, the two industries are competing in duopolistic competition. Then, the parameters will be plugged into the Cournot model specified earlier. Thus, the marginal cost function of each industry represents total supply. The supply of each industry is $(p(q_j) = c_{1j} + c_{2j} q_j, j \in \{H, F\})$. According to the price elasticity of supply presented in Table 1, cost parameters can be calculated and then used in each case for the model presented in the previous section. Moreover, for Scenario A, in which symmetrical industries are assumed, it is hypothesised that the prepared turkey imported from Brazil is mainly competing with intra-EU imports and approximately in the same volumes. Hence for the illustration of Scenario A, domestic production is assumed to be half of the summation of imports from Brazil and intra-EU imports. However, since asymmetries have been assumed in Scenario B, the real amounts of imports from Brazil and of production of prepared turkey in the EU are considered as those estimated in Table 1. For Scenario A, the results are also available for the case in which the industries are asymmetric and the amounts produced by the foreign and home industries are different, and are available upon request. Table 2 represents the calculation of parameters of the model, using the data in Table 1.

4.1. SCENARIO A

Table 3 shows the calibration of the models in Scenario A. There are three main columns in the table. The first main column from the left shows the case in which the total population is indifferent to the negative characteristics of the foreign product. As observed, the different cases elaborated in Scenario A have similar (subjective) welfare implications when all members of the population are indifferent to the potential harm of salmonella induced from Brazilian prepared turkey. This also means that consumers subjectively enjoy higher utility compared with other situations where some parts $(1-\eta)$ of the population become concerned about the bad product.

The first main column from the right shows the situation in which the whole population is concerned about the negative attributes of the imported turkey $(1-\eta=1)$. As observed, the initial welfare of consumers and domestic producers is lower than when the whole population is indifferent or when a portion of the population is concerned (second main column from the right, $1-\eta=0.773$). This is mainly because of a decrease in demand due to the perceived harm of the Brazilian product by concerned consumers. When consumers are not informed about the exclusion of the harmful product from the market after the NTM (Case II), their subjective welfare drops even more than when they are informed (Case I). However, their objective welfare when they are not informed (Case IIB) is higher than when they are informed (Case I). Although they perceive that they still receive products with bad characteristics, they do not actually suffer from the bad product after the NTM is imposed. This is because after the NTM is enforced, the market structure changes to a monopoly. If they are informed that there is no bad product on the market, the total demand curve will shift upwards. This will lead to a price burden on them, as the market is working as a monopoly and because there are increasing costs due to scale effects in Case I. In Case II, the market structure has also changed, and consumers still consider the negative effect of the bad product subjectively. Thus, their changed utility is even lower than in case I. However, in Case IIB, they do not consider the negative effect of the bad product objectively. Thus, there is a greater increase in their new objective surplus.

When the government informs consumers that there are no more foreign products on the market (Case I), the domestic producers' profit will increase more than if the government does not inform consumers (Cases II and IIB). This is mainly because the demand for domestic prepared turkey increases after consumers are fully aware of the safety of products. As noted above the EU's comprehensive program has been very effective with information transparently available in the Official Journal of the European Union. As Henke et al. (2020) shows only 2.8% of their survey respondents had never heard of salmonella, and 77.3% of respondents had heard of salmonella and knew how to protect themselves. Therefore, Case I is closer to reality than other cases, which also results in much higher domestic welfare gains after the prohibitive NTM is imposed; thus international welfare, that also includes the foreign industry's loss, is highly positive.

Table 3 / Calibration results for Scenario A

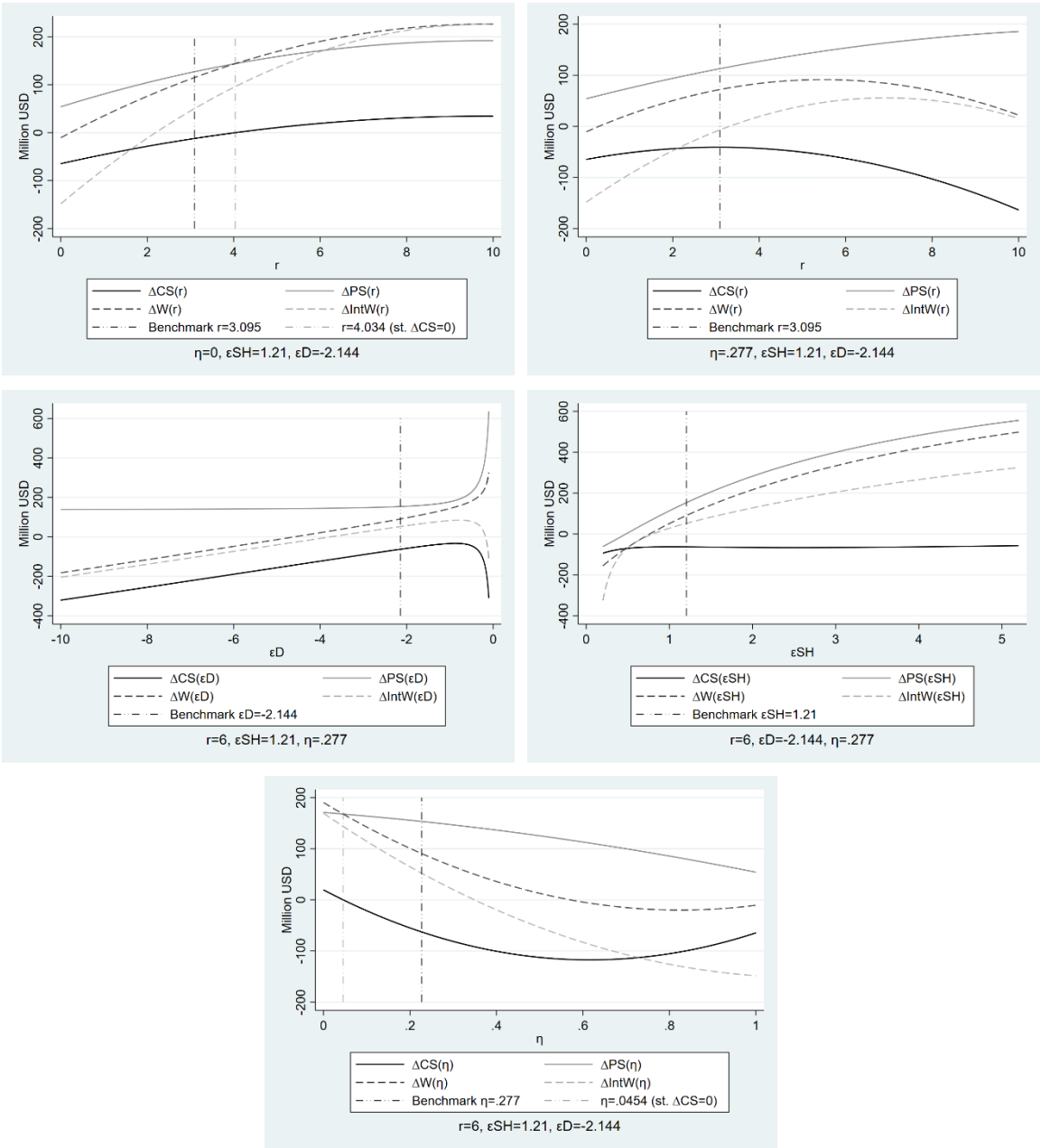
Variables	$(\eta = 1)$			$(\eta = 0.227)$			$(\eta = 0)$		
	Case I	Case II	Case IIB	Case I	Case II	Case IIB	Case I	Case II	Case IIB
CS_O	99.14	99.14	99.14	78.83	78.83	78.83	64.83	64.83	64.83
PS_{OH}	137.78	137.78	137.78	100.04	100.04	100.04	90.10	90.10	90.10
CS_M	34.50	34.50	34.50	34.50	31.90	80.24	34.50	22.56	81.91
PS_M	191.80	191.80	191.80	191.80	139.26	139.26	191.80	125.43	125.43
ΔCS	-64.63	-64.63	-64.63	-44.33	-46.93	1.41	-30.33	-42.27	17.08
$\frac{\Delta CS}{CS_O}$	-0.652	-0.652	-0.652	-0.56	-0.60	0.02	-0.47	-0.65	0.26
ΔPS	54.03	54.03	54.03	91.7	39.23	39.23	101.7	35.33	35.33
$\frac{\Delta PS}{PS_O}$	0.3902	0.3902	0.3902	0.92	0.39	0.39	1.13	0.39	0.39
ΔW	-10.61	-10.61	-10.61	47.44	-7.70	40.64	71.38	-6.94	52.42
$\frac{\Delta W}{W_O}$	-0.045	-0.045	-0.045	0.265	-0.043	0.227	0.461	-0.045	0.338
$\Delta IntW$	-148.38	-148.38	-148.38	-52.6	-107.74	-59.40	-18.72	-97.04	-37.68
$\frac{\Delta IntW}{IntW_O}$	-0.396	-0.396	-0.396	-0.19	-0.39	-0.213	-0.08	-0.40	-0.154

Welfare amounts are in USD million.
CS: consumer surplus; PS: producer surplus; W: home total welfare; IntW: international welfare.
Case IIB is the Case II of Scenario A, with objective calculation of welfare after NTM, while Case II was mainly calculating the subjective welfare after NTM.
Source: own calculation.

Considering consumers as the owners of domestic industry, it can be shown that, in the case of concerned consumers in society, there are social welfare gains resulting from the introduction of a prohibitive NTM. In other words, the increase in domestic producers' profit is higher than consumers' welfare losses when there is a larger share of concerned consumers in society. However, when everybody is indifferent to the potential harm caused by the foreign product, the NTM will cause losses to the whole of society, as the increase in profit for the home industry does not compensate for the losses suffered by consumers. This happens also because the government does not earn any revenue by imposing an NTM, whereas it does through the introduction of tariffs. Since the market becomes monopolistic, and the marginal cost is an increasing function of production, such a loss is evident.

Figures 4, 5 and 6 present sensitivity analyses of welfare changes with respect to changes in each of the raw parameters of the model when holding other parameters constant.

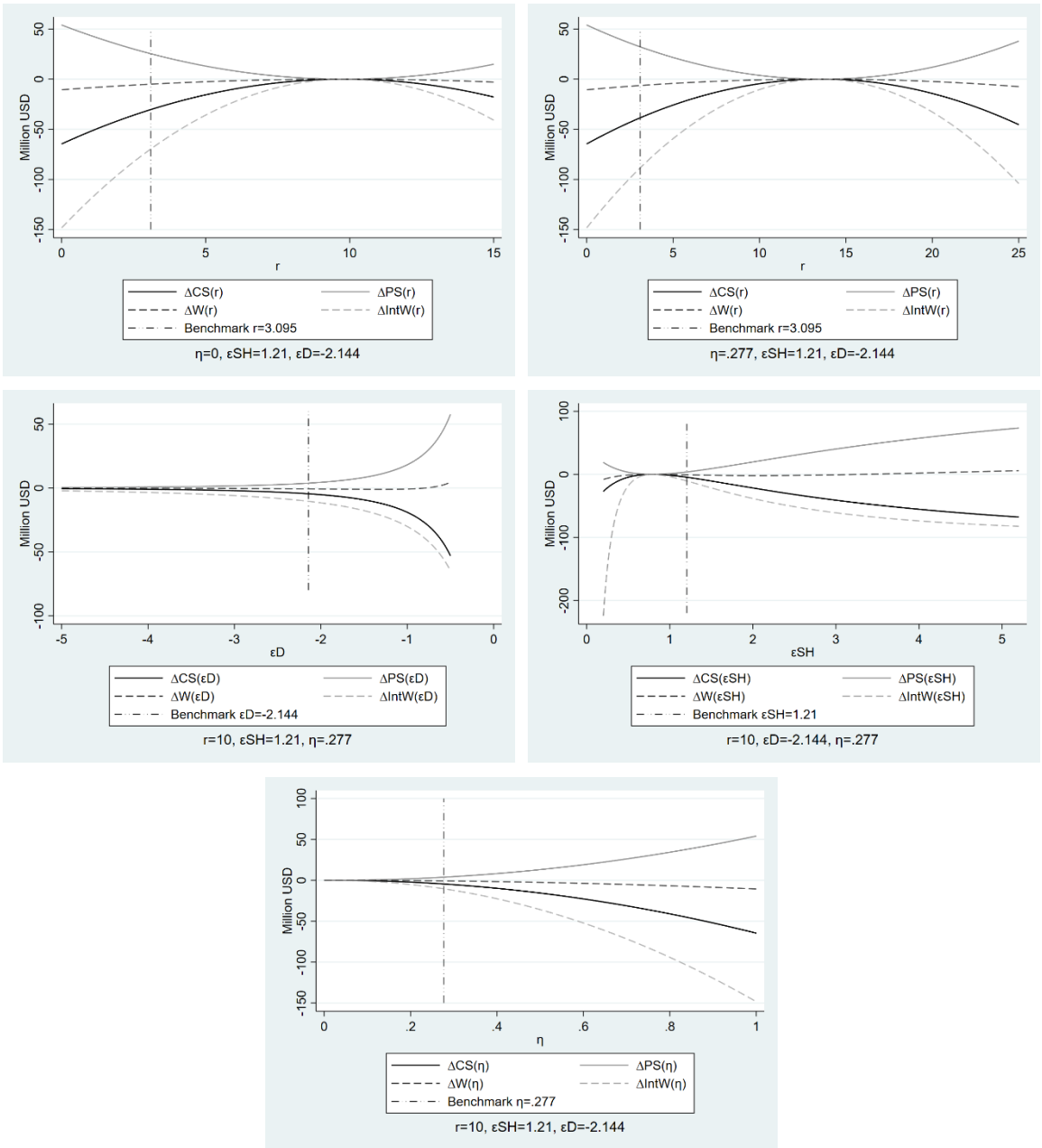
Figure 4 / Sensitivity test of welfare changes with respect to parameters, Scenario A, Case I



In Case I depicted in Figure 4, consumers receive information about the elimination of bad products after the NTM is imposed. When all consumers are concerned about the harm ($1-\eta=1$) that is depicted on the top left panel of Figure 4, the larger the negative impact of the bad product r, the larger are the positive welfare implications of the prohibitive NTM. In fact, an r that is larger than 4.034, produces a positive change in consumer surplus after the prohibitive NTM is imposed. As also noted in Table 3, with the benchmark value of negative impact (i.e., $r=3.095$) in the model, the change in consumer surplus in Case I is negative and equal to USD -12.06m. When the number of concerned consumers decreases, the change in consumer surplus also decreases. For instance, in the top right panel of Figure 4, with only 77.3% of the population concerned about the bad product ($\eta=0.227$), the change in consumer surplus is

negative and equal to USD -40.8m as also shown in the middle column of Table 3, which also decreases further with an increase in r. However, as the domestic producer surplus increases with r, total welfare decreases and approaches zero. Changes in price demand elasticity ε_D and supply elasticity ε_s are also shown in the middle panel. Converging the price demand elasticity from -10 to -0.86824 would make the demand for the product less elastic with respect to changes in price as observed on the mid-left panel of Figure 4. Therefore, a change in the market structure from duopoly to monopoly that leads to an increase in the equilibrium price, would lead to a smaller change in the demanded quantity, and thus, less negative impact on consumer surplus when the magnitude of demand elasticity is closer to unity.

Figure 5 / Sensitivity test of subjective welfare changes with respect to parameters, Scenario A, Case II

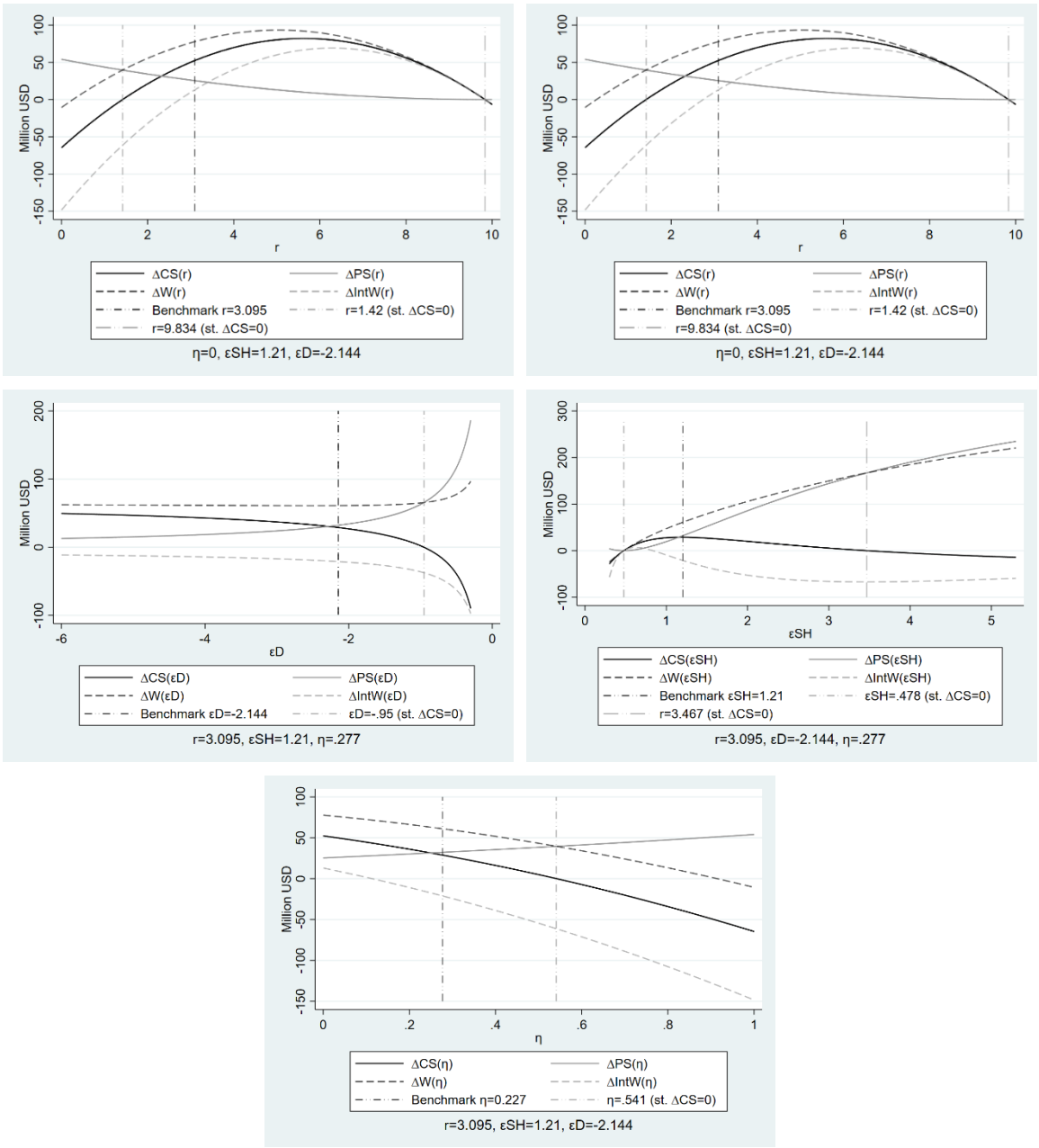


With a change in price demand elasticity from -10 to -0.86824, the impact on producer surplus changes slowly as observed in the mid-left panel of Figure 4. When we increase supply price elasticity and keep other parameters constant, changes in consumer surplus remain relatively stable while the change in producer surplus increases. This leads to an increase in domestic welfare in supply elasticity ε_s. At the same time, the profit loss of the foreign producer increases with such an increase in its supply elasticity that it reduces the increasing slope of international welfare $IntW$. Furthermore, it is observed from the low panel of Figure 4 that a reduction in the proportion of concerned consumers in society $(1-\eta)$ leads to a reduction in changes in consumer surplus, producer surplus, welfare, and international welfare. With $r = 6$ and the benchmark parameters of elasticities, at least 95.46% of the population must be concerned about the harms of salmonella, so that the change in consumer surplus in Case I should be non-negative.

Figure 5 presents the sensitivity test of welfare changes with respect to parameters of the model in Case II, where consumers do not become informed about the exclusion of the bad product after the prohibitive NTM is imposed. As observed in all panels of this figure, the curve of changes in consumer surplus does not pass the horizontal axis. Therefore, regardless of the model's parameters, when consumers are not informed about the elimination of a bad product, subjective consumer surplus can never become positive due to the change in the market structure and yet with the wrong perception that the bad product still exists. However, decreasing price demand elasticity (mid-left panel) and increasing supply price elasticity (mid-right panel) and the ratio of concerned consumers (bottom panel) augment changes in producer surplus.

Figure 6 presents the sensitivity test of objective welfare changes with respect to parameters of the model in Scenario A Case IIB when consumers are not informed about the elimination of the bad product after the prohibitive NTM is imposed. In both top panels of Figure 6, changes in producer surplus decrease in r. This is mainly because consumers are concerned about the harmful product, but they are not aware of its elimination after the NTM is imposed. Therefore, if they perceive a greater negative effect of the bad product, they may demand less of the domestic good even after the market is safe with the NTM imposed. However, since the objective welfare of consumers is calculated in this case, the change in consumer surplus with respect to r has an inverse U shape graph, which increases with the amount of r. If the whole population is concerned about the bad product, i.e., $1-\eta = 1$, then the minimum amount of r to produce a positive change in the objective consumer surplus should be equal to 1.42 while the maximum amount r to do the same should be 9.834 (top left panel). When only 77.3% of the population is concerned about the bad product (top right panel), then the minimum amount of r to produce a positive change in the objective consumer surplus should be equal to 1.962. As the mid-left panel of Figure 6 shows, decreasing the magnitude of price demand elasticity in this case decreases changes in consumer surplus and increases changes in producer surplus. The less elastic the product demand, the less demand for the product should change given a change in price deriving from a change in market structure. Therefore, the change in producer surplus should increase and the change in subjective consumer surplus should decrease. As the mid-right panel of Figure 6 also shows, the increase in supply elasticity also increases the change in producer surplus and decreases the change in consumer surplus after a certain threshold. Furthermore, as the bottom panel shows, when the portion of non-concerned consumers η increases, the NTM imposition becomes costlier as changes in consumer surplus, domestic welfare, and international welfare decrease.

Figure 6 / Sensitivity test of objective welfare changes with respect to parameters, Scenario A, Case IIB



To consider the situation from a protectionism perspective, the following can be argued. Domestic industry always gains from the market structure changing into a monopoly. Therefore, it can be observed that the government is not pursuing an improvement in consumer welfare when r is very small or the portion of concerned consumers in population is too little. Through the introduction of a prohibitive NTM, the domestic producer will become first a monopolist. Then, after the removal of the competitor from the market, some information regarding the availability of a harmless product on the market after the NTM will boost demand from consumers. The information provided by the government will support domestic industry, and profits will increase even more than when such information is not provided to consumers.

Overall, according to the assumptions of the model whereby consumers are completely aware of the harm of the product and can rationally adjust their budget in line with their preferences for the product, such a policy instrument favours domestic producer and consumers. This assumption is lifted in Scenario B, which will be illustrated next.

4.2. SCENARIO B

Table 4 presents the results from the calibration of Scenario B. There are two main columns in this table, showing symmetrical industries and asymmetrical industries. If we consider the lack of awareness of consumers about the possible damaging effects of harmful prepared poultry, then the value of r should be at least an amount that increases consumer supply after the NTM prohibits imports. Therefore, another value of r is calculated for each main column, in addition to the benchmark value of USD 1.88: USD 0.978 in the left column and USD 0.747 in the right column. These are the amounts of the negative effects at which the prohibitive NTM becomes neutral in terms of consumer welfare changes in symmetrical and asymmetrical cases, respectively. The right column of the two main columns shows that for these values, the total welfare of consumers is unchanged after the imposition of an NTM.

Table 4 / Calibration results for Scenario B

Variables	Symmetrical industries		Asymmetrical industries	
r	Benchmark	Consumer welfare equaliser	Benchmark	Consumer welfare equaliser
	$1.88	**$0.978**	**$1.88**	**$0.747**
CS_O	-25.27	34.50	-134.19	143.71
PS_{OH}	137.78	137.78	662.45	662.45
CS_M	34.50	34.5	143.71	143.71
PS_M	191.8	191.80	798.91	798.91
ΔCS	59.78	0.000	227.9	0.000
$\frac{\Delta CS}{CS_O}$	2.36	0.000	2.07	0.000
ΔPS	54.03	54.03	136.45	136.45
$\frac{\Delta PS}{PS_O}$	0.39	0.39	0.21	0.21
ΔW	113.80	54.03	414.36	136.45
$\frac{\Delta W}{W_O}$	1.01	0.31	0.78	0.17
$\Delta IntW$	-23.97	-83.75	38.20	-239.71
$\frac{\Delta IntW}{IntW_O}$	-0.10	-0.27	0.04	-0.20

Welfare amounts are in millions of USD.
CS: consumer surplus; PS: producer surplus; W: home total welfare; IntW: international welfare.

Since the government acts paternalistically in Scenario B, concerned consumers do not enter the model. Therefore, a sufficiently large negative effect of the bad product r that could be for instance equal to the benchmark value in the simulation above (i.e., $r = 1.88$) could make the consumer surplus negative subjectively in the initial condition. This obliges the government to intervene and prohibit imports of the

bad product. The negative initial consumer surplus is even stronger when considering the EU's total production of prepared or preserved turkey in the simulation (i.e., $q_H = 436.88$ kilo tons). The share of imported product from Brazil in this asymmetric case is much smaller than the symmetric case whereby only intra-EU imports (i.e., $q_{H'} = 45.59$ kilo tons) are considered in the simulation (left panel). This means that the negative parts of objective consumer welfare associated with the bad product imported from Brazil should be much lower, which should produce a total positive consumer surplus. However, it was assumed in the model that after the product is imported into the market, home and foreign products could no longer be differentiated as they are mixed in the market.

Figure 7 / Sensitivity test of welfare changes with respect to *r*, Scenario B, asymmetrical industries

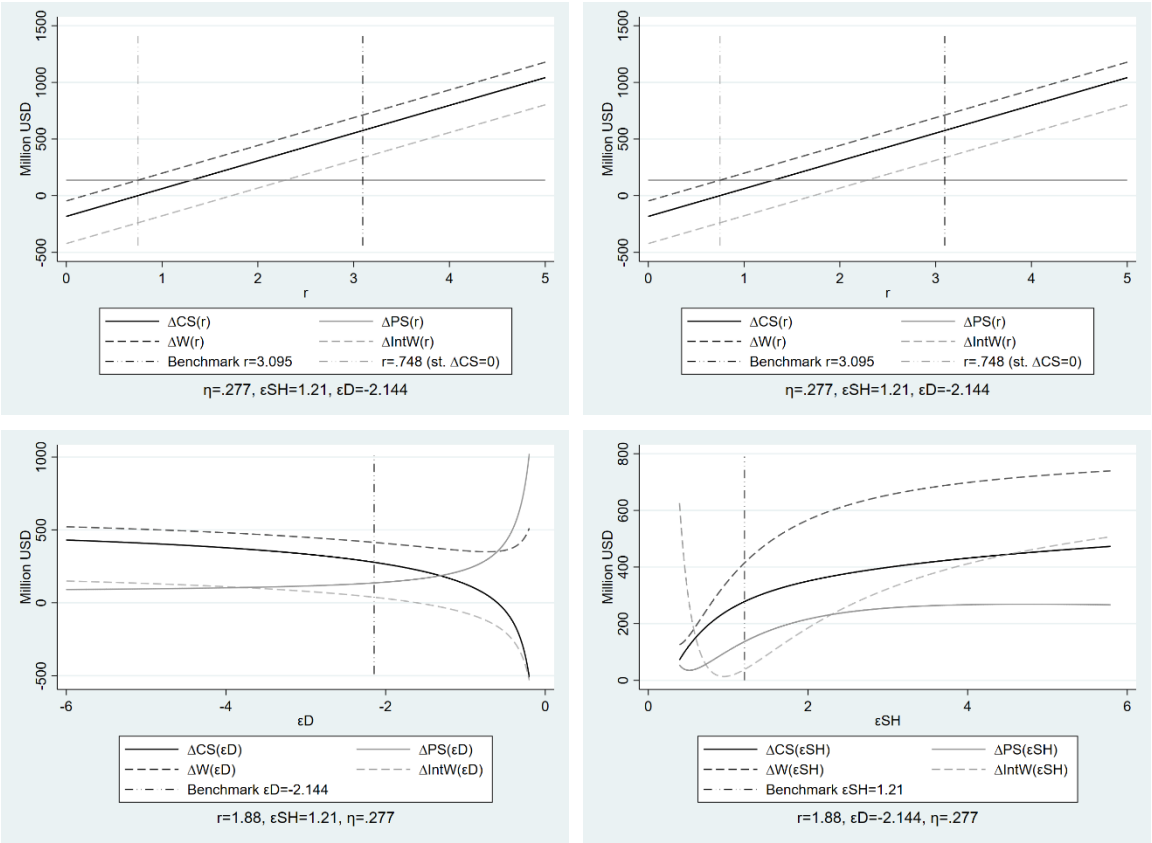
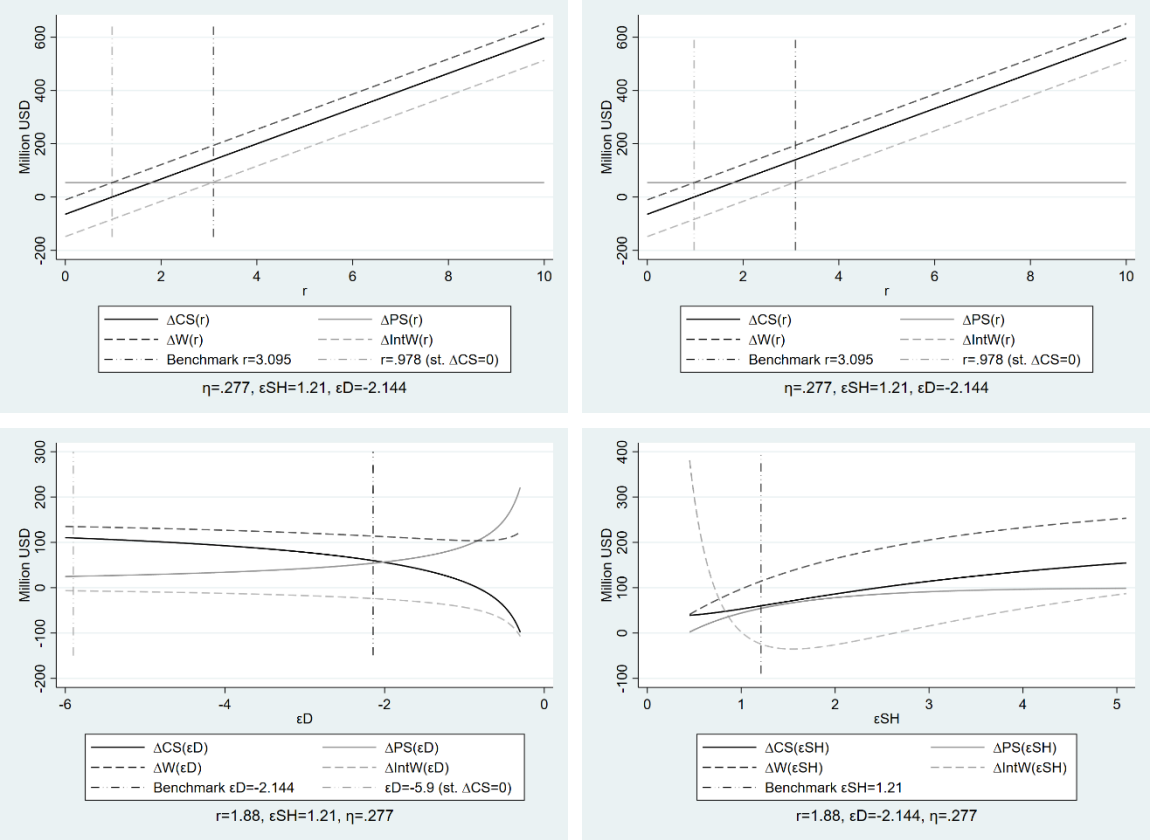


Figure 7 and Figure 8 depict the sensitivity test of objective welfare changes with respect to parameters in scenario B with symmetric and asymmetric cases. By increasing the amount of r in all top panels of these two figures, consumer welfare increases while the producer surplus remains unchanged. One can observe that the difference between the symmetrical and asymmetrical case of industries is only the difference in magnitudes of changes in welfares, while the shape of curves depicted in these two figures remains similar. In both asymmetrical and symmetrical cases of industries, a decrease in the magnitude of price demand elasticity and supply elasticity both lead to a reduction in consumer surplus changes. A decrease in the magnitude of import demand elasticities and an increase in the supply elasticity augment producer surplus changes. This indicates the importance of these elasticities when considering the imposition of an NTM that prohibits the importation of a product that harms populations.

If the government tries legitimately to impose NTMs in line with international agreements for the sake of consumers, it should provide evidence that the potential harm of the imported product equals at least r, in order to neutralise consumer welfare changes. If the evidence shows less damage than this amount, the government is not acting in pursuit of consumer welfare. In such a case, one might conclude that protection of domestic industry is being prioritised over protection of consumers' health.

Figure 8 / Sensitivity test of welfare changes with respect to *r*, Scenario B, symmetrical industries



5. Summary and conclusions

Since the beginning of the century, the EU has legislated and enforced the most comprehensive program in history to combat salmonella spp., an infection caused by edibles and mostly by animal products such as poultry. Where production hygiene is not controlled, the infection becomes more prevalent. The EU's restrictive program has been to monitor, control, and inspect livestock farms and firms that import meat and animal products in the EU to achieve a salmonella-free market. This program has become a success story, reducing salmonella cases in the 15 EU member states from 200,000 cases before 2004 to 91,000 cases in the 27 member states recently. According to the European Food Safety Authority (EFSA), the overall economic burden of these cases reaches to EUR 3bn per year. Moreover, imports of products targeted by this stringent program have been disrupted.

In November 2021, a Dispute Settlement case was initiated by Brazil under the WTO Dispute Settlement Mechanism. The case involved a regulatory NTM in the form of an SPS measure imposed by the EU on the importation of prepared and preserved poultry. This case was initiated after two Specific Trade Concerns (STCs) were raised by Brazil in 2017 and 2018 on restrictive SPS measures imposed by the EU on the importation of poultry meat and poultry preparations. This paper provides a theoretical framework for measuring the welfare implications of these restrictive SPS measures imposed by the EU on imports of prepared turkey from Brazil, which dropped from more than 78 kilo tons in 2006 to less than 1 kilo ton in 2019. The theoretical model distinguishes between the portion of the population concerned about the harm of salmonella and aware of elimination of the bad product after the restrictive NTM is imposed.

The model has both a foreign and a domestic supplier. The analysis focuses on consumer awareness of the damaging effects of the hazardous goods. Whether or not consumers are aware of these characteristics is considered in two different scenarios. It is assumed that products cannot be differentiated and that consumers cannot distinguish between the origins of the products. This is exactly why a prohibitive SPS measure prevents the importation of hazardous goods to the market with frequent inspections and testing of the imported product. Two types of consumers in society are considered: the first group of consumers might be indifferent to the potential harm of a product, whereas the second group is assumed to be concerned about the potential damage from a foreign product. Therefore, both subjective consumer surplus and objective consumer surplus are derived in the model to measure the costs and benefits of imposing the restrictive SPS measure preventing the importation of a bad product.

In the first scenario of the model, it was assumed that consumers receive valid information from the authorities and the media, that there is a harmful product being imported from abroad. However, since they cannot distinguish between the good and bad product, they assign a probability to their chances of purchasing the harmful product. Equilibrium quantities and prices in the oligopolistic market are calculated analytically and the initial level of welfare of consumers and producers is established; based on this, the situation after the imposition of a prohibitive NTM and the emergence of a monopolistic market is studied. According to this scenario, two cases are analysed: whether or not consumers are informed that the harmful product is no longer available on the market following the imposition of the

NTM. For the case where no information on the existence of the foreign product after the imposition of NTM is provided, both subjective and objective welfare of consumers are calculated separately.

The model is illustrated with data on the EU27's importation of prepared and preserved turkey from Brazil, the EU27's importation of meat and poultry meat, and production of meat and poultry meat products in the EU27, while other parameters are obtained from the literature. The welfare losses related to halting the import of Brazilian prepared turkey are mostly related to changes in the structure of the market, into a less competitive environment. Consumers face higher prices as the market changes from the duopoly of two industries to the monopoly of a domestic industry. Therefore, the domestic industry always gains from the imposition of the prohibitive regulatory NTM. However, the changes in consumer surplus may become positive when the harm associated with the bad product in the market increases and the portion of concerned consumers in the society regarding the bad product increases, given the probability of consuming the bad product mixed with the safe product on the market.

The second scenario of the model analyses a situation in which consumers are not aware of the damaging effect of the foreign product and then, their objective welfare is calculated. It is assumed in this scenario that only the government has such knowledge, and it can introduce a prohibitive NTM to eliminate the potential damage of a foreign product on the domestic market. This happened in 2017 after the EU's authorities inspected imported prepared turkey from Brazil and found the presence of salmonella in several imported batches. This occurred even though the exporting Brazilian establishments were authorised by the EU before, and the Brazilian authorities had confirmed the safety of exported poultry preparations in pre-export testing. Thus, the government (the EU) sought to improve the welfare of consumers through the regulatory NTM. Hence, there was a minimum damaging effect of the foreign product that left the consumer surplus unchanged after the policy was calculated. Considering society's objective welfare, the consumer surplus before the imposition of NTM might be negative when the negative effect associated with the bad product is sufficiently high. This means that the imposition of an NTM that eliminates the bad product from the market should increase the consumer surplus and the total welfare of the society objectively, regardless of the awareness of consumers.

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Appendices

APPENDIX A1. CALCULATIONS OF SCENARIO A AND SCENARIO B

Scenario A

Consumers' utility maximization problem:

The utility function for an indifferent consumer will be as follows:

$$U_i(q_i, w_i) = aq_i - \overline{b}\, q_i^2/2 + w_i\,, i \in [1, N_1] \tag{1}$$

The individuals in society maximize their utility subject to a budget constraint:

$$pq_i + w_i = y_i \tag{2}$$

where *p* represents the price of the good, y_i stands for the income of the representative consumer *i*, and the price of the numeraire is equal to 1. The Lagrangian utility maximization problem is:

$$\mathcal{L}_i = aq_i - \overline{b}\, q_i^2/2 + w_i + \lambda(y_i - pq_i - w_i), i \in [1, N_1] \tag{3}$$

First Order Conditions (FOC) for utility maximisation of an indifferent individual will give the demand of each indifferent individual:

$$q_i = \frac{a-p}{\overline{b}}, i \in [1, N_1] \tag{4}$$

The Lagrangian utility maximization problem for a concerned individual will be:

$$\mathcal{L}_i = aq_i - \overline{b}\, q_i^2/2 - \tau r q_i + w_i + \lambda(y_i - pq_i - w_i), i \in (N_1, N] \tag{5}$$

After setting FOC for utility maximisation, the demand of each concerned consumer will be:

$$q_i = \frac{a-\tau r-p}{\overline{b}}, i \in (N_1, N] \tag{6}$$

Considering aggregate demand of all consumers as $Q_A^D = \sum_{i=1}^{N} q_i\,(p, r)$, the proportion of indifferent consumers as $\eta = N_1/N$, and assuming $b = \overline{b}/N$, the aggregate demand will be derived as follows:

$$\begin{aligned} Q_A^D(p,r) &= \begin{cases} \dfrac{a-p}{\overline{b}}\eta N, p \geq a - \tau r \\ \dfrac{a-p}{\overline{b}}\eta N + \dfrac{a-\tau r-p}{\overline{b}}(1-\eta)N, 0 \leq p \leq a - \tau r \end{cases} \\ &= \begin{cases} \dfrac{\eta(a-p)}{b}, p \geq a - \tau r \\ \dfrac{a-\tau r(1-\eta)-p}{b}, 0 \leq p \leq a - \tau r \end{cases} \end{aligned} \tag{7}$$

Therefore, the aggregate inverse demand will be:

$$p_A^D(Q,r) = \begin{cases} a - \frac{b}{\eta}\, Q, 0 \le Q \le \frac{\tau r \eta}{b} \\ a - \tau r(1-\eta) - bQ, Q \ge \frac{\tau r \eta}{b} \end{cases} \quad (8)$$

Firms' profit maximisation:

Assuming symmetry, the profit of each firm competing in a Cournot duopoly ($Q = q_H + q_F$) is:

$$\pi_j = \begin{cases} \left(a - \frac{b}{\eta}\, Q\right) q_j - c_1 q_j - \frac{1}{2} c_2 q_j^2 - K, 0 \le Q \le \frac{\tau r \eta}{b}\ , j = \{H, F\} \\ (a - \tau r(1-\eta) - bQ) q_j - c_1 q_j - \frac{1}{2} c_2 q_j^2 - K, Q \ge \frac{\tau r \eta}{b}, j = \{H, F\} \end{cases} \quad (9)$$

The FOC for profit maximisation of each firm is:

$$\frac{\partial \pi_j}{\partial q_j} = 0 \Rightarrow \begin{cases} a - \frac{b}{\eta} q_{j'} - c_1 - \left(\frac{2b + \eta c_2}{\eta}\right) q_j = 0, p \ge a - \tau r\ ; (j, j') \in \{(H,F),(F,H)\} \\ a - \tau r(1-\eta) - b q_{j'} - c_1 - (2b + c_2) q_j = 0, 0 \le p \le a - \tau r;\ (j, j') \in \{(H,F),(F,H)\} \end{cases} \quad (10)$$

Therefore, before imposition of a restrictive NTM, the best response functions of the home industry (BR_{HA}) and the foreign industry (BR_{FA}) in a Cournot duopoly will be, respectively:

$$BR_{HA}(q_F)\colon q_H = \begin{cases} \frac{\eta(a - c_1)}{2b + c_2 \eta} - \frac{b}{2b + c_2 \eta} q_F\ , a - \tau r \le p \le a \\ \frac{a - \tau r(1-\eta) - c_1}{2b + c_2} - \frac{b}{2b + c_2} q_F, 0 \le p \le a - \tau r \end{cases} \quad (11_{/1})$$

$$BR_{FA}(q_H)\colon q_F = \begin{cases} \frac{\eta(a - c_1)}{2b + c_2 \eta} - \frac{b}{2b + c_2 \eta} q_H\ , a - \tau r \le p \le a \\ \frac{a - \tau r(1-\eta) - c_1}{2b + c_2} - \frac{b}{2b + c_2} q_H, 0 \le p \le a - \tau r \end{cases} \quad (11_{/2})$$

After finding the Nash Equilibrium, quantities supplied by the home industry (q_{AOH}) and the foreign industry (q_{AOF}) in the oligopoly will be as follows:

$$q_{AOH} = q_{AOF} = \begin{cases} \frac{\eta(a - c_1)}{3b + c_2 \eta}\ , a - \tau r \le p \le a \\ \frac{a - \tau r(1-\eta) - c_1}{3b + c_2}, 0 \le p \le a - \tau r \end{cases} \quad (12)$$

Domestic monopolist's profit maximisation problem, Case I

There is no foreign product with negative characteristics on the market after the NTM, and consumers are informed of this. The inverse aggregate demand is $p_{AI}^{D}(Q,r) = a - bQ$. The profit of the home industry acting as a monopolist after imposition of NTM that is to be maximised is as follows:

$$\pi_H = (a - bq_H)q_H - c_1 q_H - \frac{1}{2}c_2 q_H^2 - K_H \tag{13}$$

The FOC of the profit maximisation with respect to quantity will give the equilibrium supply quantity (Q_{AMI}) as:

$$\frac{\partial \pi_H}{\partial q_H} = 0 \Rightarrow\ Q_{AMI} = q_H = \frac{a - c_1}{2b + c_2} \tag{14}$$

Scenario B

Unaware consumers' aggregate inverse demand is $p_B^D(Q,r) = a - bQ$. The two industries maximise the following profit in the Cournot duopoly:

$$\pi_j = (a - bQ)q_j - c_{1j}q_j - \frac{1}{2}c_{2j}q_j^2 - K_j, j = \{H,F\};\ Q = q_H + q_F \tag{15}$$

The first order conditions for the profit maximisation problem of each firm will be:

$$\frac{\partial \pi_j}{\partial q_j} = 0 \Rightarrow a - bq_{j'} - c_{1j} - \left(2b + c_{2j}\right)q_j = 0, (j,j') \in \{(H,F),(F,H)\} \tag{16}$$

The best response functions of the home industry (BR_{HB}) and the foreign industry (BR_{FB}) in this duopoly will be, respectively:

$$BR_{HB}(q_F)\colon q_H = \frac{(a - c_{1H})}{2b + c_{2H}} - \frac{b}{2b + c_{2H}}q_F \tag{17/1}$$

$$BR_{FB}(q_H)\colon q_F = \frac{(a - c_{1F})}{2b + c_{2F}} - \frac{b}{2b + c_{2F}}q_H \tag{17/2}$$

After finding the Nash Equilibrium, quantities supplied by the home industry (q_{BOH}) and the foreign industry (q_{BOF}) in the oligopoly will be, respectively:

$$q_{BOH} = \frac{(a - c_{1H})(2b + c_{2F}) - b(a - c_{1F})}{(2b + c_{2H})(2b + c_{2F}) - b^2} \tag{18/1}$$

$$q_{BOF} = \frac{(a - c_{1F})(2b + c_{2H}) - b(a - c_{1H})}{(2b + c_{2H})(2b + c_{2F}) - b^2} \tag{18/2}$$

Total quantity supplied in the oligopolistic market (Q_{BO}) will be:

$$Q_{BO} = \frac{(a - c_{1H})(b + c_{2F}) + (a - c_{1F})(b + c_{2H})}{(2b + c_{2H})(2b + c_{2F}) - b^2} \tag{19}$$

APPENDIX A2. PROOF OF THE EXISTENCE OF PURE STRATEGY NASH EQUILIBRIUM

Given the demand and inverse demand functions in equations (7) and (8) in the main text, and assuming that q_F is given, define

$$\pi_1(q_H|q_F) = \left(a - \frac{b}{\eta}(q_H + q_F)\right)q_H - c_1 q_H - \frac{1}{2}c_2 q_H^2 - K \qquad (1/1)$$

$$\pi_2(q_H|q_F) = \left(a - \tau r(1-\eta) - b(q_H + q_F)\right)q_H - c_1 q_H - \frac{1}{2}c_2 q_H^2 - K \qquad (1/2)$$

$$\pi(q_H|q_F) = \pi_1(q_H|q_F) \text{ for } q_H + q_F \leq \frac{\tau r \eta}{b}, \ \pi(q_H|q_F) = \pi_2(q_H|q_F) \text{ for } q_H + q_F \geq \frac{\tau r \eta}{b}$$

Symmetric pure strategy Cournot equilibrium (Nash Equilibrium in quantities):

Pair (q^*, q^*) s.t.

$$q^* solves \max_{q_H \geq 0} \pi(q_H|q^*)$$

Since for any $q_F \geq 0$, the maximand of $\pi(q|q_F)$ is $\leq \frac{a-\tau r(1-\eta)}{b}$ and, as we shall see, the profit function is continuous, there is a mixed strategy Nash Equilibrium. However, a pure strategy Nash Equilibrium may not exist.

We now consider some properties of the profit functions $\pi_1(.|q_F)$ and $\pi_2(.|q_F)$.

1. They are both strictly concave
2. Suppose $\frac{\tau r \eta}{b} > q_F$. Then $\pi_1(q_H|q_F) = \pi_2(q_H|q_F)$ if and only if $q_H = \frac{\tau r \eta}{b} - q_F$, in particular, the profit function $\pi(.|q_F)$ is continuous.
3. Suppose $\eta < 1$ and $\frac{\tau r \eta}{b} > q_F$. For $q_H > \frac{\tau r \eta}{b} - q_F$. $\pi_2(q_H|q_F) > \pi_1(q_H|q_F)$ and for $q_H < \frac{\tau r \eta}{b} - q_F$. $\pi_2(q_H|q_F) < \pi_1(q_H|q_F)$. This in particular means that

$$\frac{\partial \pi_2}{\partial q_H}(q_H|q_F) > \frac{\partial \pi_1}{\partial q_H}(q_H|q_F) \; for \; q_H = \frac{\tau r \eta}{b} - q_F$$

Proposition:

(q^*, q^*) is a pure strategy Nash Equilibrium if and only if one of the following three conditions holds:

i (a) $q^* \geq \frac{\tau r \eta}{b}$ and (b) $\frac{\partial \pi_2}{\partial q_H}(q^*|q^*) = 0$

ii (a) $q^* \leq \frac{\tau r \eta}{b}$ and (b) $2q^* \geq \frac{\tau r \eta}{b}$, (c) $\frac{\partial \pi_2}{\partial q_H}(q^*|q^*) = 0$ and (d) with $\hat{q}$ solving $\frac{\partial \pi_1}{\partial q_H}(q^*|q^*) = 0, \pi_1(\hat{q}|q^*) \leq \pi_2(q^*|q^*)$.

iii (a) $q^* \leq \frac{\tau r \eta}{b}$ and (b) $2q^* \leq \frac{\tau r \eta}{b}$, (c) $\frac{\partial \pi_1}{\partial q_H}(q^*|q^*) = 0$ and (d) with $\hat{q}$ solving $\frac{\partial \pi_2}{\partial q_H}(q^*|q^*) = 0, \pi_1(q^*|q^*) \geq \pi_2(\hat{q}|q^*)$.

Proof:

***(I) Sufficiency*:**

In case (i), for any choice $q_H \geq 0$ by a domestic firm, $q_H + q^* \geq \frac{\tau r \eta}{b}$, so that the profit of the firm 1 is $\pi_2(q_H|q^*)$, which is by concavity and (i)(b) maximized at $q_H = q^*$. Hence, (q^*, q^*) is a Nash Equilibrium.

In case (ii), if a domestic firm chooses $q_H > \frac{\tau r \eta}{b} - q_F$, its profit is $\pi_2(q_H|q^*)$ which by (ii)(b) is maximized at $q_H = q^*$. If a domestic firm chooses $q_H \leq \frac{\tau r \eta}{b} - q_F$, its profit is $\pi_1(q_H|q^*) \leq \pi_1(\hat{q}|q^*) \leq \pi_2(q^*|q^*)$ by (ii)(d). Thus, (q^*, q^*) is a Nash Equilibrium.

In case (iii), if a domestic firm chooses $q_H < \frac{\tau r \eta}{b} - q_F$, its profit is $\pi_1(q_H|q^*)$ which by (iii)(b) is maximized at $q_H = q^*$. If a domestic firm chooses $q_H \geq \frac{\tau r \eta}{b} - q_F$, its profit is $\pi_2(q_H|q^*) \leq \pi_2(\hat{q}|q^*) \leq \pi_1(q^*|q^*)$ by (iii)(d). Thus, (q^*, q^*) is a Nash Equilibrium.

(II) Necessity:

If (q^*, q^*) is a symmetrical pure strategy Nash Equilibrium, then either (i)(a) or (ii)(a) and (b) or (iii)(a) and (b) holds.

If (i)(a) holds, for any $q_H \geq 0$ chosen by a domestic firm, the resulting profit is $\pi_2(q_H|q^*)$. Since the domestic firm is maximising profit, by function concavity (i)(b) must then hold.

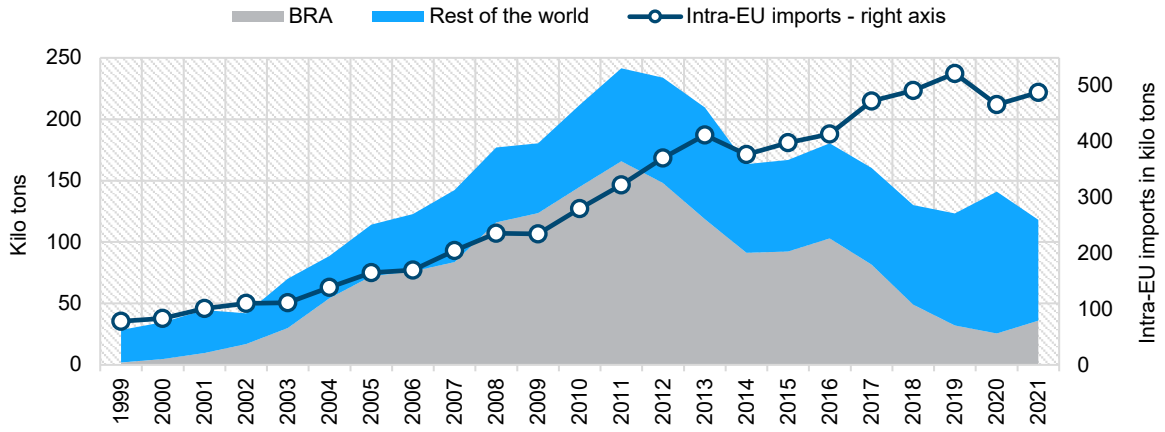
If (ii)(a) and (b) hold, let q_F^* solve $\max_q \pi_2(q|q^*)$. If $q_F^* < \frac{\tau r \eta}{b} - q^*$ by property (ii), $\pi_1(q_F^*|q^*) \geq \pi_2(q_F^*|q^*) > \pi_2(q^*, q^*)$, so that (q^*, q^*) is not a Nash Equilibrium, i.e. we have a contradiction. Hence, $q_F^* \geq \frac{\tau r \eta}{b} - q^*$, i.e. $q_F^* = q^*$, then, (ii)(c) must hold. If $\hat{q} \geq \frac{\tau r \eta}{b} - q^*$, by property (ii) $\pi_2(q^*, q^*) \geq \pi_2(\hat{q}|q^*) \geq \pi_1(\hat{q}|q^*)$, so (ii)(d) holds. If $\hat{q} \leq \frac{\tau r \eta}{b} - q^*$, since (q^*, q^*) is a Nash Equilibrium, $\pi_1(\hat{q}|q^*) \leq \pi_2(q^*, q^*)$, so again (ii)(d) holds.

If (iii)(a) and (b) hold, let q_H^* solve $\max_q \pi_1(q|q^*)$. If $q_H^* > \frac{\tau r \eta}{b} - q_F^*$ by property (ii),$\pi_2(q_H^*|q^*) \geq \pi_1(q_H^*|q^*) \geq \pi_1(q^*|q^*)$, contradicting that (q^*, q^*) is a Nash Equilibrium. Hence, $q_H^* \leq \frac{\tau r \eta}{b} - q^*$, i.e. $q_H^* = q^*$, then, (iii)(c) must hold. If $\hat{q} \leq \frac{\tau r \eta}{b} - q^*$, $\pi_1(q^*, q^*) \geq \pi_1(\hat{q}|q^*) \geq \pi_2(\hat{q}|q^*)$, where the first inequality comes from (iii)(b) and the last one follows from property (ii), thus, (iii)(d) holds. If on the other hand $\hat{q} > \frac{\tau r \eta}{b} - q^*$, since (q^*, q^*) is a Nash Equilibrium, $\pi_2(\hat{q}|q^*) \leq \pi_1(q^*, q^*)$, so again (iii)(d) holds.

The simulated model in the illustration section fulfils the first condition in the proposition above to constitute a pure strategy Nash Equilibrium for the model.

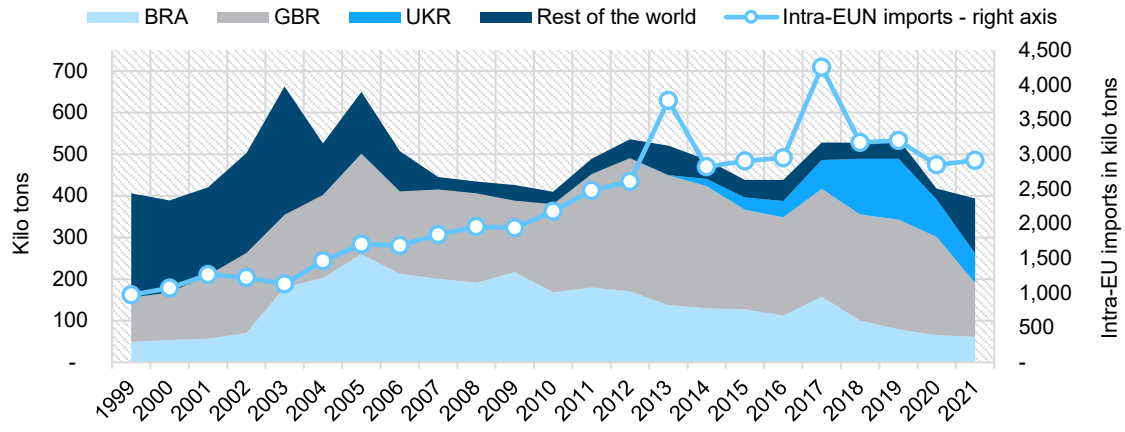
APPENDIX B. ADDITIONAL GRAPHS

Figure B1 / EU's import volumes of prepared or preserved fowls of the species Gallus domesticus (HS 160232) by trading partner in kilo tons - 1999-2021



Source: WITS, UN COMTRADE, author's elaboration.

Figure B2 / EU's import volumes of meat and edible offal of the poultry (HS 0207) by trading partner in kilo tons - 1999-2021



Source: WITS, UN COMTRADE, author's elaboration.

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