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The access to CETA quotas: Extending CGE models with a market for quota licenses

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Abstract

We analyze the market dynamics that are caused by tariff-rate quotas, particularly the effects of quota license allocation between heterogeneous commodities at the tariff line level. The allocation is endogenously modeled with a mixed complementarity problem approach for the case of the Comprehensive Economic and Trade Agreement between Canada and the European Union. The model results are compared both with alternative models that resemble pre-existing approaches and with the real trade figures that have been collected since the trade agreement's implementation. Our analysis shows a bias toward more expensive commodities if the shadow value of a quota license manifests in a secondary license market. The same quota can thereby be binding to some commodities but not so for others. This feature of quotas can be crucial for policymakers who are concerned about price effects or who want to understand the effects of lumping together commodities of different quality in one quota.

Keywords: Tariff-rate quotas, CETA, License administration.

JEL code: C63

1. Introduction

The Comprehensive Economic and Trade Agreement (CETA) between Canada and the EU, provisionally applied since September 2017, contains a wide range of commitments, for example, on the liberalization of tariffs, intellectual property rights, or geographical indications. Sensitive agricultural and food commodities are in part liberalized via tariff-rate quotas (TRQs). TRQs are trade barriers that allow a certain quantity of goods to be imported at a low or zero inside-quota tariff rate (IQTR), and beyond this, any quantity to underlie a higher out-of-quota tariff rate (OQTR). This way, TRQs grant access to the domestic market, on the one hand, while maintaining some control over the import quantities, on the other hand.

In textbooks such as Francois and Reinert (2012), the market situation under a quota is presented with the ordinary depiction of an upward-sloping supply curve (with different tariffs added) and a downward-sloping demand curve, which intersect at some point below, at, or above the quota. This depiction contains the implicit assumption that suppliers at the left side of the supply curve, who can offer their product at a low price, are the

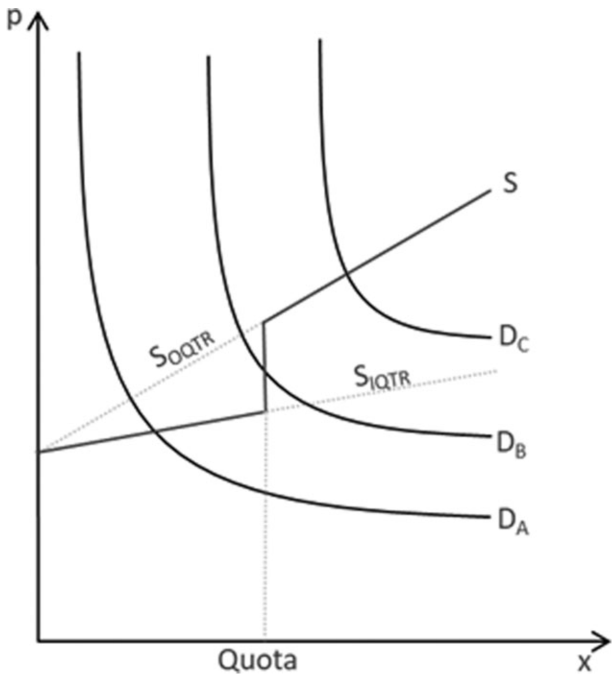

Figure 1. The TRQ adds a kink to the supply curve. Depending on whether the demand intersects with the supply curve below (D_A), at (D_B) or over (D_C) the quota volume, the IQTR applies, or the IQTR with an added premium, or the OQTR.

ones who will benefit from the preferential market access (see also Fig. 1). Suppliers further right in the supply curve have to offer outside the quota. However, Mönnich (2003) demonstrated in much detail that the quota premium may—depending on the form of quota administration—grant market access to non-marginal suppliers. What is more, competition for quota licenses between nonhomogenous commodities can explicitly put suppliers of more expensive commodities at an advantage (Vousden 1992). Therefore, while TRQs often grant access to more than one commodity and to more than one country on paper, the market access may de facto be limited to certain trade flows of a high price range.

In the case of CETA, seven commodity groups are traded through TRQs, involving Canada and all states of the EU, and most of them comprising more than one commodity code at the harmonized system (HS) six-digit level. Several studies estimated the effects of the CETA agreement with a broad trade liberalization (Hejazi and Francois 2008): implementing tariff reductions while sparing sensitive commodities to some extent (Kirkpatrick et al. 2011; Boulanger et al. 2016; European Commission 2017), or even implementing the tariff reductions of CETA at a highly disaggregated level (Jafari et al. 2021b), but did not explicitly model the new TRQs within CETA. Even if some models provide the possibility to include TRQs, such as the one used by Philippidis and Kitou (2012), the scenarios contain no specific modeling of future additional quotas but only assume the maintenance or abolition of pre-existing WTO quotas. Boulanger et al. (2016) explicitly state that modeling trade concessions in the area of sensitive commodities via tariff cuts rather than implementing TRQs is a limitation of their study. A noteworthy exception is Jafari et al. (2021a), who explicitly model TRQs in the context of CETA by disaggregating their bilateral trade volume from the computable general equilibrium (CGE) model. However, they assign the quantities that are traded within the quota at the tariff line level prior to the modeling—and thereby have no need for endogenously allocating the quota licenses between the different HS codes. Thereby, their results miss out on the dynamics between cheaper and more expensive commodities.

Concerns about the effects of quantitative restrictions on the price level of imports were probably greatest in the 1970s to the 1990s, when voluntary export restraints (VERs) and Orderly Marketing Agreements (OMAs) influenced import prices on the US market. In the time between 1981 and 1994, when the Japanese auto exports to the USA were limited through VERs, the effects on prices were subject to political debates, causing the Reagan administration, industry representatives, labor unions, and Japanese newspapers to give their assessments on how the American auto industry, the prices, and the consumers would be affected by such a quantitative restriction (Berry et al. 1999). Both Feenstra (1984) and Collyns and Dunaway (1987) try to split the price increase that followed the restriction into those that were offset by an increase in quality and those that were not. Krishna (1987) analyzes the incentives on firms' choices for a certain quality from a theoretical perspective. Falvey (1979) and Vousden (1992) point to the absolute surcharges that quotative restrictions impose upon commodities and that disadvantage cheaper commodities in a stronger manner than expensive commodities. Following the latter argument, Aw and Roberts (1986) study the substitution toward more expensive items within the footwear imports from Korea and Taiwan, which were constrained by OMAs between 1977 and 1981. Harris (1985) and Krishna (1989) added to the debate with theoretical analyses of how markets would be expected to behave in situations of very limited competition, more precisely in stylized duopolies. However, to the best of our knowledge, there are no studies available that include these effects of an endogenous license administration in an equilibrium model. The aim of our approach lies not so much in repeating that quotas can have an effect on horizontal product differentiation, but rather in including the possible effects of a quota in the common framework of vertical product differentiation that is commonly used in CGE models based on the Armington assumption, following the general logic that cheaper commodities are at disadvantage, as proposed by Falvey (1979), Aw and Roberts (1986), and Vousden (1992). Jafari et al. (2021) mention the endogenous allocation of licenses within the TRQ as one of the areas in which further research would be worthwhile, so we consider this a gap in the previous literature and will return to the precise effects on an endogenous quota license allocation in the results section.

With the help of a partial equilibrium model, we aim to better understand the market dynamics of TRQs that include several commodities from different exporting countries, which are perceived as imperfect Armington-substitutes. Our results affirm the preferential quota access for more expensive commodities and trade partners. Thereby, market access is increased while the average price of the commodity group from the trade partner may not decrease but even increase compared to the previous tariff regime.

Section 2 provides an overview of the theory of TRQs and the model framework. Section 3 describes the underlying database and its modifications. In Section 4, the results are discussed. Here, we present the changes in trade due to the implementation of CETA. In addition, the model results of the first years are compared with the real trade figures. Section 5 concludes and addresses the limitations of our approach.

2. Methodological approach

2.1 License market under TRQs

TRQs add a kink to the supply curve of the common depiction. Three regimes appear depending on where the demand curve and the supply curve intersect. Figure 1 depicts these three regimes. In the first regime (when S intersects with D_A), the quota is not binding and the IQTR applies to all imports of the trading partner. In the second regime (S intersects with D_B), the quota is binding. Here, the surplus demand creates a margin at a given quantity

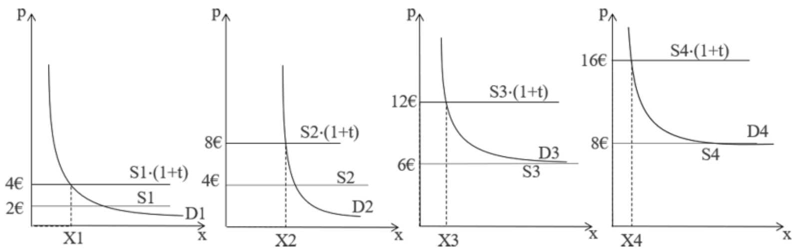

Figure 2. Four heterogeneous commodities with supply curves at different price levels (S1-S4) and differently behaving, normal demands (D1-D4).
Note: All supply prices are raised by (1 + t), where t = 100%.

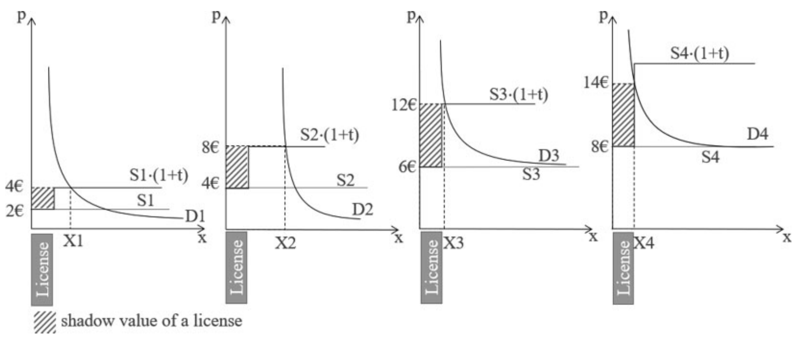

Figure 3. All commodities gain a license at the size of one unit.

that is added to the export price, commonly referred to as the quota premium. Depending on market power and the form of administration, the rent that accrues out of the premium is gained by some party along the supply chain or by the government. In the third regime (S intersects with D_C), there is trade beyond the quota, for which an OQTR has to be paid. The imports inside the quota will be sold at a price that includes the OQTR, leading to a quota premium that is equal to OQTR-IQTR. However, this simplified picture does not quite capture the case when several commodities share one quota. To illustrate this, let us imagine a market where four heterogeneous commodities face an ad valorem equivalent (AVE) tariff of 100 per cent (Fig. 2).

Now, a duty-free quota of four units is introduced and all four commodities gain access to it and gain some share of the quota licenses. Licenses are distributed among all four commodities (Fig. 3), whereby a kink is added to the supply curve at the point where the individual licenses are used up and the commodity is sold at the high tariff outside the quota. Commodities 1–3 are still sold outside the quota—their quantity and import price have not changed through the implementation of the quota. However, since a portion of their trade takes place without the application of a duty, they benefit from a quota rent (hatched area).[1] Commodity 4 can actually increase its exports through the quota license and has an equilibrium import price that is lower than before, adding a quota rent of only €6. The premium reflects the shadow value of a license to the supplier. As we can see, the shadow value of a license ranges from €2 to €6. The supplier of commodity 1, who saves on a comparably small absolute tariff burden, has an incentive to sell his license to one of the other suppliers, who would all be willing to pay more for it.

If the secondary market for licenses works efficiently, an equilibrium is reached where the price of a license is equal to the shadow value that each supplier attributes to its licenses (Fig. 4). The equilibrium price of a license lies at €4. Supplier 1 will not hold any licenses at

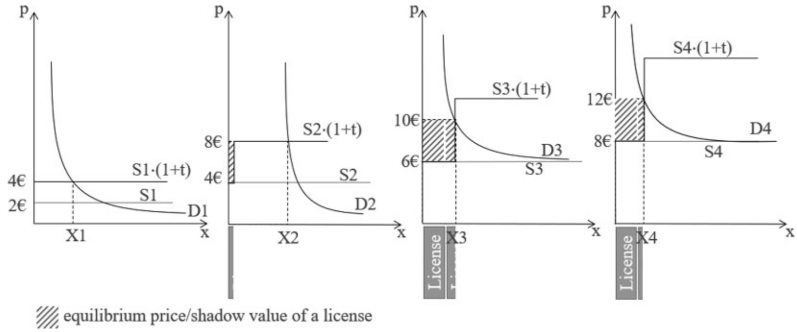

Figure 4. Equilibrium state of the license market.

this license price as paying the tariff costs and exporting outside the quota is cheaper for this commodity. Suppliers 3 and 4 export just the right amounts so that their quota premium can compensate for their license purchase. Supplier 2 is indifferent between buying a license or exporting outside the quota since both will cost €4. Supplier 2 thereby functions as a marginal supplier who consumes the licenses that are still available in the market.

This illustrates why cheaper exporters are less likely to export inside the quota when ad valorem tariffs apply outside the quota—it is simply not worthwhile to them to afford an expensive license. More expensive exporters have higher opportunity costs of not owning a license, as their absolute tariff burden is high if they have to export outside the quota. However, depending on the features of the demand for their commodity, a high price alone is no guarantee for holding the most licenses in equilibrium, as the comparison of the licenses held by suppliers 3 and 4 shows.

Due to their bias toward expensive commodities, quotas have sometimes been compared to specific tariffs or transport costs, which both add an absolute surcharge to the price that affects cheaper commodities in a stronger fashion (Falvey 1979). This, however, fails to capture the entirety of the mechanism of TRQs, because while a quota with ad valorem tariffs outside the quota favors expensive commodities in their access to quota licenses, the commodities outside the quota operate under a non-distorting ad valorem tariff. The advantages of more expensive commodities in gaining access to the quota can considerably influence, for instance, the effects of a liberalization of a quota: If one considers all imports with access to the quota as a uniform block, then an extension of the quota does not seem to grant market access once the quota is overfilled. This is because the quota does not appear to be the binding element, but rather the OQTR. However, a quota can appear binding to some commodities while being non-binding to others, whereby an extension of the quota can grant additional market access, even if out-of-quota imports already take place.

However, one should note that it is the ad valorem tariff that elevates the shadow value of a quota for the export of more expensive commodities. In reality, specific or mixed tariffs can apply outside the quota, whereby cheap and expensive commodities have a more similar payoff of gaining quota licenses and will hence demand them in a more balanced manner.

2.2 Modeling approach

Bishop et al. (2001) elaborate on why mixed complementarity problems (MCPs) are a convenient problem formulation for modeling TRQs. It was then used in variations, for example, by van der Mensbrugghe et al. (2003), Grant et al. (2006, 2009), Junker and Heckelei (2012), and Jafari, Britz et al. (2021).

The partial equilibrium model seeks to identify which commodities gain access to the quota and at which quota premium. With the new trade agreements, certain commodities

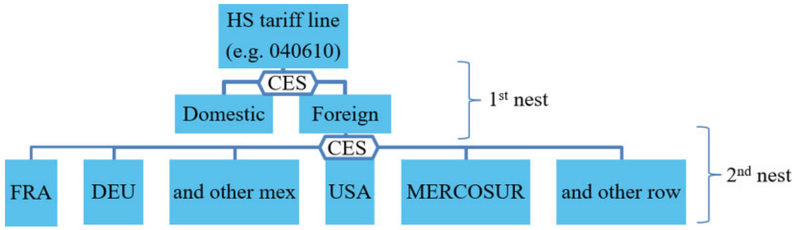

Figure 5. Nesting structure of imports.

from the preferentially treated partner country become cheaper and a higher portion of them is demanded. In the process, the profit maximization on the supply side is considered, as well as a nested Armington demand structure that relies on a constant elasticity of substitution utility function with strong parallels to the structure of the Global Analysis Project Model (GTAP), as well as an endogenous license allocation. However, in order to not overcharge the model with complexity, several more complex forms of interaction (such as substitution between different commodity codes or changes in income, changes in factor prices, or changes in prices for domestically produced competing commodities) were not included in the model.

In the following, *HS* will denote the six-digit tariff lines included in the TRQ (with the HS nomenclature of the 2007 edition), *mim* will be the CETA members as importing countries (i.e. either Canada or the member states of the EU), and *ex* will be all exporting countries. The exporting countries will be further split into partner countries *mex* that have access to the quota (i.e. the member states of the EU or Canada) and the other countries *oex*—this is no split in the nesting structure, see Fig. 5). The different years of the schedule are labeled with the index *y*. Variables of the first nest include a '1' in their label, such as the summarized value of imports of one HS line to one importer *mim* ($V1_{mim,HS,y}$), while variables of the second nest, such as the trade volume ($X2_{ex,mim,HS,y}$) or the unit value ($UV2_{ex,mim,HS,y}$), include a '2' in their variable. The same applies for the share parameter $\alpha2_{mim,HS}$ as well as the Armington elasticities $\sigma1_{mim,HS}$ and $\sigma2_{mim,HS.}$ The competition for licenses in the second nest is further described by a variable for the shadow value of a quota license ($LICENSEPRICE_{mim,HS,y}$), the quantity share of a bilateral export that is imported under a license ($LICENSESHARE_{mex,mim,HS,y}$), and the quota premium that is added to the unit value and the IQTR ($PREMIUM_{mex,mim,HS,y}$). The OQTR is labeled $oqtr_{mex,mim,HS,y}$, the IQTR $iqtr_{mex,mim,HS,y}$, and the initial tariff $t2_0$.

In the MCP approach, variables are linked to variables with so-called perps (⊥), which indicate a pair-wise complementarity between an inequality constraint and the variable and its bounds. If the variable is equal to one of its bounds, the constraint applies in the form of inequality. If the variable is between its bounds, its corresponding equation has to be binding with an equality sign. Sometimes a variable only has one bound (either an upper bound or a lower bound), which is equivalent to a second bound equal to negative or positive infinity, which will never be reached. All equations are explained in the following. For better readability, the indices will be left away as far as possible. Variables are written in capitals.

The first equation describes how each import quantity depends on its own price and the price of all competing commodities of the same HS code according to an Armington CES function:

$$X2 = \left(\frac{\alpha2}{UV2 * (1 + iqtr + PREMIUM)}\right)^{\sigma2} * \frac{V1}{\sum_{ex} \alpha2^{\sigma2} * (UV2 * (1 + iqtr + PREMIUM))^{1-\sigma2}} \perp UV2. \quad (1)$$

However, imports also compete with domestic commodities. For this, we implement a higher nest in which the sum of all imports competes with domestically produced commodities (equivalently to the GTAP demand side). The first nest is then also described by a CES function—but in order to just rely on the information on values rather than quantities, it looks slightly different.

$$\frac{\mathrm{V1}}{\mathrm{expenditures} - \mathrm{V1}} = \frac{(\mathrm{UV2}_0 * (1 + t2_0))^{\sigma 1 - 1}}{\left(\sum_{ex} \frac{\mathrm{X2}}{\sum_{ex} \mathrm{X2}} * \mathrm{UV2} * (1 + \mathrm{iqtr} + \mathrm{PREMIUM})\right)^{\sigma 1 - 1}} * \frac{\mathrm{V1}_0}{\mathrm{expenditures} - V1_0} \perp \mathrm{V1}. \quad (2)$$

On the supply side, the unit values are the result of a profit maximization, in which marginal revenues are equal to marginal costs. The marginal costs on the right are simply a constant *fc*, since there are no economies of scale, and we assume factor prices not to change through the liberalization. The marginal revenues on the left are a more complex function, as the suppliers of the imperfectly substitutable Armington commodities have some limited market power.

$$\frac{\partial\ (\mathrm{UV2}\,(\mathrm{X2}) * \mathrm{X2})}{\partial\ \mathrm{X2}} = fc \perp \mathrm{X2}. \quad (3)$$

The imports X2 can either be imported with quota licenses or imported at the higher OQTR. Which share of the imports is imported with licenses is described by the variable LICENSESHARE. The sum of the given licenses may not exceed the quota volume. Once the quota is filled, licenses are a scarce resource and receive a (shadow) price, which is more or less visible in the market, depending on the efficiency of the market for quota licenses. This explains the perpendicularity between this equation and the variable LICENSEPRICE: If the equation becomes binding, then a positive price for licenses appears.

$$\begin{aligned} &\mathrm{quota} \geq \sum_{\mathrm{mex,mim,HS}} \mathrm{LICENCESHARE} * \mathrm{X2} \perp \mathrm{LICENSEPRICE} \\ &\text{i.e.} \\ &\mathrm{quota} = \sum_{\mathrm{mex,mim,HS}} \mathrm{LICENCESHARE} * \mathrm{X2} \text{ if } \mathrm{LICENSEPRICE} > 0 \\ &\text{and} \\ &\mathrm{quota} > \sum_{\mathrm{mex,mim,HS}} \mathrm{LICENCESHARE} * \mathrm{X2} \text{ if } \mathrm{LICENSEPRICE} = 0. \end{aligned} \quad (4)$$

Obviously, the variable LICENSESHARE can lie anywhere between 0 and 1. If it is equal to 1, all imports between this preferentially treated exporter and the importer are traded with a quota license. In that case, the premium is smaller than OQTR–IQTR. (Technically, one can imagine the premium to be at the maximum coincidentally, which is also allowed for by the model.) If some[2] or all exports are exported without a license, those exports will automatically underlie the high OQTR, and since only one market price applies for each commodity, the premium has to be at its maximum in that case:

$$\begin{gathered} \mathrm{PREMIUM} \neq \mathrm{oqtr} - \mathrm{iqtr} \perp \mathrm{LICENSESHARE} \\ \text{i.e.} \\ \mathrm{PREMIUM} \leq \mathrm{oqtr} - \mathrm{iqtr} \text{ if } \mathrm{LICENSESHARE} = 1 \\ \text{and} \\ \mathrm{PREMIUM} = \mathrm{oqtr} - \mathrm{iqtr} \text{ if } 0 < \mathrm{LICENSESHARE} < 1 \\ \text{and} \\ \mathrm{PREMIUM} \geq \mathrm{oqtr} - \mathrm{iqtr} \text{ if } \mathrm{LICENSESHARE} = 0. \end{gathered} \quad (5)$$

The shadow price of licenses, at which they are sold in an ideal market, is equal to the rent that is gained from receiving an additional license (i.e. the unit value UV2 times a premium). If their rent per unit cannot afford them to gain a license, they have to sell outside of the quota and the corresponding variable—the premium—will be at its maximum.

$$\begin{gathered} UV2 * PREMIUM \neq LICENSEPRICE \perp PREMIUM \\ \text{i.e.} \\ UV2 * PREMIUM \leq LICENSEPRICE \text{ if } PREMIUM = OQTR - IQTR \\ \text{and} \\ UV2 * PREMIUM = LICENSEPRICE \text{ if } 0 < PREMIUM < OQTR - IQTR \\ \text{and} \\ UV2 * PREMIUM \geq LICENSEPRICE \text{ if } PREMIUM = 0. \end{gathered} \tag{6}$$

The market for licenses that are assumed here is an idealization of the real market situation. The quota license allocation in CETA takes place with a mix of license-on-demand and first-come-first-serve mechanisms, which does not guarantee market efficiency (Skully 2001). However, since license holders are able to transfer their quota licenses and since the possible development of a secondary market for import licenses was explicitly addressed in the Meeting of the Committee of Agriculture (European Commission 2018), we assume that the results will resemble a market allocation of the quota licenses. Furthermore, we separated the license market of the profit maximization process. Theoretically, one could imagine that additional quota licenses are paid for by marginal profits that accrue due to expanded production. Or that, to the contrary, the willingness to pay for licenses is diminished by decreasing revenues resulting from the decreasing prices entailed by the liberalization. However, since quota holders are not necessarily producers, but rather firms on the importing side, as in the case of the cheese quotas (Kerr and Hobbs 2015), it is not clear how much the quota rent and the license prices will really influence the decisions in production. Mönnich (2003) even explicitly criticizes that literature on the quota administration often implicitly or explicitly assumes that producers are directly affected by windfall profits of the quota, when in fact they do not engage in international trade, but specialized firms do. This is why we decided to keep those market decisions separated.

2.3 Mimicking standard modeling approaches for comparison

In the literature, different approaches are used to deal with TRQs. To get a better grasp of the advantages of a disaggregated model, we will compare our model to different other methods that are commonly seen.

The simplest way to deal with TRQs is maybe by recalculating them into an AVE tariff. This is based on the idea that the quota premium adds a margin to the unit value of the imported good, similar to the one a tariff would add. No matter whether the margin is added as a premium or a tariff, it should result in the same intersection of supply and demand in a simplified diagram such as in Fig. 1 and should therefore be import equivalent (Döbeling and Pelikan 2020). Since the precise premium is hard to estimate, a simplified approximation is often used. The MAcMap database, for instance, provides an AVE for TRQs that is calculated by the following formula:

$$AVE = \begin{cases} \frac{IQTR+OQTR}{2} \text{ if fillrate} \leq 80\% \\ OQTR \text{ otherwise} \end{cases}. \tag{7}$$

Since the fillrate is not known prior to the implementation of new quotas, we will simply divide the initial values with the quota to get a rough idea of the fillrate. The resulting AVE (according to the MAcMap methodology above) is then included in our partial equilibrium model like a normal tariff to calculate the resulting import changes.

A second way to deal with TRQs is by implementing them directly, but keeping them at an aggregated level.

A third way is an MCP model in which licenses are previously allocated and then remain at their level rigidly. This method is comparable to the mechanism used by Jafari et al. (2021a) and is useful for a comparison of a dysfunctional license market with a functioning one. For this, we keep the first three equations, but then match the equation that defines the maximum of the premium with a new variable for imports outside the quota (X_OQ).

$$\begin{gathered} \text{oqtr} - \text{iqtr} \geq \text{PREMIUM} \perp \text{X\_OQ} \\ \text{i.e.} \\ \text{oqtr} - \text{iqtr} \geq \text{PREMIUM if X\_OQ} = 0 \\ \text{and} \\ \text{PREMIUM} = \text{oqtr} - \text{iqtr if X\_OQ} > 0. \end{gathered} \tag{8}$$

And add an equation that states that the exporting country does not need to make use of all its licenses if it cannot generate a premium out of using them. As soon as it generates a premium from its exports though, its total exports need to be the sum of all preassigned licenses plus its out-of-quota exports.

$$\begin{gathered} \text{licenses} + \text{X\_OQ} \geq \text{X2} \perp \text{PREMIUM} \\ \text{i.e.} \\ \text{licenses} + \text{X\_OQ} \geq \text{X2 if PREMIUM} = 0 \\ \text{and} \\ \text{licenses} + \text{X\_OQ} = \text{X2 if PREMIUM} > 0. \end{gathered} \tag{9}$$

Each exporting country applies for the licenses that equate to the export amounts that it used to export before the introduction of the quota. If the quota is exceeded by the sum of these applications, they are shortened proportionally, as would be the case in the license-on-demand system that is in place for several TRQs in CETA.

The model is rather flexible on the usage of licenses, much as in the real world. The quota does not need to be depleted before exports outside the quota can take place, and licenses do not need to be used by the applicants (although there are punitive mechanisms in CETA to prevent the disuse of licenses).

2.4 Sensitivity analysis

In our dataset, some commodities had very little or no imports in the base period. The TRQs for sweetcorn, pork, and beef all contain at least one tariff line for which the trade values are at zero in the initial database. These zero trade values can either reflect the market situation (e.g. because there is little demand for the imported commodity), a lack of data, or the infeasibility of imports under a high level of protection before CETA. If one of the latter is the case, the CES function will systematically underestimate the market potential of these commodities once the market is liberalized—the so-called 'small shares stay small' problem. Considering that TRQs are usually applied to the most sensitive commodities—that is, commodities that are considered to have high market potential, for which a sudden trade liberalization may harm prevailing suppliers on the domestic market—we run a second, adapted version of the simulation, in which we shock the initial trade values of commodities that are likely to fall under the 'small shares stay small' problem. As criteria for this, we require that

1. the exporting country has no export volumes to the CETA partner;
2. the exporting country exports to countries of the importing country's reference group;
3. the importing country imports from countries of the exporting country's reference group;

Figure 6. Variations of the Armington elasticity σ for the sensitivity analysis.

4. the importing country initially imposes a higher tariff rate toward the exporting country than toward other countries (on average) that did manage to export to the importing country; and
5. the prices (including tariffs) of the exporting country are higher than those that the reference groups have on average in the importing country.

Their export volumes will then be adapted: For the calibration, their export quantities, unit values, and tariffs will, therefore, be set to the average of the country's reference group (the arrangement in groups was taken from Horridge and Laborde 2008). After the calibration, the tariffs will be set back to their initial height, their unit values to the average that they could offer to other countries of the reference group, and their quantities will be calculated according to the Armington demand function. Several zero-imports are thereby replaced with small quantities that reflect the export potential of those countries.

Furthermore, we will vary on our Armington elasticities—a common approach for a sensitivity analysis in CGE models and a reasonable one, given that the Armington elasticities that we use show high standard deviations. Fontagné and Guimbard (2019) provide the average standard deviations for their estimations for each product group. We variated the Armington elasticities upwards by adding one standard deviation. An obvious downwards variation would be to reduce our Armington elasticities by the standard deviation, but this was bound to fail, as some of the deviations are so large that this would change the sign of the elasticity. Thus, as a variation in the other direction, we divide the elasticities in half for another run (Fig. 6).

3. Data

In the CETA agreement, TRQs are defined for six product groups on the European side (for shrimps, cod, common wheat, sweetcorn, pork, and three TRQs for bison meat/beef) and one product group on the Canadian side (cheese, divided by its further usage for retail or further processing). The TRQs are defined at a high level of detail, going beyond the six-digit scheme of the HS. The six-digit scheme, however, is the highest level at which internationally harmonized trade data are available. Therefore, we translate the TRQs to the six-digit level, which is why the TRQs for bison meat and beef as well as the two TRQs for cheese are merged in the following analysis. Annex 1 shows the TRQs and administration methods in CETA and how these commodities are combined at the six-digit level for our analysis.

Trade volumes are taken from the CEPII BACI database (Gaulier and Zignago 2010), and CIF unit values from the TUV database from CEPII (Berthou and Emlinger 2011). For both, a simple 3-year average of 2014, 2015, and 2016 is calculated. Where unit values are missing, a proxy could be calculated out of the values and quantities given in the BACI database. But the magnitude of these proxies differs strongly from the existing trade unit values. Therefore, in this study, we decide not to consider these imports.

In the initial tariffs, the AVEs from the Market Access Map (MAcMaps 2019) are used. As can be seen in Table A1, TQB1, TQP, and cheese include preexisting quotas. These were added to the quota volumes, but for the calibration in the initial period, they were only considered in the form of AVE tariffs as taken from the MAcMap database—similarly to the calibration by Jafari et al. (2021a). Additionally, imports from Canada through the Hilton Quota become duty-free, which was not reflected in our calculations.

For the elasticities of substitution, we rely on the estimations by Fontagné and Guimbard (2019). The elasticities for the first nest are derived from this via the Rule of Two, which was used in the GTAP model (Hertel and van der Mensbrugghe 2016). A recent study by Feenstra et al. (2018) could not reject this rule for four-fifths of the goods, albeit this was due to large standard errors. In the second model variation, where commodities are aggregated, a simple average of the elasticities was used, and they were doubled when more than two HS-lines were integrated into a block.

Since there are no data on the domestic values at the HS six-digit level of the commodities, we make an estimate of the values based on the GTAP database. From there, we extract the relation between domestic and imported commodities for each sector and country and assume that this relation is also valid for all corresponding tariff lines.

$$\text{expenditures} = \left(1 + \frac{\text{VDPM} + \text{VDGM} + \sum_{\text{receiving sector}} \text{VDFM}}{\sum_{\text{exporter}} \text{VIMS}}\right) * \sum_{\text{exporter}} \text{X2}_0 * \text{UV2}_0 * (1 + \text{T2}_0). \tag{10}$$

We then formulate our equations in a way that they do not rely on volumes and prices for domestic commodities, but solely on the estimation of domestic values (equation (10)).

For the comparison with real trade data, we mainly used the BACI database, although it is only given at the six-digit level and does not distinguish between commodities traded within the quota and outside. For more disaggregated data on quantities traded within a quota, there are two databases of the EU. Firstly, for quotas that are managed according to the 'first-come-first-served' method (i.e. the quotas for shrimps, cod, sweetcorn, and a part of the beef quota, TQB3), the import quantities are given by the Commission's Directorate-General for Taxation and Customs Union (DG TAXUD 2021). Secondly, for quotas that are allocated via licenses on demand (i.e. common wheat, pork, and the other two parts of the beef quota, TQB1 and TQB2), the allocation coefficients are published by the Commission's Directorate-General for Agriculture and Rural Development (DG AGRI 2021). For the cheese quotas that Canada opened toward the EU, there is the utilization database by the Canadian Government (Government of Canada 2021). All these databases collect their data precisely for those commodities that were allowed to enter within the TRQ, with all properties that are defined beyond the HS six-digit level. However, the allocation coefficients by DG AGRI do not seem to contain all order numbers that are traded via license-on-demand within CETA. The DG TAXUD database does not match well with the BACI dataset that we used—the quantities exported within the quota at the much more disaggregated system of the Combined Nomenclature (CN) already contain more imports than their superordinate HS six-digit tariff lines in the BACI database. The Canadian database does not seem to properly match with other sources—for example, according to the report on the Second Meeting of the Committee on Agriculture, Canada pointed out that the cheese quota had a very high fillrate of around 99 per cent in 2018 (European Commission 2019), while the utilization database only names about 6,000 kg across the cheese quotas, with 9,650 tons being available in that year. Since the objective of comparing model results with real trade data is to evaluate the precision and validity of the model, we decided to compare our model results only to BACI data. This is the only fair comparison, as any other dataset might also include different standards (in terms of units, a recalculation from product to carcass weight, harmonization, cutoff dates for data collection, and so on), which add model-unrelated deviation to the juxtaposition.

For a comparison of the price levels before and after the implementation of CETA, we use the Access2Markets database (DG Trade), which lists the products at the level of the CN and thereby more disaggregated than the level that we can use for our model (as our model

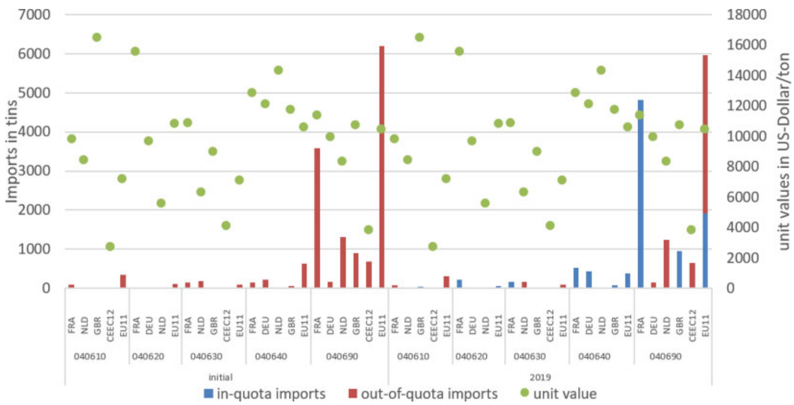

Figure 7. Access to quota licenses and the comparison of imports before and after the implementation of CETA.

includes trade between non-EU countries, for which there are no trade data that are harmonized with the European definitions). On the downside, the Access2Markets database does not specify whether imports are entering via quota licenses or at the OQTR. Nevertheless, it is a useful database for giving an impression of the price composition before and after the implementation of CETA.

4. Results

4.1 Access to the quota for different price groups

As an exemplary illustration for quota access, Fig. 7 shows the modeled access to the TRQ for cheese in 2019. Naturally, by the calibration of our CES function, our resulting imports take their bearings from the initial imports. Yet we can see that some commodities can benefit noticeably from the additional quota access—such as the tariff lines 040620 to France and 040640 exported to France and Germany. Their high unit values grant them a better chance of gaining a quota license. This was to be expected, as a moderate quota premium on an expensive good can yield the means to afford the price for a license. Less expensive commodities would need a much higher premium to yield a rent per unit that can afford them a quota license, and this premium may cost them their competitiveness in the market—or simply exceed the maximum premium they can add to their commodity.

As a result, the TRQs do not grant equal access to all commodities that are allowed within them, but they give an advantage to more expensive commodities.

With respect to liberalization efforts, this means that TRQs can increase the volume of imports but distort the market toward more expensive imports, resulting not in lower, but even in increased average prices. This is illustrated by the developments of the TRQ for common wheat in Fig. 8. While the volume of EU imports increases, the immediate effect of the additional imports is a rising average price of the imports that are included in the TRQ, since the quota mainly gives access to a higher price segment. In the following years, the liberalization is proceeded with a decreasing OQTR, until the tariff protection is completely abolished in 2024. Thereby, more, or the lower-priced, imports can enter without a quota license over the years and the average price sinks again.

A schedule that uses the quota quantity instead of the OQTR as a lever to liberalization can therefore have a different effect on prices. As presented in Fig. 9, cheese imports from the EU to Canada, which are liberalized over an increasing quota, see a sharp increase in their average price. With a growing quota quantity, also cheaper commodities slowly start to benefit from the quota access (and the exports outside the quota only consist of the

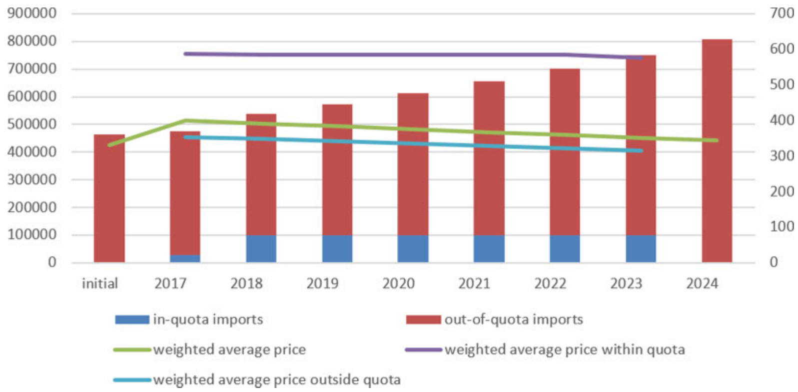

Figure 8. Imports and average prices in the TRQ for Common Wheat.

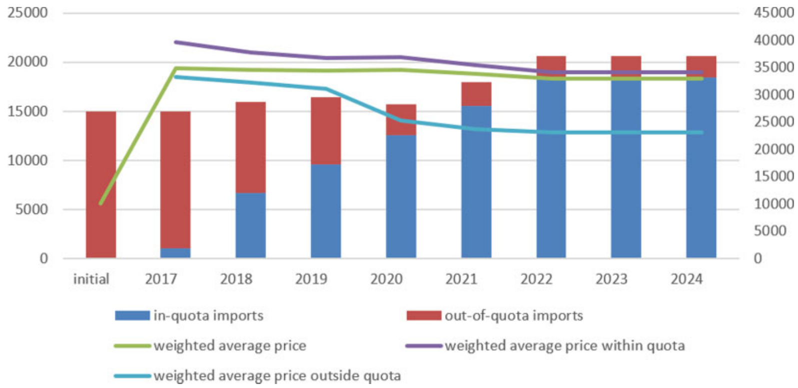

Figure 9. Imports and average prices in the TRQ for Cheese.

remaining cheapest exports), yet the liberalization is not enough to let the average price return to its initial value.

The empirical literature has testified to this effect, as we noted earlier. Even without diving deep into an empirical analysis of the unit values for TRQs in CETA, we can easily find indications that this effect also holds true for licenses in CETA. When the commodities that had access to TRQs are compared, depicting their unit values and quantities in scatterplots, one can see differences in the time before and after the application of the CETA agreement (Figs 10–12). While import quantities and unit values are negatively correlated before 2017, as one would expect with a demand for normal commodities that act as substitutes, this negative correlation is extenuated after the quota is implemented. Although noteworthy, this very simple regression of quantities on prices without including any other properties of the related, not entirely homogeneous commodities is not significant though.

4.2 Liberalization of quotas

A close look at Fig. 9 already hinted at the liberalization that can be caused by extending a quota quantity. Quotas can either be liberalized over increasing quantities or decreasing OQTRs—in the case of CETA, both methods are applied, sometimes even within the same quota. The quota for sweetcorn, for instance, increases the imported quantity from 1,333 to 8,000 tons, while decreasing additionally the OQTR for the included tariff line 071040, leaving however the OQTR for the other included tariff line, 200580, at its initial tariff level.

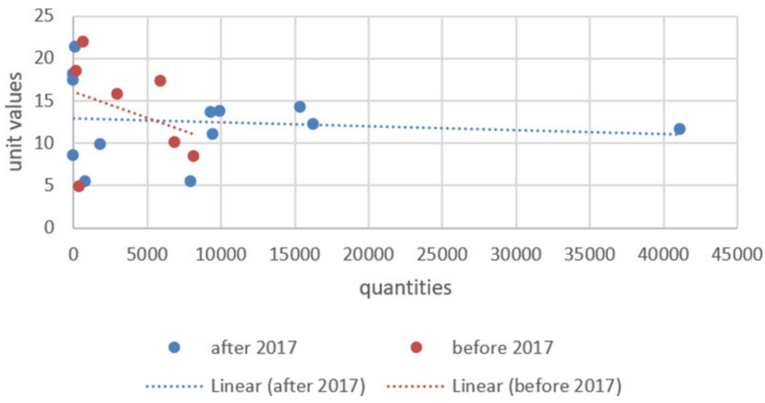

Figure 10. Quantities and prices of the quota for beef.

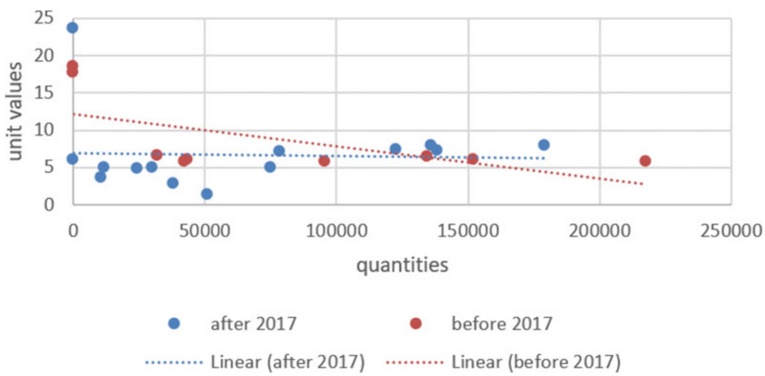

Figure 11. Quantities and prices of the quota for cod.

When a quota is expected to be overfilled, an increase in the quota quantity appears to have little effect on the price levels and the import quantities—at least if one considers TRQs to work according to the simplified Fig. 1: Since the premium is already at its maximum, an increase in the quota quantity will shift the kink in the supply curve to the right, but will not affect the intersection point of supply and demand, unless the quota becomes big enough to cause a regime change to a binding quota. However, if one considers the dynamics of quota license allocation in the matter, both import quantities and the composition of different price levels can be affected by an increasing quota, even if it is not binding.

Figure 13 compares the liberalization that can be seen when different models are applied for the consideration of TRQs. The model at the HS tariff line level (labeled 'HS') is compared to an aggregated modeling of TRQs (labeled 'TRQ_aggregated'). In there, an extension of the quota volume will have no effect on the trade volume until a regime change takes place. In a model with an endogenous license allocation, such as ours, expensive commodities to which the quota was previously binding can get additional access to the quota, while the demand for cheaper commodities traded outside the quota does not necessarily sink proportionally. At the same time, the suppliers' unit values may change due to the changed volumes, which influence their access to quota licenses. The third depicted model allocates licenses that cannot be traded after their initial allocation (labeled 'licenses fixed'). Exporting countries may find that they applied for too few licenses, resulting in a situation where out-of-quota exports take place even if the quota licenses have not been entirely used. This can be observed in real trade, causing, for instance, the MAcMap database

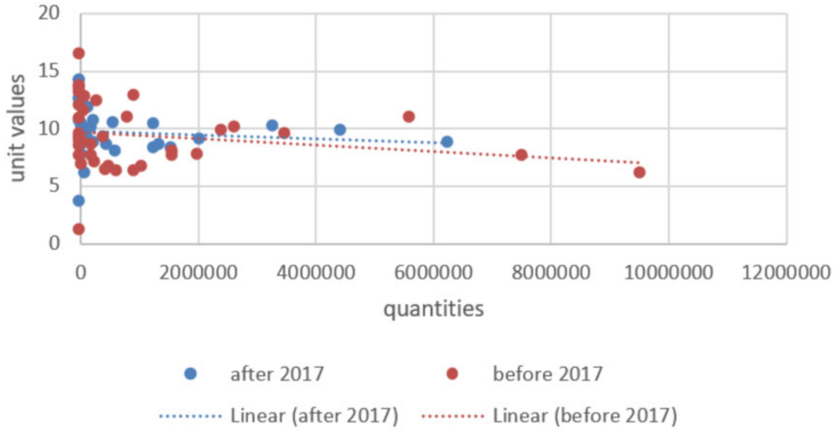

Figure 12. Quantities and prices of the quota for shrimps.

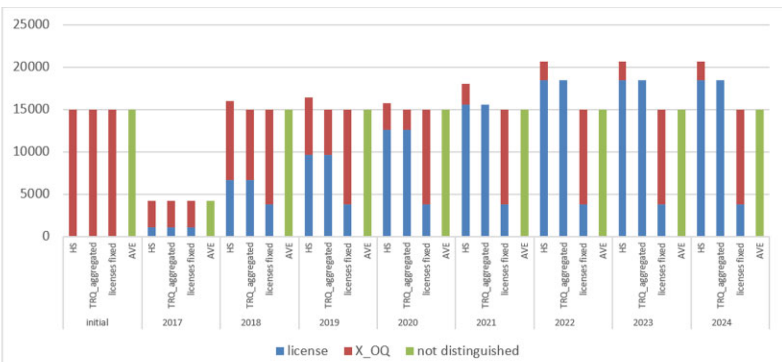

Figure 13. Comparison of the liberalization of cheese with different models considering TRQs.

to treat a quota as filled once it has reached a fill rate of 80 per cent. The fourth bar (labeled 'AVE') shows a very simple, yet very common consideration of TRQs: The trade quantities of some reference period are compared to the level of the quota premium, and if the quota is likely to be filled (based on MAcMap, we set the threshold to 80 per cent here), then an equivalent tariff is roughly estimated out of the level of the IQTR and the OQTR. With this kind of guess—which always yields the OQTR as an AVE since our cheese quota is likely to be filled—the liberalization of the TRQ vanished entirely. For all models, the exports inside the quota (labeled 'license') and the exports outside the quota (labeled 'X_OQ') are shown, independent of whether the model contains these variables or if they need to be calculated indirectly out of the variables LICENSESHARE and X2. For the AVE model, which does not contain a license allocation, all imports independent of their trade inside or outside the quota are depicted in the column labeled 'not distinguished'.

4.3 The projected trade quantities

How do our modeled imports compare to real trade data since the implementation of CETA? Figure 14 shows some sobering results: Our much more disaggregated model does not produce more reliable trade quantities than the simpler models.

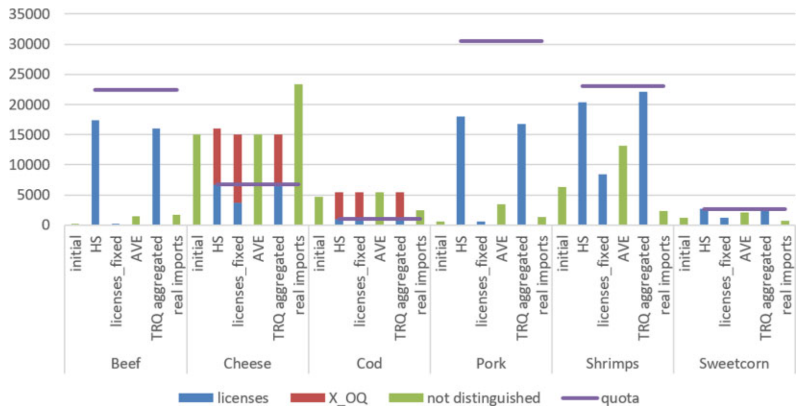

Figure 14. The results of different forms of modelling in comparison to real trade data for the year 2018.
Note: To use a comparison with real data that fully matches with the HS6 definition at which we calculated, we took the data for the real imported data out of the same BACI data source.

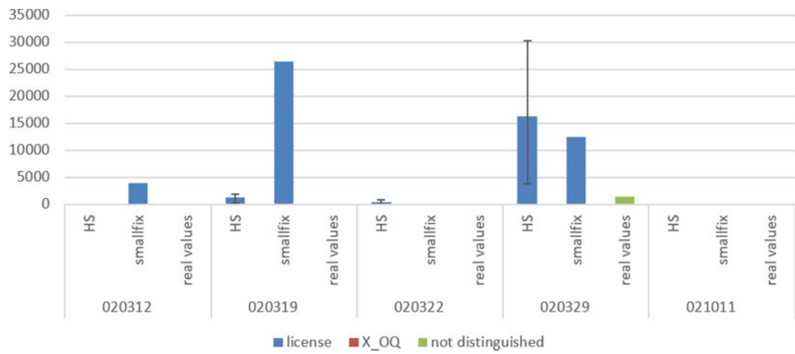

Figure 15. Sensitivity analysis on the Armington elasticities for the TRQs of pork.
Note: A run where zero values are under some circumstances replaced by reference values is labeled "smallfix" here.

This is not due to the small-shares-stay-small problem that we suspected during our first analysis of our data. On the contrary, small initial imports expand very slowly, and our model already tends to overestimate the trade potential in the short term.

Rather, our overestimations are likely to result from insufficient precision in our data. One insufficiency is our quantities and unit values at the HS six-digit level, which is still much more aggregated than the level at which TRQs are defined. The contradictive data situation was described in Section 3. *Data* contribute to the problem. The second insufficiency lies in the strong uncertainty in the estimators of the used Armington elasticities. Figure 15 shows large error bars, which can on their own explain a large extent of our overestimations. However, imprecise model parameters may not be the only reason for the discrepancy between modeled outcomes and reality: Despite their preferential access conditions, the above-mentioned databases of the EU and Canada show that quotas are often not even entirely used. This may generally be due to several reasons: incomplete information about the quota usage by the time that the data are reported, inefficiencies in the transfer of unused licenses, or even purposeful retention of licenses to archive some sort of market power (although CETA puts punitive mechanisms in place for not using one's quota licenses). It may also indicate that other trade barriers might still exist. Kerr and Hobbs (2015), for instance, expound the differing production requirements for Canadian meat producers, who commonly use hormones in their beef production and the growth promotant ractopamine in their pork production for their domestic consumers, but may not use these if they want to qualify for the European TRQs. Equally, an inefficient quota allocation could inhibit the full potential usage of the quota. This issue can also revolve around market decisions under uncertainty that accrues from quotas: Kerr and Hobbs (2015) explain how the decision for a hormone-free growth cycle has to be made before the acquisition of a quota license, which results in a considerable risk for beef producers. Several TRQs, such as the ones for sweetcorn, shrimps, and common wheat, however, also show projections that are close to the real trade data of imports.

5. Conclusion

TRQs are a popular instrument to grant market access while keeping the volumes of imports in check. With their common usage for sensitive commodities, properly capturing their effects is an important element of model-based policy assessment.

Indeed, modeling TRQs at the tariff line level yields some predictive and explanatory potential when it comes to a shift in the composition of commodities. Several authors have emphasized the effect on average import prices with theoretical reasoning as well as with empirical studies, yet common equilibrium models do not include the mechanisms behind this shift.

In terms of precise projections for the imported quantities, our model with a disaggregated representation of tariff lines and an endogenous license allocation was, however, not any more convincing than some alternative models that we set up in the style of pre-existing approaches for TRQ modeling. Using reference group values to prevent the small-shares-stay-small problem is not a useful approach here—apparently, the zero-trade values were not caused mainly by prohibitive tariffs but rather by other factors such as standards or low demand. Rather, non-tariff barriers to trade should be taken into consideration, and all results need to be gauged in the context of imprecise Armington elasticities. However, we can show that modeling the entire quota as a block or estimating a simple AVE to include TRQs in one's model does not appear as a necessarily inferior approach in dealing with TRQs.

Letting tariff lines interact at a more disaggregated level conveys a more complex understanding of the protectiveness that quotas generate. Quotas for which exports outside the quota exist are usually not considered binding. Yet, for some commodities, they can well be the binding element. As soon as the quota quantity increases, their suppliers may be able to expand their production, while the suppliers of cheaper commodities outside the quota do not proportionally decrease their exports. These and similar effects can result in rising exports, even if an already overfilled quota volume is increased. Additionally, quotas may be a way to guarantee a trade partner some sort of quantitative access, but they are not a form of liberalization that decreases the consumption prices for the common consumers.

Since trade-distorting effects of quantitative restrictions were already theoretically examined and empirically shown in the literature of the 1970s–1990s and since bilateral trade agreements of recent years very commonly include TRQs, we believe that a stronger inclusion in modeling studies is both worthwhile and necessary. Moreover, the literature of these redistributive effects is often focused on quotas that cannot be overfilled, while TRQs allow for exports outside the quota. Therefore, situations can come into place that were previously not examined—such as an overfilled quota that is liberalized over the quota quantity, prompting questions over the effectiveness of such liberalization. A disaggregated model with endogenous license administration can project and explain liberalizing effects here, were models based on AVEs or aggregated quotas are not able to do so.

We believe that the setup of our model is useful for a good inclusion of these effects. However, we are well aware that the underlying HS six-digit level apparently still leads to strong overestimations, which is exacerbated by contradictive data concerning the current quota fill rate and a high> sensitivity to Armington elasticities, which tend to have high standard deviations.

Data availability

The data that support the findings of this study are in the case of trade quantities (Gaulier and Zignago 2010), unit values (Berthou and Emlinger 2011), tariffs (MAcMaps 2019) and elasticities (Fontagné and Guimbard 2019) openly available in the CEPII databases on international trade at http://www.cepii.fr/CEPII/en/bdd_modele/bdd_modele.asp. The ratio between domestic and imported commodities for each sector and country was calculated from data from the GTAP 9 database in the respective MAGNET disaggregation, which is available to license-holders.

End Notes

1 In some systems of license administration, such as an auction of licenses, this quota rent is absorbed by the government. Note that with a license administration as used in CETA—a mix of a 'license on demand' system and a 'first come first serve' system'—the licenses are per se free of charge. However, since license holders are able to transfer their quota licenses and since the possible development of a secondary market for import licenses was explicitly addressed in the Meeting of the Committee of Agriculture European Commission (2018), we built our endogenous license administration on the development of such a market for licenses.

2 A supplier who exports some but not all of his exports in the license constitutes the rare case of a marginal exporter. Such a supplier is entirely indifferent between exporting inside or outside the quota, as he will not benefit from being able to import at a lower cost than outside the quota, and as the price of the license will consume his rent. This is the reason why the variable LICENSESHARE is so flexible in this case, serving to deplete any licenses that did not find a supplier with a higher willingness to pay.

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Annex 1: Quotas in CETA.
Table A1. Overview over TRQs in CETA.

Commodity (importing partner)	Order number[a]	Quotas and liberalization	Administration	HS07 codes at the six-digit level that we used
Shrimps (EU)	09.8404	TQShrimps: 23,000 tons. OQTR is reduced to 0 until 2024	First-come first-served	160520
Cod (EU)	09.8403	TQCod: 1,000 tons. OQTR is reduced to 0 until 2024	First-come first-served	030429
Common wheat (EU)	09.4124	TQCW: 100,000 tons. OQTR is reduced to 0 until 2024	License-on-demand	100190
Sweetcorn (EU)	09.8405	TQSC: increasing from 1,333 tons in 2017 to 8,000 tons in 2022. OQTR is reduced to 0 until 2024	First-come first-served	071040, 200580
Beef (EU)	TQB1: 09.4280 TQB2: 09.4281 TQB3: 09.8400	TQB1: fresh or chilled. From 5,140 tons carcass weight equivalent in 2017 to 30,840 tons in 2022, plus 4,160 tons CWE from Council Regulation (EC) 617/2009, 13 July 2009 TQB2: from 2,500 tons CWE in 2017 to 30,840 tons in 2022 TQB3: Bison. 3,000 tons	TQB1: license-on-demand TQB2: license-on-demand TQB3: first-come first-served	020110, 020120, 020130, 020220, 020230, 020610, 020629, 021020, 021099
Pork (EU)	09.4282	TQP: from 12,500 tons CWE in 2017 to 75,000 tons in 2022, plus 5,549 tons CWE from the WTO TRQ between Canada and the EU for pig meat	License-on-demand	020312, 020319, 020322, 020329, 021011
Cheese (Canada)		Cheese: from 1,667 tons in 2017 to 16,000 tons in 2022 Industrial cheese: from 2,83 tons in 2017 to 1,600 tons in 2022 A total of 800 tons from the WTO TRQ are reallocated to the EU	License-on-demand	040610, 040620, 040630, 040640, 040690

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