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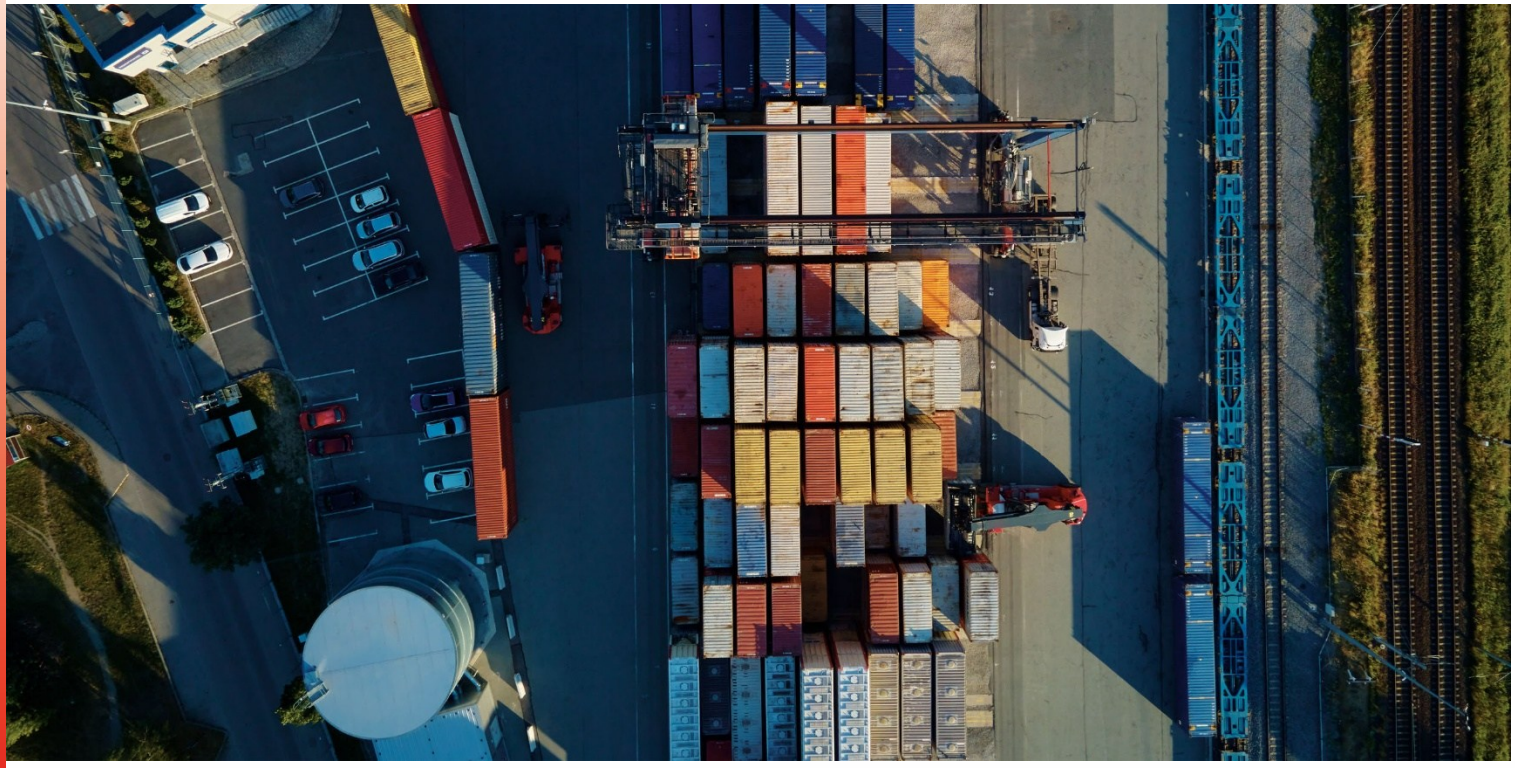

Tariff rate quotas for agricultural imports in Switzerland: A comparison of allocation methods

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Summary

Tariff rate quotas (TRQs) are a key trade policy instrument combining two tariff levels: a lower "in-quota" tariff for imports up to a specified volume, and a higher "out-of-quota" tariff for quantities beyond that limit. A critical question is who gets to import at the low in-quota tariff, which offers a profitable import opportunity. Major administration methods include auctions, historical allocation, and “first-come, first served” systems.

This report examines two questions: how different TRQ administration methods in Switzerland compare in theory and practice, and what happens when the administration method changes. The analysis combines a conceptual review of TRQ economics with two empirical case studies: one on high-quality beef and sirloin strips (TRQ no. 5.7) and another on table potato imports (TRQ no. 14.3). In 2015, the TRQ administration for beef shifted from a mostly auction-based system to more historical allocation. In contrast, new auctions were introduced for table potatoes in 2018, replacing some of the former historical allocation methods. Data from three years before and after the respective change were analyzed using comparative metrics such as quota fill rates, importer and country concentration, and price levels, as well as a Parity Bounds Model to assess market efficiency and rents.

The findings show that all TRQ administration methods aim to ration limited in-quota rights. Auctions are theoretically the most efficient because they capture willingness to pay, reduce distortions and generate government revenues, while historical allocation tends to favor incumbents. However, auctions involve also administrative costs and may not always outperform simpler “first-come, first-served” systems.

Empirical evidence from the beef and potato market indicates that the shift in the allocation methods did not significantly change market outcomes. Quotas remained binding and fully utilized, importer concentration and country concentration changed marginally, possibly due to external factors unrelated to TRQ administration. TRQs consistently create rents for quota holders. Auctions reduce these rents and transform them partly into government revenue, but do not eliminate them completely.

In conclusion, TRQs effectively protect domestic markets in a WTO-compliant way, regardless of the administration methods. While theory favors auctions, empirical evidence suggests limited impact of method changes on market outcomes.

Policy implications include the need for pragmatic solutions, fiscal arguments, administrative simplicity, and transparency. Auctions are an effective tool for preventing monopolies and collusion. They should be the preferred method for products with high import values because the fiscal benefit of bid revenues likely outweighs the administrative costs. For large quotas, quotas with low demand and/or low turnover, a first-come, first-served system could be a better alternative thanks to its simple administration. There are no strong arguments in favor of historical allocation. In fact, particularly for historic domestic purchasing, calculating the correct historical shares can be difficult, resulting in high administrative costs for the regulator. Furthermore, this system disadvantages new entrants, necessitating additional remedies, such as mixed systems or newcomer quotas.

Zusammenfassung

Zollkontingente sind ein wichtiges handelspolitisches Instrument, das zwei Zollniveaus kombiniert: den niedrigeren «Kontingentzollansatz» für Importe bis zu einer bestimmten Menge und den höheren «Ausserkontingentzollansatz» für Mengen, die diese Grenze überschreiten. Dabei ist die Frage zentral, wer zum niedrigen Kontingentzollansatz importieren darf, da dieser eine lukrative Einfuhrmöglichkeit darstellt. Zu den wichtigen Zuteilungsmethoden gehören Versteigerungen, die historische Zuteilung nach Marktanteil und das «Windhund»-Verfahren nach dem Prinzip «Wer zuerst kommt, mahlt zuerst».

Dieser Bericht behandelt zwei Fragen: den theoretischen und praktischen Vergleich verschiedener Verfahren zur Zuteilung von Zollkontingenten in der Schweiz sowie die Folgen eines Wechsels der Zuteilungsmethode. Die Analyse verbindet die konzeptionelle Betrachtung der ökonomischen Funktionsweise von Zollkontingenten mit zwei empirischen Fallstudien zu High-Quality-Beef und Nierstücken (Zollkontingent Nr. 5.7) sowie zu Einfuhren von Speisekartoffeln (Zollkontingent Nr. 14.3). Die Zuteilung von Zollkontingenten für Rindfleisch wechselte 2015 von einem vorwiegend auf Versteigerungen basierenden System hin zu einer stärker historischen Zuteilung. Dagegen wurden 2018 neue Versteigerungen für Speisekartoffeln eingeführt, z. T. anstelle der früheren historischen Zuteilungsmethoden nach Marktanteil. Die Daten aus den drei Jahren vor und nach der jeweiligen Änderung wurden anhand von Vergleichskennzahlen wie Kontingentausschöpfung, Importeurs-Konzentration und Länderkonzentration sowie Preisniveaus analysiert. Zudem wurden die Markteffizienz und die Renten anhand eines Parity-Bounds-Modells bewertet.

Die Ergebnisse zeigen, dass alle Methoden zur Zuteilung von Zollkontingenten darauf abzielen, die begrenzten Kontingenzzollansätze zu verteilen. Versteigerungen sind theoretisch am effizientesten, weil sie die Zahlungsbereitschaft abschöpfen, Verzerrungen verringern und Staatseinnahmen generieren, während die historische Zuteilung tendenziell etablierte Marktteilnehmende begünstigt. Allerdings verursachen Versteigerungen auch Verwaltungsaufwand und sind dem einfacheren Windhund-System nicht immer überlegen.

Empirische Daten zu Rindfleisch und Kartoffeln deuten darauf hin, dass eine Änderung der Zuteilungsmethoden die Marktentwicklung nicht wesentlich beeinflusst hat. Die Kontingente blieben bindend und wurden vollständig ausgeschöpft, die Konzentrationsgrade bei den Importeuren und den Herkunftsländern veränderten sich nur geringfügig – möglicherweise wegen von der Kontingentzuteilung unabhängiger externer Faktoren. Zollkontingente generieren stets Renten für die Kontingentsinhaber. Versteigerungen reduzieren diese Renten bzw. verwandeln sie teilweise in Staatseinnahmen, ohne sie jedoch komplett zu neutralisieren.

Abschliessend schützen Zollkontingente – unabhängig von der Zuteilungsmethode – die heimischen Märkte auf WTO-konforme Weise. In der Theorie spricht zwar vieles für Versteigerungen, aber laut den empirischen Analysen wirkt sich eine Änderung der Methoden nur begrenzt auf die Marktergebnisse aus.

Aus politischer Sicht sind u. a. pragmatische Lösungen, fiskalische Argumente, einfache Administration und Transparenz wichtig. Versteigerungen bilden ein wirksames Instrument zur Verhinderung von Monopolen und Absprachen. Bei Produkten mit hohen Importwerten sollten sie bevorzugt angewandt werden, weil der fiskalische Gewinn aus den Versteigerungserlösen wahrscheinlich höher ist als die Verwaltungskosten. Für grosse oder wenig nachgefragte und/oder umsatzschwache Kontingente ist das Windhund-System mit der einfachen Verwaltung womöglich die bessere Alternative. Für eine historische Zuteilung sprechen keine stichhaltigen Argumente. Gerade bei historischer Inlandsleistung ist die Berechnung der korrekten Marktanteile des Vorjahrs oft kompliziert und mit grossem Verwaltungsaufwand für die Regulierungsbehörde verbunden. Darüber hinaus benachteiligt das System neue Marktteilnehmende, sodass weitere Abhilfemassnahmen wie gemischte Systeme oder Kontingente für Neueinsteiger erforderlich sind.

Résumé

Les contingents tarifaires constituent un instrument clé de la politique commerciale qui combine deux niveaux de droits de douane: un droit «contingentaire», inférieur, applicable aux importations n'excédant pas un volume déterminé, et un droit «hors contingent», plus élevé, applicable aux quantités dépassant ce seuil. Une question cruciale est de savoir qui peut importer au droit préférentiel, car celui-ci offre un avantage économique. Les principales méthodes d'attribution comprennent les mises aux enchères, l'attribution selon les parts de marché historiques et l'attribution dans l'ordre d'arrivée des demandes selon le principe «premier arrivé, premier servi».

Le présent rapport traite de deux questions principales: d'une part, la comparaison, en théorie et en pratique, des différentes méthodes d'attribution des contingents tarifaires en Suisse; d'autre part, les conséquences d'un changement de méthode d'attribution. L'analyse associe un examen conceptuel du fonctionnement économique des contingents tarifaires à deux études de cas empiriques, la première portant sur le High-Quality-Beef et les alloyaux (contingent tarifaire n° 5.7), la seconde sur les importations de pommes de terre de consommation (contingent tarifaire n° 14.3). En 2015, l'attribution des contingents tarifaires pour le bœuf est passée d'un système principalement basé sur des enchères à une attribution davantage fondée sur les parts de marché historiques. À l'inverse, de nouvelles enchères ont été introduites en 2018 pour les pommes de terre de consommation, remplaçant une partie des anciennes procédures basées sur les parts de marché historiques. Les données des trois années précédant et suivant chaque changement ont été analysées à l'aide de paramètres comparatifs tels que le taux d'exploitation des contingents, la concentration des importateurs et des pays d'origine, et le niveau des prix. En outre, l'efficacité du marché et les rentes ont été évaluées à l'aide du modèle Parity Bounds.

Les résultats montrent que toutes les méthodes d'attribution des contingents tarifaires poursuivent le même objectif: répartir des droits limités dans le cadre du contingent. En théorie, les enchères sont les plus efficaces, car elles reflètent la disposition à payer, réduisent les distorsions du marché et génèrent des recettes publiques, tandis que l'attribution selon les parts de marché historiques tend à privilégier les opérateurs déjà établis. Cependant, les enchères entraînent également des coûts administratifs et ne sont pas toujours plus performantes que des mécanismes plus simples, tels que le principe du «premier arrivé, premier servi».

Les données empiriques relatives à la viande bovine et à la pomme de terre indiquent que le changement de méthode d'attribution n'a pas entraîné de modification significative dans l'évolution du marché. Les contingents sont restés contraignants et ont été pleinement utilisés; la concentration des importateurs et des pays d'origine n'a que très peu évolué, peut-être en raison de facteurs externes sans rapport avec l'attribution des contingents tarifaires. Ces derniers génèrent systématiquement des rentes pour leurs détenteurs. Les enchères permettent de réduire ces rentes et d'en transférer une partie sous forme de recettes publiques, sans toutefois les supprimer entièrement.

En conclusion, les contingents tarifaires, indépendamment de la méthode d'attribution, protègent efficacement les marchés intérieurs dans le respect des règles de l'OMC. Si la théorie privilégie les enchères, les données empiriques suggèrent que les changements de méthode ont un impact limité sur les résultats du marché.

D'un point de vue politique, il est important de privilégier des solutions pragmatiques avec des arguments budgétaires solides, une administration simple et une grande transparence. Les enchères constituent un outil efficace pour prévenir les monopoles et les ententes. Elles devraient être la méthode privilégiée pour les produits à forte valeur d'importation, car les recettes fiscales générées par les enchères sont probablement supérieures aux coûts administratifs qu'elles impliquent. Pour les contingents importants, caractérisés par une demande faible et/ou une rotation faible, un système selon le principe du «premier arrivé, premier servi» pourrait constituer une meilleure alternative en raison de sa simplicité administrative. Il n'existe pas d'arguments solides en faveur de l'attribution selon les parts de marché historiques. En effet, en particulier pour les prestations domestiques passées, le calcul des parts de marché corrects peut s'avérer complexe, entraînant des coûts administratifs élevés pour l'autorité de régulation. De plus, ce système désavantage les nouveaux entrants, ce qui nécessite des mesures correctives supplémentaires, telles que des systèmes hybrides ou des contingents réservés aux nouveaux acteurs du marché.

Riassunto

I contingenti doganali (CD) sono uno strumento chiave della politica commerciale che prevede due livelli di aliquota: una «nel contingente», più bassa, per le importazioni fino a un determinato volume e un'altra «fuori contingente», più elevata, per i quantitativi che superano tale soglia. È decisivo stabilire chi può beneficiare dell'aliquota ridotta, che offre un'opportunità d'importazione redditizia. I principali metodi di gestione includono le aste, l'assegnazione storica e i sistemi «primo arrivato, primo servito».

Il presente rapporto esamina due questioni: confronta, sul piano teorico e pratico, i diversi metodi di gestione dei CD in Svizzera e valuta che cosa succede quando il metodo di gestione cambia. L'analisi combina una revisione concettuale dell'economia dei CD con due casi di studio empirici: il primo sulla carne bovina di alta qualità e sui lombi (CD n. 5.7) e il secondo sulle patate da tavola importate (CD n. 14.3). Nel 2015, la gestione dei CD per la carne bovina è passata da un sistema basato prevalentemente sulle aste a un'assegnazione più storica. Al contrario, nel 2018 sono state introdotte nuove aste per le patate da tavola, che hanno sostituito alcuni dei precedenti metodi di assegnazione storica. I dati relativi ai tre anni precedenti e successivi al cambiamento sono stati analizzati sulla base di parametri comparativi, tra cui i tassi di riempimento dei contingenti, la concentrazione degli importatori e dei paesi nonché i livelli dei prezzi, oltre a un modello di parità dei confini per valutare l'efficienza del mercato e i rendimenti.

I risultati dimostrano che tutti i metodi di gestione dei CD mirano a razionare i diritti limitati «nel contingente». Le aste costituiscono teoricamente il metodo più efficiente perché riflettono la disponibilità a pagare, riducono le distorsioni e generano entrate pubbliche, mentre l'assegnazione storica tende a favorire gli operatori già presenti sul mercato. Le aste implicano però anche costi di gestione e potrebbero non essere sempre più efficienti dei sistemi più semplici del «primo arrivato, primo servito».

I dati empirici relativi al mercato della carne bovina e delle patate suggeriscono che il cambiamento dei metodi di assegnazione non ha modificato in modo significativo i risultati del mercato. I contingenti sono rimasti vincolanti e sono stati pienamente utilizzati, mentre la concentrazione degli importatori e dei paesi sono cambiate in misura marginale, forse a causa di fattori esterni non correlati alla gestione dei CD. I CD generano costantemente rendite per i titolari dei contingenti. Le aste riducono tali rendite e le trasformano in parte in entrate pubbliche, ma non le eliminano completamente.

Per concludere, i CD proteggono efficacemente i mercati interni nel rispetto delle norme dell'Organizzazione mondiale del commercio, indipendentemente dai metodi di gestione. Sebbene la teoria favorisca le aste, i dati empirici suggeriscono un impatto limitato dei cambiamenti di metodo sui risultati del mercato.

Le implicazioni politiche includono la necessità di soluzioni pragmatiche, motivazioni fiscali, semplicità di gestione e trasparenza. Le aste rappresentano uno strumento efficace per prevenire monopoli e collusione. Dovrebbero essere il metodo da prediligere per i prodotti con valori d'importazione elevati, poiché il vantaggio fiscale derivante dalle entrate delle offerte supera probabilmente i costi di gestione. Per i contingenti di grandi dimensioni, i contingenti con una domanda ridotta e/o un fatturato ridotto, un sistema del «primo arrivato, primo servito» potrebbe costituire un'alternativa migliore dato che è semplice da gestire. Non esistono argomenti solidi a favore dell'assegnazione storica. In effetti, soprattutto nel caso degli acquisti interni storici, il calcolo delle quote storiche corrette può risultare complesso e generare costi di gestione elevati per l'autorità di regolamentazione. Inoltre, questo sistema svantaggia i nuovi operatori, rendendo necessarie ulteriori misure correttive, come per esempio i sistemi misti o i contingenti per i nuovi operatori.

1 Introduction

Tariff Rate Quotas (TRQs) are a central instrument in agricultural trade policy, designed to combine two tariff levels: a lower “in-quota” tariff for imports up to a specified volume and a higher “out-of-quota” tariff for quantities exceeding that limit. This mechanism was introduced during the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) as part of a broader effort to replace non-tariff barriers such as import quotas with more transparent and market-oriented measures. Today, TRQs remain widely used for politically sensitive agricultural products in more than forty countries, including Switzerland (Beckman et al., 2017; WTO, 2025). In 2024, 20.9 percent of Swiss agricultural imports were subject to TRQs, compared to an average of 9.1 percent across World Trade Organization members, underscoring their importance in Swiss trade policy (WTO, ITC, UNCTAD, 2025).

The economic rationale behind TRQs lies in their ability to create controlled market access while maintaining a degree of price stability for domestic producers. However, TRQs also generate economic rents because the right to import at the lower tariff creates profitable arbitrage opportunities, especially in high-price countries such as Switzerland (Loi et al., 2016; Gray et al., 2017; Hillen, 2019; Loginova et al.,2021). These rents per unit can be substantial for products with large price gaps between domestic and international markets and products with relatively low in-quota tariff levels. How these rents are distributed depends on the method used to allocate quota shares. In Switzerland, Article 22 of the Federal Act on Agriculture (SR 910.1) names in particular six allocation methods, including auctions, historical allocation based on past imports or domestic purchases, and first-come-first-served systems. Each method reflects a trade-off between competing objectives: protecting the domestic agri-food sector, ensuring fair access for importers, minimizing market distortions, and maintaining administrative feasibility. While economic theory tends to favor market-based approaches such as auctions for their efficiency, practical considerations often lead to mixed systems that combine different methods to accommodate political, social, and logistical constraints. Earlier research by Jörin (2001, 2002, 2003) and Schluep-Campo (2004) provides more detail on the Swiss TRQ system and discusses how imperfect competition can change the market outcome.

This report addresses two complementary research questions. First, how do different TRQ administration methods compare in theory and practice? To answer this, we review the conceptual framework of TRQ administration developed by Skully (2001), analyze the economic implications of various allocation methods, and assess their advantages and disadvantages in terms of efficiency, equity, and administrative complexity. Second, what happens when the administration method changes for a given product? To explore this, we conduct an empirical case study on two Swiss import product groups that experienced changes in the TRQ administration method: high quality beef and sirloin strips (TRQ No 5.7) and table potatoes (TRQ no 14.3). In 2015, the TRQ administration for beef shifted from a mostly auction-based system to more historical allocation. For table potato imports, the allocation system shifted in 2018 from 100 percent historical allocation based on domestic purchasing to a mixed system combining auctions with historical allocation based on overall market share. Using detailed data from 2015 to 2020, we compare key indicators before and after the reform, including quota fill rates, importer and country concentration, price levels, and estimated rents. We complement this comparative analysis with a Parity Bounds Model (PBM) to evaluate market efficiency and the persistence of rents under different administrative regimes.

By integrating theoretical insights with empirical evidence, this report aims to provide a comprehensive understanding of TRQ administration in Switzerland. It highlights the extent to which allocation methods influence market outcomes and discusses whether changes in administration can achieve policy objectives such as greater efficiency, improved equity, and reduced distortions. Ultimately, the findings inform policy recommendations for the design of TRQ systems that are economically sound and involve reasonable administrative effort. In doing so, the report contributes to ongoing debates about the role of TRQs in agricultural trade policy and the challenges of reconciling domestic interests with international obligations.

2 Background

In this section, we present the conceptual basis for our analysis. While this is based on the seminal work by Skully (1999), it also reflects advancements in digital administration and information systems since 1999. These advancements have implications for information asymmetry, administrative costs and logistical concerns, although the basic functioning of TRQ administration methods remains unchanged. This provides structure to our work, informs our a priori expectations, and assists in interpreting our empirical findings. We then provide a brief theoretical overview of the various quota administration methods and discuss how they apply to the Swiss context.

2.1 Conceptual background: the economics of TRQs

In TRQ systems, during a given period, a reduced in-quota tariff (t) applies to the initial Q units of imports, while a higher over-quota tariff (T) applies to imports in excess of this quantity. Unlike quantitative restrictions, TRQs do not impose a limit on import volumes. Yet, if the over-quota tariff makes imports prohibitively expensive, the volume of imports will reflect that of a conventional quota (Chen et al., 2011). If the difference between domestic and international prices exceeds the over-quota tariff, the trade volume resulting from a tariff quota differs from that of a standard quota. Importers will continue to import even if they are charged the over-quota tariff, whereas a standard quota would not allow imports beyond the established limit. Consequently, a tariff quota is theoretically less restrictive than a conventional quota because of this nuanced difference (Gaisford & Kerr, 2001).

The effect of a TRQ on import incentives can be visualized by the effective supply curve (S) of exports to the importing market, which has two horizontal segments (Figure 1). We set the world market price to 1, so that the lower segment corresponds to in-quota imports, extending from zero to Q at a price of 1 + t. The upper segment indicates the effective supply of over-quota imports, extending from Q to infinity at a price of 1 + T. A vertical line connects these segments at the in-quota volume Q. The impact of a TRQ on trade depends on the excess demand for imports, which can be represented by four different excess demand scenarios, denoted as curves D1 to D4, indicating different levels of import demand.

In the first scenario, domestic excess demand is insufficient to facilitate imports even at the world price, resulting in an import quantity of M1 = 0. In the second scenario, there is sufficient excess demand to result in imports of M2, but the quota limit is not reached: M2 < Q. In this situation, as long as imports satisfy domestic demand below Q, the tariff quota functions similarly to an ordinary applied tariff at the in-quota rate t. The third scenario illustrates a binding TRQ. In the absence of the TRQ, an unlimited in-quota tariff would allow imports of Q3. It follows that with a zero tariff, imports would total F3 (where F is free trade), resulting in M3 = Q < T3 < F3. If imports under a binding TRQ are less than those achievable with an unbounded in-quota tariff, then M3 units of imports must be allocated to a demand for Q3 units. This allocation process, or rationing, is central to the administration of TRQs. In the fourth and final scenario, excess demand is high enough to sustain imports at the over-quota tariff (M4 > Q). Thus, the volume of imports is no longer limited to Q, and the domestic price rises to P = 1 + T. Nevertheless, the rationing challenge remains for imports within the quota, allowing the opportunity to import at a price of 1 + t while selling at the domestic price of 1 + T. The maximum rent R obtainable under a TRQ is then given by T - t = (1 + T) - (1 + t), which also requires rationing.

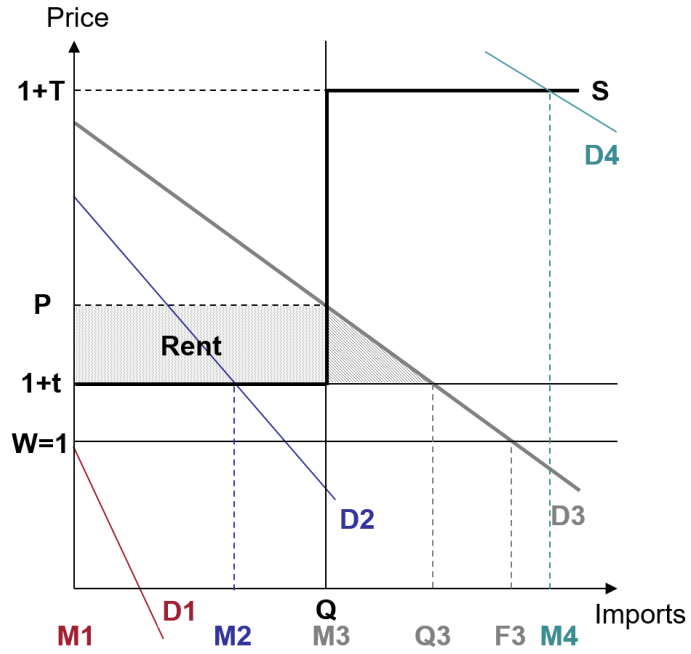

Figure 1: Four scenarios of excess demand conditions for TRQs. Source: Own representation, adapted from Skully (1999), p.14.

Prices are adjusted by markets to ration the available supply among demanders, following the fundamental economic principle of equilibrium prices that balance supply and demand. TRQs could be managed through price and market mechanisms. For example, to align imports with Q, the in-quota tariff could be raised to P-1. However, this approach has two major challenges: it requires accurate knowledge of domestic excess demand elasticity and other market dynamics to set an appropriate tariff, and it requires constant updating due to rapidly changing market conditions. The ability to import under a TRQ and sell in the domestic market provides a risk-free profit opportunity for each imported good, represented by the rent R = P - (1 + t), where raising the tariff to R + t effectively taxes away this rent, which would be a complex undertaking. Instead, a market or quasi-market could be established for the right to import within a quota, allowing potential importers to bid approximately R for the chance to earn a risk-free profit. This is what the various TRQ administration methods aim to do.

2.2 Legal background: The WTO and TRQ administration

The administration of TRQs is guided by Article XIII of the GATT, specifically entitled "Non-Discriminatory Administration of Quantitative Restrictions". This Article identifies two primary criteria for assessing the proper administration of tariff quotas: quota fill and distribution of trade (Desta, 2002).

Criterion 1: Quota fill rate

The concept of quota fill requires that imports equal to the in-quota amount should be permitted when market conditions permit. Therefore, administrators should refrain from imposing barriers to imports beyond the requirement to pay the in-quota tariff. There have been several WTO disputes, e.g., for China with TRQ fill rates systematically as low as 15% for certain commodities (Glauber and Lester, 2021). Quota fill is evaluated under a two-part test. The first question is whether the quota has been filled. If not, the second question is whether market conditions allowed imports. For example, if demand curve D3 reflects typical import demand but there is an unusually large domestic supply, the increase in domestic supply may reduce excess demand, leading to Scenario 1, where the domestic market-clearing price equals the world price, resulting in zero imports. In such cases, the unused quota is justified by the lack of domestic demand under prevailing market conditions. Conversely, a slight increase in domestic

demand to curve D2 would allow imports to meet excess demand and partially fill the quota – an example of legitimate under-utilization.

In practice, a simplified version of the second stage of this test assesses whether the domestic price is below the world price plus the in-quota tariff. If it is, this indicates that there is no excess demand for imports. Conversely, if the domestic price is above 1 + t and the quota remains unfilled, this prompts an investigation into the underlying causes, which may include legitimate transaction costs or the administrative methods used for the TRQ.

The WTO Secretariat has periodically published reports detailing the fill rates of notified TRQs, calculating average fill rates based on different administrative methods and commodity categories, such as dairy products and cereals. However, these reports refrain from drawing conclusions about the comparative advantages of different administrative approaches. The choice of administrative method for each commodity reflects a complex political economy. Fill rates thus reflect the criteria that influence the government's choice of administration, as well as the inherent characteristics of the chosen method and the market conditions during the observation period. Commodities that are considered politically sensitive[1] are more likely to be administered through methods with a predictable outcome, such as historical allocation. Conversely, imports that are less politically sensitive are generally managed through market or quasi-market methods[2] or, in the most liberal scenarios, by not imposing the over-quota tariff at all, referred to as the applied tariff method or the non-administered TRQ.

Criterion 2: Distribution of trade

According to GATT Article XIII, paragraph 2, contracting parties are encouraged to seek a distribution of trade that approximates that which would be expected in the absence of restrictions. This language suggests the establishment of a counterfactual scenario representing free trade or the equivalent of a single tariff. Thus, one should analyze the distribution of trade (importer market shares), which would be expected if a tariff was used to restrict imports to the quota level Q. The assessment of the administration method is then based on how closely the actual distribution of trade under the TRQ matches this counterfactual distribution.

In essence, a pie chart representing the market shares of importers under a nondiscriminatory TRQ should approximate the corresponding pie chart derived from a single tariff scenario in order to minimize trade distortions. The GATT principle of non-discrimination asserts that trade shares should be determined by the relative efficiency of suppliers rather than by alternative discriminatory criteria, ensuring distributive justice.

2.3 Welfare Implications of Rationing Methods

The welfare implications of various TRQ administration methods are illustrated in Figure 2. The international supply curve is again represented by S. Q is the quota volume, t the in-quota and T the over-quota tariff. We discuss here Scenario 3 of a binding quota, where import demand is high enough to fill the quota but insufficient to trigger the over-quota tariff. Under free trade, the quantity imported would be equal to F3, and the domestic price would equal the world price, P = W = 1. The resulting economic surplus from international exchange, represented by the area below the demand curve and above the supply curve, includes regions A, Rent, Tariff, B, C, and D. In the case of a simple tariff, unlimited imports are allowed at the in-quota tariff (t), resulting in a domestic market equilibrium with imports of Q3 and a domestic price of 1 + t. Demand is inframarginal[3] to P, and the domestic price is equal to W = 1. Inframarginal demand is satisfied at P = 1 + t, resulting in domestic consumer surplus, represented by areas A, Rent, and B, while the government collects tariff revenue, represented by areas Tariff and C. Triangle D illustrates the deadweight welfare loss due to the imposition of the tariff.

[1] «Sensitive products» refer to products with large differences between domestic and international price levels, which can generate large profits for the importing companies.
[2] *Market methods* use competitive dynamics to allocate resources efficiently, typically through pricing mechanisms. *Quasi-market methods*, on the other hand, incorporate market principles into regulated sectors, enabling competition among providers while ensuring oversight and public accountability. In the context of TRQ administration, this may involve allocating import quotas through competitive bidding or licensing processes, helping to balance efficient market access with regulatory objectives.
[3] Demand is considered inframarginal when there are buyers, whose willingness to pay exceeds the market clearing price P (Gale and Sabourian, 2005; see Section 3.2 for details).

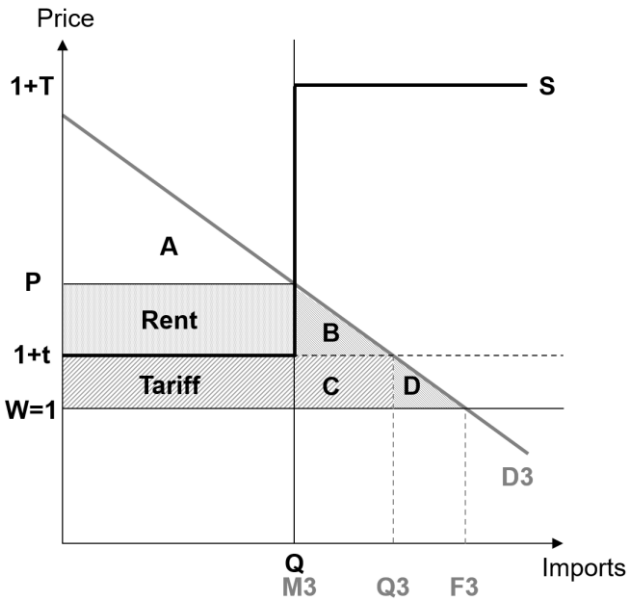

Figure 2: Welfare analysis of TRQ rationing. Source: Own representation, adapted from Skully (1999), p.14.

In the case of a binding quota, imports are limited to Q at the in-quota tariff, resulting in a domestic market price of P and a further decrease in welfare. Domestic consumer surplus is reduced to the area labeled A, and tariff revenue is reduced to the rectangle labeled "Tariff." The area labeled "Rent" represents the arbitrage profits from the ability to import units of Q at a cost of 1 + t, while the domestic market value is P. These tariff quota rents arise from the rationing of Q units of supply against Q3 units of demand. Although the rents are neither intrinsically beneficial nor harmful, they arise as a consequence of the rationing that bridges the gap between domestic and world prices. Since clear ownership of these rents is often lacking, they function as a common property resource, which needs to be allocated, and which potentially lead to wasteful rent-seeking behavior (Barichello, 2000). With imports limited to Q, the optimal attainable welfare is A + Rent. The illustration assumes that a market mechanism is used to ration the supply of Q against the demand for Q3 and assumes that the allocation of rents is done in the most efficient way. This is a strong assumption that, if not met, could lead to results far less favorable than those achieved through market allocation, such as auctions. An underutilization of the quota due to administrative barriers or intransparency can further decrease welfare (Muchopa, 2009).

3 Comparison of administration methods

We have shown that TRQ administration is essentially about rationing, which can be either efficient or inefficient. This section first explores, which administration methods are used for which products in Switzerland. We then evaluate the various methods of administering TRQs in terms of the GATT criteria of quota fill and trade distribution, examining their respective advantages and disadvantages. Finally, we address practical, administrative, and logistical issues relating to the different methods.

3.1 Switzerland's TRQ landscape

According to Article 22 of the Federal Act on Agriculture (910.1), there are currently six methods to allocate TRQs for imports into Switzerland, as listed in Table 1. The definitions commonly used in the Swiss administration differ slightly from the ones more commonly used in international contexts and the scientific literature (e.g. Skully, 1999). Table 1 therefore lists and matches them both.

Table 1. Overview of Quota Allocation methods, following the definition by the Swiss administration, and the international classification, as in Skully (1999).

	Swiss definition	Definition as in Skully (1999)
1	Auction	Auction
2	Quantity requested	License on demand
3	First come, first served (FCFS) at FOAG	FCFS
4	First come, first served (FCFS) at the border	FCFS
5	Domestic purchasing	Historical allocation
6	Applicant's imports to date	Historical allocation

In practice, for a given quota, also mixed procedures are applied. Although the two types of historical allocation — based on either domestic purchases or past imports — are treated as different methods in theory, they can be combined in practice to measure total market share (e.g. for apples). For certain products (e.g. egg products, TRQ no 10 and 11), the quota allocation is currently not regulated, i.e., all imports are allowed at the in-quota tariff, functioning like a simple applied tariff. Out-of-quota tariff could be re-applied in the future.

In total, there are 28 Swiss TRQs notified at the WTO. However, those 28 only refer to broad product groups. Some are further split into national sub-quotas that may be also subject to specific administration methods. Table 2 displays an overview of the WTO multilateral TRQs currently applied to Swiss imports by product groups and allocation method.

Table 2. Overview of Multilateral Swiss Tariff Rate Quotas and their actual allocation method.

TQ ID	Description of product	Description of import arrangement applicable
CHEQ01	Live horses, asses, mules and hinnies	First come, first served at the border
CHEQ002	Live bovine animals	Auction (two tranches: 70% and 30%)
CHEQ003	Live swines	First come, first served at FOAG
CHEQ004	Live sheep and goats	First come, first served at FOAG
CHEQ005	Animals for slaughter; meat mainly produced on the basis of coarse fodder	(a) Bovine & sheep meat: 50% domestic purchasing + 50% auction (b) Goat & horse meat: 40% domestic purchasing + 60% auction (c) Dried meat & meat preparation (beef): auction *(d) Pâtés, terrines, meat granules, flour, powder and the similar: not regulated*
CHEQ006	Animals for slaughter; meat mainly produced on the basis of concentrated fodder	(a) Auction *(b) Pâtés, terrines, meat granules, flour, powder and the similar: not regulated*
CHEQ007	Dairy products	(a) Auction (powders, butter) (b) First come, first served at FOAG (miscellaneous) (c) First come, first served at the border (“Fontal”) *(d) Not regulated (others)*
CHEQ008	Casein	*Not regulated*
CHEQ009	Birds' eggs, in shell	First come, first served at the border
CHEQ010	Egg products, dried	*Not regulated*
CHEQ011	Egg products, other than dried	*Not regulated*
CHEQ012	Bovine semen	*Not regulated*
CHEQ013	Cut flowers	*Not regulated*
CHEQ014	Potatoes, seed and table; potato products	(a) Domestic purchasing (seedlings, processing) (b) 50% auction and 50% market share (domestic purchasing + applicant’s imports to date; table potatoes) (c) First come, first served at the border (semi-finished potato products) (d) Auction (finished potato products)
CHEQ015	Vegetables	(a) Applicant’s imports to date and market share (a combination of domestic purchasing and applicant’s imports, applied by tomatoes, cucumbers, planting onions, witloof chicory) (b) Applicant’s imports to date (other regulated vegetables) (c) *Not regulated (other vegetables like artichoke, asparagus, etc.)* (d) Quantity requested (vegetables for processing)
CHEQ016	Vegetables, frozen	(a) 65% domestic purchasing (b) 35% applicant’s imports to date (c) Quantity requested (harvest failures, newcomer)
CHEQ017	Apples, pears and quinces, fresh	(a) Market share (a combination of domestic purchasing and applicant’s imports): apples (b) *Not regulated (quinces, nashis)* (c) Applicant’s imports to date (pears) (d) Quantity requested (for processing)
CHEQ018	Apricots, cherries, plums and sloes, fresh	(a) Applicant’s imports to date (b) Quantity requested (for processing) *(c) Not regulated (sour cherries, plums other than damsons like reineclaudes, mirabelles etc.)*
CHEQ019	Other fruit, fresh (berries)	Applicant’s imports to date berries include strawberries, blackberries, raspberries, currants (excl. black currants that are currently *not regulated*)
CHEQ020	Fruit for cider and distillation	First come, first served at the border
CHEQ021	Seed fruit products	First come, first served at the border
CHEQ022	Grape juice	*Not regulated*

TQ ID	Description of product	Description of import arrangement applicable
CHEQ023-CHEQ025	White wine and red wine imported within the limits of tariff quota Nos. 23-25	First come, first served at the border
CHEQ026	Durum wheat	*Not regulated*
CHEQ027	Bread grains	First come, first served at the border
CHEQ028	Coarse grains fit for human consumption (corn, oats, barley)	*Not regulated*

Source: WTO (2025, Table MA:2).
Note: CHEQ005 is further split into 6 sub-quotas.

This complex landscape of allocation methods is strongly linked to specific products. Less sensitive products are typically not regulated, whereas the most sensitive products are often based on historical methods or mixed methods (e.g. tomatoes, potatoes, many meat products). Another specific trait of the Swiss TRQ system is that for some products, the annual quota volume is autonomously increased. For bread grains, for example, autonomous quota openings occur when the domestic harvest is insufficient. Similarly, for seasonal TRQs for vegetables, the quota openings are negotiated on a weekly basis, depending on the current domestic supply and demand. Consequently, efficiency and rent distribution vary over time (Hillen, 2019). Such seasonal TRQs only apply during the domestic harvest and storage season of the respective crops. Outside of this season, when there is no domestic market to protect, unlimited imports are permitted at the lower in-quota tariff. The length of this non-administered period can be extended by FOAG each year, depending on the domestic supply situation. These seasonal TRQs apply to most fruits and vegetables produced in Switzerland during their respective seasons, such as apples, strawberries, tomatoes and cucumbers. Note that even for these seasonally and flexibly administered TRQs, a minimum annual import quota must be permitted at the low in-quota tariff, as notified to the WTO. The flexibility of the system relates to the timing and any quantities above this notified quota (Loginova et al., 2021).

All of the above refers to WTO-notified multilateral TRQs, which are valid for all trading partners. Additionally, Switzerland has bilateral TRQs with specific trade partners, which are negotiated and regulated in preferential trade agreements. The largest and most significant of these are with the European Union (EU) and were agreed upon in Bilateral Agreement I, which entered into force in 2002. Furthermore, bilateral TRQs were established with the United Kingdom after it left the EU. For the remaining trade partners, bilateral TRQs are limited to a few specific goods, such as olive oil (from Albania, Jordan, Tunisia and Lebanon), grapes (from Chile, Lebanon, Egypt, Turkey, Bosnia and Herzegovina and Montenegro) and, most recently, palm oil (from Indonesia). For a full list of bilateral TRQs, see Appendix A, Table A2.

After a brief introduction to the theoretical framework used in our analysis (Section 3.2), we explore the different allocation methods in detail (Sections 3.3–3.8).

3.2 Theoretical concept

As a theoretical concept for the following analysis of the different administration methods, we follow the framework of infra- and extramarginal buyers (Gale and Sabourian, 2005; Skully, 2001). A market achieves maximum surplus when all buyers and sellers to the left of the equilibrium point on the supply and demand curves can transact. These buyers, whose willingness to pay exceeds the market clearing price, are called inframarginal buyers. Conversely, extramarginal buyers, located on the demand curve to the right of equilibrium, are those whose willingness to pay falls below this price. Similarly, inframarginal suppliers are those willing to accept prices below the market clearing price, while extramarginal suppliers, located on the supply curve to the right of equilibrium, are willing to accept prices above it. To mitigate distortionary trade, it is essential to exclude extramarginal suppliers. In free markets and single tariff systems (applied tariff), this happens through price mechanisms. In TRQ systems, the potential for quota rents creates an incentive for extramarginal traders to enter the market. Market-based management methods, such as auctions, mitigate this incentive. In tendency, the greater the deviation of TRQ administration from market-based methods, the greater the likelihood of displacement and biased trade distribution.

3.3 Auction

Auctions can be a way to identify infra- and extramarginal suppliers. In TRQ systems, demand that is inframarginal to the world price (W) but extramarginal to the tariff-rate quota price (P_{TRQ}) will enter the market, as will supply that is inframarginal to P but extramarginal to W. In the absence of quota rents, only inframarginal traders would participate in the market, thereby maximizing welfare. Auctions serve to neutralize these quota rents. The ability to buy at W and sell at P - (1 + t) creates a rent (R) equal to P - (1 + t). Inframarginal traders are likely to bid R for this opportunity, while extramarginal firms will bid less than R, thereby achieving the necessary discrimination.

In a quota auction, consumers would bid at the margin with R = P - (1 + t) – representing the difference between the domestic price P (given imports of Q) and the world price plus the in-quota tariff. If all successful bids are charged the marginal winning bid in a uniform price auction, the auction revenue corresponds to the shaded rectangle denoting "Rent". Consumers have a willingness to pay at least P, and thus realize a consumer surplus, represented by area A. The domestic economy benefits from trade through auction revenue plus consumer surplus A. This allocation reflects the outcome that would result from the tariff equivalent of a tariff quota, denoted by t* = t + R.

Thus, in theory, auctioning is the most efficient allocation method, as it captures importers' willingness to pay and reduces welfare deadweight losses. It excludes extramarginal buyers and hence minimizes trade distortions. Even better, governments can generate additional revenue from the auctioning process, which can be used to support domestic agricultural programs. Another advantage is the transparency of the auction process, which provides information on the demand for quotas. In Switzerland, sealed bids are used, and information about individual bid amounts is not made public. However, the FOAG website publishes auction results, including average hammer prices, the lowest accepted bid, and the number of bidders at past auctions. It also publishes the dates of upcoming auctions (SR 916.01, Art. 16-20). This information contributes to price discovery and is available to all stakeholders and potential importers, decreasing the risk of underfill. Also, this type of first-price sealed-bid auction is considered a very competitive type of auction that can help prevent preventing monopolies and collusion (Hu et al., 2011).

In practice, however, auctions are not necessarily the ideal instrument for all products and markets. In particular, less than 5% of all TRQs reported to the WTO in 2021 used auctions, and the trend is declining (WTO, 2022). In Switzerland, too, the administration has introduced "FCFS (first come first serve) at the border" in recent years for several products previously regulated by auctions, e.g. fruit for cider and distillation (TRQ no. 20) and seed fruit products (TRQ no. 21), both in the year 2022. This is because auctions are considered complex and involve transaction costs that may outweigh the fiscal benefits. These transaction costs include the set-up and the execution of the auctions and increase with a greater number of auctions per year. Once executed, auctions result in payment flows. If auction winners do not pay, this leads to legal proceedings and costly dunning procedures. Moreover, there are concerns about market power, as larger firms may dominate the auction process, potentially leading to higher prices for smaller competitors. Finally, it can increase price volatility. Prices can fluctuate significantly based on bidding behavior, which can lead to uncertainty among participants.

Also, auctions only work in markets characterized by sufficient liquidity, which includes a substantial trading volume and multiple competing traders. As market liquidity decreases, the market's ability to discover prices also deteriorates, leading to inefficiencies. In addition, the number of active traders affects market efficiency, and an insufficient number of traders can hinder performance. Gervais and Surprenant (2003, 2000) argue that under such conditions of imperfect competition, historical allocation might be superior to auctions if social welfare is considered. Finally, a political dimension may contribute to the infrequent use of auctions. Auctions function as markets, which can be difficult to regulate. If the government agency overseeing the TRQ has strong preferences about which countries or companies receive quota rights, it may choose not to use auctions.

In Switzerland, auctions play an important role for sensitive products for which there is high demand for quota shares. These include live bovines, which are auctioned in two tranches of 70% and 30%; dairy products such as butter and milk powder; fully processed potato products; and certain meats (partial TRQs 5.1–5.6, 5.76, 6.1–6.3, 6.41 and 6.42; see SR 916.341, Art. 17). For any other meat, however, only part of the quota quantity is auctioned (currently 50–60%), with the remainder based on historical allocation. Technically, therefore, these products fall under the mixed-

methods allocation. Häfner (2023) analysed the Swiss auctioning system for beef imports in more detail. We discuss this study, its findings and its limitations in Appendix A.

3.4 Quantity Requested / License on Demand

"Quantity requested" allocation, also called "license-on-demand", typically operates in a structured manner. Prior to the start of the import period, potential importers are invited to apply for import licenses, specifying the quantity of imports they wish to undertake. Let the demand of the i^{th} applicant be denoted by q^{i*}, with the aggregate of all import applications represented by $Q^* = \sum q^{i*}$. In scenarios where domestic demand exceeds the quota limits, the quota becomes binding, so $Q^* > Q^{TRQ} = \lambda Q^*$. To ration the available licenses, the application quantities are proportionally reduced by a factor $\lambda < 1$. Thus, if an applicant applies for q^* units and the quota is binding, the applicant will be granted a license for λq^* units at the in-quota rate. This is the case for all applicants equally, regardless of the timely order of applications. To mitigate the minimum shipload problem, many jurisdictions also impose a minimum license threshold, resulting in an allocation rule of λq^* units, subject to a minimum of γ units.
This allocation method is barely used in Switzerland and is of little relevance. In fact, it is only applied to certain fruits and vegetables intended for processing (SR 916.121.10, art. 5). Here, the domestic processing industry notifies its import requirements. Fruit and vegetables intended for human consumption do not fall under this category. The common seasonal TRQs with administered and non-administered periods apply here. License on Demand should not be confused with First Come First Served at the FOAG, where quota shares are allocated based on the order of incoming applications. For the sake of completeness, we will still describe how it works below.

3.4.1 Implications of Quota Fill

The proportional reduction of license applications introduces some complexity into the import process. If a trading firm accurately reports its desired import volume while the quota is binding, it will receive less than it requested, creating an incentive for firms to overstate their license requests. Differences in overestimation among applicants will lead to a redistribution of shares, introducing uncertainty into planning. This can be offset by allowing shares to be transferred among importers for utilization, as it is the case in Switzerland (see Section 3.8, resale market for quota shares).

3.4.2 Trade Distribution

The potential for a distorted distribution of trade resulting from TRQ administration necessitates an examination of the supply-side dynamics within the rationing framework (see Figure 3). For simplicity, we assume a scenario in which the in-quota tariff is zero, the over-quota tariff is prohibitively high, and the domestic market clears at price P. The unit quota rent is defined as R = P - W. An upward sloping supply curve S is plotted, with supply induced at price P normalized to one. The area below the supply curve represents payments to the factors involved in producing the traded good. Suppliers extramarginal to W incur costs in excess of W per unit to mobilize labor, capital, and other resources for output that has a market value of only W. Thus, production by extramarginal suppliers does not add value; rather, it results in economic inefficiencies, illustrated by the shaded triangle representing extramarginal factor utilization.

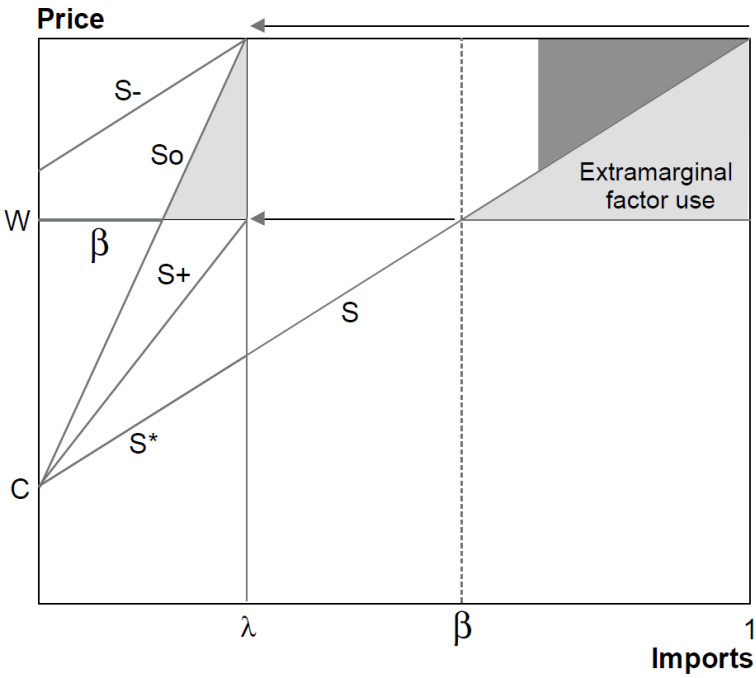

Figure 3. Supply side analysis of quasi-market methods. Source: Own representation based on Skully, 2001.

In theory, license-on-demand allocation can be understood as a lottery system. All inframarginal firms have an incentive to participate in this quota lottery. The aggregate of applications, as previously analyzed in the context of underfilling, exceeds the available quota: $Q^* = 1 > QTRQ = \lambda$. Each applicant receives a pro rata share of the total quota, equal to λq^* units. The effective supply curve associated with this equal allocation of quota rights becomes S0. The fraction of quota rights allocated to suppliers that are inframarginal to W is denoted by β. Under the above assumptions, license-on-demand allocation results in the displacement of $\lambda(1 - \beta)$ inframarginal suppliers by an equal number of extramarginal suppliers. This expected distribution of trade differs from the tariff-equivalent counterfactual distribution, which consists only of inframarginal suppliers. The welfare loss attributable to license-on-demand allocation is represented by the shaded triangle beneath S0. This theoretical welfare loss is primarily due to the displacement of inframarginal suppliers by extramarginal suppliers.

In Swiss practice, however, the right to participate is often restricted by several formal requirements. For breeding animals, for instance, the pedigree certificate must already be enclosed with the application. For the import of frozen vegetables, there are even stricter rules: Only processing companies who have contracts with domestic producers can apply. They must have crop losses officially confirmed. The industry association then conducts a survey to determine whether domestic vegetables are available for processing elsewhere. Only when this is not the case, the industry association submits an application to the FOAG for the release of a quota share for the applicant (IG-EA, 2025). The practical benefits of this approach include its inherent flexibility, allowing importers to apply for licenses in response to current market demand.

3.5 First-Come, First-Served Allocation

The first-come, first-served (FCFS) allocation mechanism allows goods to be imported at the in-quota rate of duty until the designated quota is fully utilized. In cases where domestic demand is sufficient to exhaust the quota, a single shipment, referred to as the nth shipment, will either fully or partially exceed the quota. All shipments after the nth will be charged at the over-quota rate. This allocation method is a mixture of market and random processes, also known as a quasi-market method. In practice, FCFS allocation can take place at the border upon arrival of the goods or at the administrative body, i.e. in the order that applications are received by the relevant government office. First, we discuss the general economic functioning, and then we discuss the practical differences between FCFS at the border and at the administrative body.

3.5.1 Implications of Quota Fill

Adopting the complainant's position on the n^{th} shipment can be costly. Importers are faced with critical decisions: if the shipment is indivisible, they must decide whether to divert the entire shipment to another destination or pay the over-quota duty on the excess volume. Conversely, if the shipment can be split, the out-of-quota portion can be rerouted or forfeited at the border, allowing only the in-quota portion to be imported. To ensure that importers know how much of the quota remains, the system relies on timely and accurate dissemination of quota usage data to customs agents. Switzerland, like many other countries, uses a unified electronic surveillance system that facilitates the identification and notification of the n^{th} importer prior to customs clearance. This allows importers to fully utilize the quota without the risk of being charged over-quota duties. In the absence of timely quota information, potential importers may refrain from shipment for fear of exceeding the quota, resulting in a potential underutilization of the quota even if domestic prices exceed the in-quota landed value.

3.5.2 Market Disruption Potential

A disadvantage of the FCFS allocation method is its potential to disrupt market stability. For example, suppose a TRQ is administered on an annual basis, with the quota year beginning on April 1 and ending on March 31 of the following year. The distribution of quota fill can then spike dramatically in April, as has been shown for the U.S. peanut TRQ (Skully, 1999). This pattern can lead to unnecessary, sudden declines in domestic prices and unjustified domestic storage costs.

3.5.3 Trade Distribution

To effectively analyze the FCFS allocation process, certain assumptions must be made about the position of suppliers in the FCFS queue. If lower cost suppliers consistently occupy positions ahead of higher cost suppliers, the effective quota supply curve will remain aligned with the original supply curve S within the interval (0, λ): S*. However, since all suppliers have access to international markets, W serves as a lower bound on the willingness to supply in the TRQ market among suppliers below this marginal cost. Assuming that each inframarginal supplier has an equal probability of supplying the TRQ market, a random selection from the pool of inframarginal suppliers results in an effective quota supply curve S^+. This selection process facilitates efficient discrimination between inframarginal and extramarginal suppliers, producing a trade distribution similar to that achieved by auction allocation.

In practice, however, achieving such efficient sorting of applicants outside of an auction framework is challenging. The two FCFS allocations, S* and S^+, assume a perfect correlation between lower cost and queue position – an assumption that, while strong, is not entirely implausible. In scenarios where there is zero correlation between cost and rank, license-on-demand allocation is effectively equivalent to the FCFS method. A random selection of β units from a population uniformly distributed over the interval (C, P) yields an expected distribution represented by the curve S^0. An FCFS process with positive but imperfect correlation will produce an expected allocation of quota rights among suppliers represented by a supply curve that lies between S^+ and S^0 over the interval (0, λ). Therefore, if an FCFS process results in a positive but imperfect correlation between cost and queue position, some degree of inframarginal displacement is expected. The lower the correlation, the greater the expected shift.

3.5.4 Implementation concerns

In Switzerland, FCFS allocation can take place at the border upon the physical arrival of goods, or at the administrative body (e.g. FOAG as the registration body), in which case it is based on the order of electronic applications prior to shipment. The differences between FCFS at the border and FCFS at the administrative body are more logistical and administrative than economic ones. These differences are summarized in Table 3.

A **FCFS allocation at the border** has the advantages that good can immediately be verified, physically controlled, and the quota is allocated in real time, following the actual arrival of the goods. Disadvantages include logistical

challenges relating to physical transport, limited flexibility in import timing, and higher storage and transport costs without a guaranteed import quota.

In Swiss practice, however, goods are often stored in customs-bonded warehouses in advance. These warehouses offset potential logistical issues and avoid over-quota tariffs (Hezarkhani et al., 2023). Importers are permitted to store shipments after their arrival until customs clearance, and if necessary, until the next quota opening. Clearly, this is only possible for storable goods, and hence a common practice for bread grains. However, such solutions are less necessary for products with a relatively short shelf life (e.g. eggs), as bulk imports are not an option, and importers will limit their shipments to expected demand over a given period.

With **FCFS allocation at the FOAG**, these physical issues are less relevant. Advantages include high flexibility in import timing, provided that registration is completed in advance. Guaranteed quotas minimize the risk and cost of import rejection at the border. While this procedure is theoretically administratively efficient, it can lead to new problems in practice. Highly demanded or very small quotas may be filled immediately upon opening, with allocation going to the applicants who submit their application the fastest. Therefore, there are specific rules for quota exhaustion. On the day the tariff quota is exhausted, the remaining quantity is allocated proportionately to applications received that day (SR 916.01, Art. 23). Consequently, it then functions like the Quantity Requested method described in Section 3.4. A disadvantage of FCFS at the administrative body is the risk of overbooking. Importers may secure quotas without having immediate import plans. In Switzerland, where in-quota imports are generally a profitable business opportunity, and quota transfers are possible, this is less of an issue, and it can be further reduced by multiple smaller quota openings throughout the year. There is also a certain risk of fraud, since the quota is allocated based on documentation. Verification of the physical goods can only take place later at the border. However, this risk is negligible with an efficient customs administration, such as in Switzerland, where customs declaration may be amended by the authorities, e.g. after a physical control.

Table 3. Comparing First-come, first-served at the border and at the office.

	At the border	**At the administrative body**
Pros	Administrative simplicity: Customs declaration = application for quota share. Immediate verification of quantity and quality of imports, reducing the chances of fraudulent claims Real-time allocation, based on the actual arrival of goods (might ensure a fairer distribution)	Flexibility through planning and registering imports in advance Reduced costs and risk, because only goods with guaranteed quotas are transported
Cons	Logistical challenges of physical transport, especially for perishable goods Higher cost for storage and transport without guaranteed quota Limited flexibility, e.g. for strategic import timing	Potential for overbooking: Risk of speculative claims by importers, intending to secure quotas without immediate import plans Monitoring challenges: Ensuring compliance may be challenging without the physical presence of goods Delayed verification until goods are eventually presented at the border

Source: own illustration, based on Barichello (2000), Hezarkani et al. (2023); Skully (1999), AEV SR 916.01 Art. 22-26.

In Switzerland, FCFS allocation is used for a wide range of import categories. At the border, it is used for importing live horses, eggs, semi-finished potato products, fruit for cider and distillation, pomace fruit products, wine, bread grains and for most of the preferential bilateral tariff quotas. At the FOAG, FCFS allocation is used for fewer products, including live pigs, sheep and goats, and a partial tariff quota for various dairy products (TRQ no. 07.3, e.g. yoghurt without flavorings or additives). However, FCFS may not be a suitable solution, especially for small quotas, neither at the border nor at the FOAG. Registration for the annual “yoghurt quota” of 200 tons (partial TRQ no. 07.3), for example, opens on the first working day in October and can be exhausted within a day. This is an exception, though, and FCFS is mostly used for sufficiently large quotas, such as wine and live animals. This section demonstrated that, although the theory of FCFS allocation is straightforward, its practical implementation is not. In Switzerland, too, the specific administrative rules have been repeatedly adjusted in light of past experience or changing market conditions.

3.6 Historical Allocation

Unlike FCFS and license-on-demand systems, which function as annual lotteries with new applicants being drawn each quota season, historical allocation represents a singular, one-time drawing. As a result, the historical allocation framework maintains a consistent base that is only occasionally revised, with a single realization that persists over long periods of time, often unaffected by fluctuating market dynamics. To alleviate this issue, historical allocation is often combined with a restriction-free period in Switzerland, during which all market participants can import unlimited quantities at a single tariff rate. This applies to seasonal fruits and vegetables, which are only protected by TRQs during the domestic season. The following year's historical allocation therefore also refers to this free period, integrating recent developments and leading to less rigidity.

Historical allocation can be based either on past imports, on domestic purchases or a combination of both (market share) during a past reference period. Past imports reflect the actual import behavior of firms, allowing those with established import records to maintain their market presence. It may also stabilize supply chains by allowing quota shareholders to continue their operations without disruption. However, new entrants may find it difficult to compete because they lack historical import records, potentially leading to market monopolization by established players. The system may not consider changes in domestic market structures, potentially stifling innovation and reducing overall market efficiency. This issue can be alleviated by defining annual quota shares for newcomers or by combining this method with other administration methods.

Past domestic purchases as an allocation criterion may encourage local sourcing by giving preference to firms that make domestic purchases, potentially supporting local producers. It may also better reflect current market conditions and purchasing patterns, allowing for a more responsive allocation of quotas. However, it may disadvantage import-dependent firms, and in extreme cases, quotas may not be used to benefit local producers, potentially leading to higher prices for consumers and less variety in the marketplace (Loginova et al., 2021). From an administrative perspective, tracking domestic purchases can be burdensome and may introduce inaccuracies into the allocation process. Also, multiple measures are possible for domestic purchases. For meat products, for example, domestic slaughtering, the domestic purchase of live animals or the domestic purchase of meat products are all possible measures at different stages of the value chain, which leads to different actors being entitled to quotas.

From a theoretical perspective, historical imports tend to lead to higher quota fill rates because established importers are more likely to use their allocated shares and maintain a steady level of imports. Conversely, allocations based on domestic purchases may result in lower fill rates if companies prioritize local sourcing or if there are supply constraints[4]. Yet, for Swiss imports, fill rates seem to depend more on the quota size in relation to domestic demand, and on the level difference between Swiss and global prices.

In Switzerland, historical allocation based on imports and domestic purchasing is used for fresh and frozen vegetables and apples. Most fresh vegetables, pears, stone fruit and berries, however, follow past import shares only. Furthermore, historical allocation is employed in mixed method approaches alongside auctions for products such as meat and table potatoes. For meat, the number of animals purchased and slaughtered domestically are both used as historical references.

3.7 Mixed Methods

By being aware of the specific features, potential and downsides of individual methods, governments can choose to apply a combination of these methods. For example, 50% of the quota volume could be distributed based on historical allocation and the remaining 50% could be auctioned. This may serve as a compromise to account for different stakeholder interests, especially for politically sensitive products. Further, the WTO principle of non-discriminatory

[4] For weekly releases of seasonal TRQs for fresh fruits and vegetables, low fill rates can be partially explained by short import periods of around five to seven days. If necessary, new import approvals can be issued after that period.

administration (Article XIII) requires access to quota shares for new market entrants, which necessitates combining historical allocation with other methods..

For beef and lamb (TRQ no. 5), for instance, the method mix has undergone several changes in recent decades. Until 2004, quotas were distributed based entirely on domestic meat purchases. Then, auctions were gradually introduced: 33% in 2005, 66% in 2006, and 90% from 2007 onwards. The remaining 10% continued to be distributed according to public market purchases. Following a 2013 decision by the Federal Parliament (AS 2013 3463 Agricultural Law, Art. 48 (2bis)), this reform was partially reversed in 2015 to give greater weight to domestic production (Loi et al., 2016). In 2017, the proportion of meat sold at auction was reduced to 50%, while the proportion based on domestic purchases remained at 10%. Since then, the remaining 40% have been distributed according to the number of animals slaughtered domestically.

Another example of the allocation of resources based on political decisions is the import of table potatoes. Until 2017, quota shares were distributed to packaging companies based on the quantities they in the previous year. This historical allocation proved problematic in multiple ways. Firstly, only packaging companies had access to the quota; secondly, the quantities of potatoes packaged in the reference year were difficult to monitor; and thirdly, potatoes sold openly without packaging were not considered. The FOAG therefore proposed auctioning the quota instead. Ultimately, a mixed distribution system was implemented in the beginning of 2018, whereby 50% of the quota was auctioned and the other 50% was distributed according to market share (AS 2016 4083).

As method mixes are unique combinations, it is not possible to make any general statements about their functioning, quota fill rates or distribution effects.

3.8 Resale Market for quota shares

Regardless which of the described methods are applied, it only determines who obtains a quota share, i.e. the *right* to import at the in-quota tariff. When quota shares are not transferable, importers must execute the trade to realize the associated rent, which links the distribution of rent to the distribution of trade (Boughner et al., 2000). Allowing transferability decouples these distributions. From the WTO perspective, the focus is on trade distribution, ignoring the redistribution of rent.

As Gardner (1983) noted, the transfer efficiency of commodity programs, including supplier quotas, is low. Direct cash transfers are usually more efficient than market manipulation in compensating rent claimants. This is true only in the absence of a resale market for quota rights. Resale can offset the deadweight loss caused by extramarginal suppliers displacing inframarginal suppliers. If transaction costs are negligible and agents act as rational profit maximizers, extramarginal quota holders will sell their rights to inframarginal suppliers disadvantaged by allocation mechanisms.

In a perfect market, these transactions take place at price R, the marginal auction bid. Extramarginal holders value their quota at R or less, while inframarginal suppliers value it at R or more. With resale, the rent distribution differs from the auction allocation only in that the revenue is collected by private traders instead of the government. Inframarginal suppliers retain their rights, while extramarginal holders sell them.

The effect on quota fill rates varies. In a liquid market, one would assume that those best positioned to execute imports would buy and use the quota shares. However, interest groups, such as domestic producer organizations, may also buy shares without using them in order to prevent actual imports and foreign competition.

Some countries allow the resale of quotas and quota rights, with governments often facilitating these markets. Resale mechanisms have been used and studied more extensively in contexts such as CO2 emissions reduction and fisheries management, demonstrating market-based solutions to resource allocation challenges (e.g., Homans and Wilen, 2005; Wu et al., 2023).

In Switzerland, quota rights can be traded, but only among importers entitled to obtain quota shares and holding a General Import Permit (GIP). The GIP is required to import many agricultural products and is not transferable. The

transfer of quota rights is governed by Art. 14 of SR 916.01, identifying two types of quota transfers. Percentages of quota shares must be transferred before the first quota release and reported to the FOAG. Quota shares in kilograms or units can only be transferred and reported to the FOAG once the release has been made (up to the day before import). An exception is made for several meat products, where the entire share can be transferred to an import organization immediately when the auction bid is submitted. This import organization then handles the imports on behalf of the many small quota holders.

Since quota resale is not a primary allocation method but rather in the hands of private market actors, these secondary markets are difficult to control and influence. These markets can only be analyzed in combination with the primary allocation method, which raises the question of why a second round of allocation is necessary in the given administrative system. In the case of meat, transferring to a professional import organization has logistical advantages and leverages economies of scale. Generally, transfers increase fill rates, enabling the passing on of shares that original quota holders cannot or do not want to fill themselves.

3.9 Synthesis

Having shown the variety of TRQ administration methods, we cannot conclude that one is superior to another in all respects. In Table 4, we compare them in different categories. In addition to the methods described above, we have also included applied tariffs (i.e. a single tariff system without an over-quota tariff) and mixed methods, as both are relevant in the Swiss TRQ landscape.

In terms of allocation type, auctions, resale markets and applied tariffs are clear market mechanisms, determined by demand, supply and prices. The remaining methods follow quasi-markets, which are a mixture of market and random processes, such as the order of application or last year's market shares.

When we compare the underlying concepts of equity, we see that fairness is understood and operationalized in different ways. Here, we adopt the categorization and definitions employed by Peyton (2020). All market-based methods adhere to the concept of parity, treating all potential applicants equally and placing them in the same starting position with identical exposure to market rules. In contrast, for FCFS, equity lies in prioritization. Those who presumably want and need the quota the most – i.e., those who apply first – are prioritized over those who make less effort to obtain quota shares. Historical allocation methods, however, follow the concept of proportionality. They acknowledge differences among potential importers and incorporate these into the allocation rules. These differences are measured in an objective way (e.g. last year's domestic, import or total market share) and the quota allocation is then based on this, with the aim of achieving a proportionally fair distribution.

Upon comparing the risks of under-filling the quota and of biased distributions, we agree with Skully's (1999, 2001) conclusion that the only way to eliminate these risks entirely is to implement single tariffs and abandon quota administration. Of the actual rationing methods, auctions and FCFS pose the lowest risk of under-filling the quota. For biased distributions, the risk is lowest with auctions and can be further reduced through secondary markets. Section 4 will empirically assess the quota-fill rates for different administration methods, examining their relationship with the theoretical expectations derived in Section 3.

Finally, as discussed in detail above, we acknowledge that all methods have their respective advantages and disadvantages. These may differ depending on the market and products, hence requiring a case-by-case analysis. This explains why Switzerland and many other countries that apply TRQs have a variety of methods in place rather than just one solution.

Table 4. Comparison of TRQ administration methods

Method	Allocation type	Equity concept	Risk of Under-fill	Risk of Biased Distribution	Explanation	Advantages	Disadvantages
First come, first served at FOAG	Quasi-market (FCFS)	Priority	Low	Moderate	First Q units applied for at the FOAG are charged the in-quota tariff t, subsequent imports the over-quota tariff T.	Simple Quick allocation	Potential for market disruption Biased outcomes
First come, first served at the border	Quasi-market (FCFS)	Priority	Low	Moderate	First Q units arriving at the border are charged the in-quota tariff t, subsequent imports the over-quota tariff T.		
Domestic purchasing	Quasi-market (Historical)	Proportionality	Moderate	Very high	Quota rights are allocated in proportion to domestic market shares in a base period.	Stability Predictable framework	Static Entry barriers Transaction costs (??) See comment from Emanuel
Applicant's imports to date	Quasi-market (Historical)	Proportionality	Moderate	Very high	Quota rights are allocated in proportion to import market shares in a base period.		
Quantity requested	Quasi-market (License on demand)	Proportionality	Moderate	Moderate	The requested import quantity is reduced proportionally among all applicants to meet Q.	Administrative simplicity Flexibility	Uncertainty for importers Potential hoarding
Auction	Market allocation	Parity	Low	Least	Quota shares are auctioned to highest bidders.	Neutralizes quota rents Allocative efficiency	Requires market liquidity Complex administration
Resale market	Market allocation	Parity	Variable	Decreasing	Ex-post the official quota allocation, players can trade quota shares.	Decouples rent from trade Enhances efficiency	Requires market liquidity Transaction costs
Applied tariff	Market allocation	Parity	None	None	Unlimited imports allowed at the in-quota tariff rate; i.e. the quota is not administered.	No distortions	No rationing possible
Mixed	depends	depends	depends	depends	A combination of methods above.	depends	depends

4 Case Study: Swiss Beef and Table Potato Imports

Complementing the theoretical considerations above, we now add empirical evidence. We utilize comprehensive TRQ data, provided by the Federal Office for Agriculture (FOAG) and the Swiss Federal Office for Customs and Border Security (FOCBS). Our focus is on multilateral TRQs, as notified to the WTO (2025).[5] As a case study, we analyze two products, which have experienced a change in their administration methods during this period, specifically high-quality beef and sirloin strips (part of TRQ no. 5.7)[6] and table potatoes (TRQ no. 14.3). In 2015, the TRQ administration for beef shifted from a mostly auction-based system to more historical allocation. For table potatoes, in contrast, the TRQ administration shifted in 2018 from 100% historical allocation to a mixed allocation system, combining newly introduced auctions with historical allocation (see Table 5). We compare key parameters before and after the administration changes, including a) quota fill rate, b) importer concentration, c) country composition, and d) price levels. These parameters can serve as indicators for the respective market structure and the degree of competition. A before-after comparison may provide first insights on how the administration method correlates with such market outcomes.

In addition, we employ a Parity Bounds Model (PBM), initially introduced by Spiller and Huang (1986) and further developed by Baulch (1997), Park et al. (2002), and Barrett and Li (2002). This model enables us to assess the efficiency and welfare effects (importer rents) at various points in time, thus allowing for a comparison of the same import market under the old and the new administration methods. Measuring and comparing rents helps us to identify potential inefficiencies and welfare losses under different administration methods. Note that the PBM does not allow to quantify administrative costs on the regulator's side. Rather, it estimates the trade costs for importers, including constant transport costs, the applicable tariff rates and auction bid prices, where applicable. It then sets these costs relation to the revenue achieved through the foreign-domestic price gaps and calculates whether importers do capture rents under a given TRQ administration system.

4.1 Data

We combine data on trade flows, prices, and trade costs for a six-year period around the administration change. This covers the years 2012-2017 for beef imports, and 2015-2020 for potato imports.

4.1.1 Product scope

Before 2015, Quota 05 for bovine and sheep meat was mostly distributed through auctions (90%). The remaining 10% were historically allocated based on the previous year's purchases on public domestic markets. In 2015, the percentage distributed through auctions was reduced to 50%. 40% are since then distributed according to the number of animals slaughtered domestically. The remaining 10% continue to be allocated based on the number of animals purchased on domestic markets. Because the quota for bovine and sheep meat is so large and diverse, our analysis focuses only on the sub-quota for high-quality beef, including sirloin strips, regulated under sub-quotas no. 5.711 and no. 5.712 (SV 916.341, Art. 25a).[7] For this product group, the number of auctions per year remained unchanged, with 13 auctions per year. These products are grouped under four different tariff lines, depending on whether the product is frozen or not, and whether it comes with or without bones. Specific statistical keys further identify the cut (i.e. high-quality beef or sirloin strip) and specify whether a production involved growth-promoting hormones (see Table 5).

For table potatoes (TRQ no. 14.3[8]), the change went in the opposite direction. Until 2017, 100% of the quota was distributed to packaging companies based on historical allocation, which only considered the quantity of domestic potatoes packaged by these companies. This method was difficult to monitor and ignored the quantity of potatoes

[5] Additional bilateral TRQs with several trade partners, including the European Union, exist, but are not part of this analysis (see Appendix Table A2). In the following, we therefore refer to the Swiss multilateral TRQs and their numbers, as defined nationally.
6 Note that there were changes in the administration method for beef products in the years before the study period. Yet, we limit our analysis to the changes in the year 2015 and the time span around it.
7 These are sub-quotas of the TRQ no.5 for red meat, notified with 22'500t to the WTO in the study period. For high quality beef and sirloin strips, there is no fixed notified quota. Annual quota releases vary around 5'000t and 6'000t per year.
8 Potato imports in Switzerland are regulated under the TRQ 14, which is further divided into subquotas depending on the product type. We focus only on table potatoes for human consumption (TRQ 14.3), as opposed to seed potatoes (14.1), potatoes for processing (14.2) and potato products such as chips and French fries (14.4).

sold without packaging. It also limited quota access to packaging companies only. To alleviate these issues, in 2018, one annual auction was introduced for 50% of the regular quota (3'250 tons net[9]). The other 50% (also 3'250 tons net) follow historical market share allocation, which is now a combination of domestic purchases and imports. The FOAG may temporarily increase the quota in the event of insufficient supply to the domestic market after consulting the interested parties. Such temporary quota increases are fully allocated according to historical market shares (see AS 2016 4083, Art. 40). When this is the case, e.g. because of a poor domestic harvest, the auction share may be below 50% for a given calendar year. Yet, under the new system, more entities can obtain quota shares through imports in the previous year, domestic purchases, or participation in the auction.

Table 5. Swiss import products with changes in the quota administration method

Product (Quota)	Tariff Numbers selected	Old method	New method	Year of change
Bovine meat (05.71)	High-quality beef and sirloin strips (under sub-quotas Nr. 5.711/5.712): Fresh, with bones: 0201.2091(-016/-018/-019/-916/-918/-919) Fresh, boneless: 0201.3091(-015/-016/-018/-019) Frozen, with bones: 0202.2091(-018/-019), Frozen, boneless: 0202.3091 (-016/-018/-019)	Mixed: 90% Auction 10% Domestic purchasing	Mixed: 50% Auction 10% Domestic purchasing 40% Domestic slaughtering	2015
Table potatoes (14.3)	0701.9010 (-912/-914)	100% Historical allocation (based on domestic purchasing)	Mixed: 50% Historical allocation based on overall market share (domestic purchasing and imports in the previous year) 50% auctions[10]	2018

Notes: Statistical keys 018/918 refer to “high-quality beef produced with growth-promoting hormones”, keys 019/919 refers to “other high-quality beef”, keys 015/915 refer to “sirloin strips produced with growth-promoting hormones”, 016/916 refers to “other sirloin strips meat”. We exclude all other keys of the respective tariff lines, for which imports are regulated under different sub-quotas, in particular 911 (Halal), 912 (Koscher), 926 (Pistolas) and 999 (others). For table potatoes, the key changed in 2018 from 912 to 914 (key 913 = for processing, excluded). Regular annual quota volume = 6500t for table potatoes, and varying for selected high-quality beef and sirloin strip subquota.

4.1.2 Trade and price data

We use transaction-based import data provided by the Swiss customs authorities for the case of potatoes and data provided by the FOAG for beef. This allows us to extract import volumes by tariff line and statistical key, identifying the respective product, the applicable (sub-)quota, and whether the in- or over-quota tariff applied. It further discloses the importing company, the country of origin, as well as the weight and the value of the import, allowing to calculate the import unit value in CHF/kg. This gives us an indication of the imported goods’ price level and potentially their quality.

Further, we use a foreign and a domestic reference price for each product to approximate the overall price level in the respective country.[11] For high-quality beef and sirloin strips, as a foreign reference price, we use the US price for sirloin steak (USDA Choice, Boneless, in U.S. City Average, APU0000703613, as provided by U.S. Bureau of Labor Statistics.[12] From 2012-2017, this US reference price is on average 17.81 CHF/kg – and therewith even below the out-of-quota tariff for certain tariff numbers (e.g. 20.57 CHF/kg frozen, boneless high-quality beef 0202.3091/018 and 019). As a Swiss reference price, we use the wholesale price of beef tenderloin steak, as published monthly by FOAG (“Rindsfiletsteak, Grosshandelspreise, in CHF/kg”), averaging at 70.84 CHF/kg over the observation period.

9 The quota share is allocated in kg net potato equivalents, but the customs duties are calculated on the basis of the gross weight of the goods.
10 Temporary increases in the tariff quota: 100% historical allocation based on market share
11 The import unit values reflect the quality of the specific imports (Hallak, 2006), and may hence differ in level and dynamics from the reference price in Switzerland and the trade partner.
12 https://fred.stlouisfed.org/series/APU0000703613. To transform the price series from USD/pound to CHF/kg, we apply the monthly exchange rate provided by Worldbank (average closing price), and divide the price by 0.4536 to get the kg-equivalent. We chose this reference price to be in line with the study by Häfner (2023).

For table potatoes, we use the average production price of the three main countries of origin Egypt, Israel and France, each with equal shares of one third (avg. 0.40 CHF/kg) as a foreign reference price. For Switzerland, we used retail prices for non-organic, new potatoes ("Frühkartoffeln"), as provided by FOAG[13], with a mean value of 2.92 CHF/kg over the study period.

Of course, there is a level difference between the foreign reference price and the domestic retail price, covering the supply chain steps between production and retail prices, as well as quality differences between the similar, but different reference products. We assume this level difference to be constant over time and incorporate it into the PBM specification. For the PBM estimation, we aggregate all price data on a quarterly level.

4.2 Methodology

We first do a comparative analysis of key parameters before and after the respective administration change. To do so, we compare two three-year periods before and after the administration change. For beef with the administration shift in the beginning of 2015, the before-period covers the calendar years 2012 to 2014, the after-period 2015-2017. For potatoes with the method change in the beginning of 2018, the periods cover 2015-2017 (before) and 2018-2020 (after). In particular, we compare

1) Fill rates
2) Importer concentration
3) Country concentration
4) Average import unit values
5) Trade volume

To measure importer concentration, we compute the Herfindahl-Hirschman Index (HHI) for the in-quota importers. The HHI is calculated by summing the squares of the market shares of all participating importers. For a given product, the formula is expressed as follows:

$$HHI = \sum_{i=1}^{N} (MS_i)^2 \quad (1)$$

Where MS_i is the quota share of importer i, and N is the total number of firms with access to quota shares. The HHI can range between 0 and 1, with values close to 0 indicating perfect competition among a large number of players, and 1 indicating a perfect monopoly. A market with an HHI between 0.15 and 0.25 is considered moderately concentrated (US Department of Justice, 2010). HHIs below 0.15 indicate competitive markets, while HHIs above 0.25 indicate highly concentrated markets.

For country concentration, however, we use the CR2 and CR4 measure, indicating how much of the in-quota imports come from the Top-2 and Top-4 countries of origin (Dalton and Penn, 1976). For instance, a CR2 of 0.6 would indicate that 60% of all imports come from two countries. Average import unit values indicate the volume-weighted average price of the imported good at the border in CHF/kg. This can also be seen as a proxy for quality (Hallak, 2006). Finally, trade volume is the average in-quota import amount in tons per year.

4.2.1 Parity Bound Model

The PBM, conceptualized by Spiller and Huang (1986) and developed further by Baulch (1997), Park et al. (2002), and Barrett and Li (2002), evaluates market efficiency and rent dynamics. We apply this model to both beef (high-quality beef and sirloin strips) and table potato imports, aggregating the data from the respective six-year observation period (same as above) on a quarterly level. As above, we account for the fact that there are mixed administrative systems in place and include both auctioned and historically allocated quotas in the respective empirical shares. For each point in time – before and after the administration change – the model then defines three possible market regimes based on spatial price differentials between the foreign and the domestic reference price of the respective product:

1. Rents R=0: Market efficiency with no rents
2. Rents R<0: Lack of profitable arbitrage opportunities, indicating a price differential smaller than trade costs

[13] Prices taken from agrarmarktdaten.ch, marktzahlen-kartoffeln.xlsx, Table 3a, Source: Grossopanel AG, Stans.

3. Rents R>0: Unexploited spatial arbitrage opportunities, resulting in positive rents and market inefficiency.

Additionally, we observe whether there are trade flows or no trade flows at each point in time. In total this leads to six possible regimes, each with a probability λ_j (see Table 6).

Table 6. Six possible regimes in the Parity Bounds Model.

	$R_t = 0$	$R_t > 0$	$R_t < 0$
Trade	λ_1 (perfect integration)	λ_3 (imperfect integration)	λ_5 (imperfect integration)
No Trade	λ_2 (segmented equilibrium)	λ_4 (segmented disequilibrium)	λ_6 (segmented equilibrium)

Source: own representation, adapted from Barrett and Li (2002).

When trade occurs, markets are physically integrated. If there are no trade flows, markets are segmented, regardless of efficiency. Regime 1 represents perfect integration with zero rents. Regimes 3 and 5 describe imperfectly integrated markets with positive or negative rents. Regimes 2 and 6 represent segmented equilibrium with zero or negative rents, respectively. In regime 4, markets are in segmented disequilibrium with unexploited positive rents.

Our quarterly aggregated data on trade flows, trade costs, and prices then facilitates a detailed analysis of market integration and efficiency. By comparing average and marginal rents, the study evaluates the market outcomes for both active participants and potential entrants.14 The PBM identifies periods of market integration and segmentation by estimating regime probabilities. The model's error term addresses constant measurement errors and temporary discrepancies like exchange rate fluctuations. A detailed description of the PBM, including all formulas, is found in Appendix B.

4.3 Results

4.3.1 Comparative results

For **high-quality beef (including sirloin strips)**, the shift from an auction-dominated method to a balanced auction and domestic purchasing method in 2015 did not alter the fill rate, which remained at 100% (Table 7). This is no surprise, given the significant difference in price between domestic and international levels (e.g. the US), which makes in-quota imports highly profitable regardless of the administration method. The already very high importer concentration has further increased, from HHI = 0.58 before to HHI = 0.66 after the administrative change. However, in order to understand the structure and concentration of the Swiss meat market, it is not only important to consider the number of importers, but also the role of two key players. Firstly, there is Proviande, the sector association that unites producers, traders, processors and retailers. Although they are influential in the domestic market and include importers and exporters among their members, they are not directly involved in international trade. Then there is a large private company, which specializes in meat imports. They are currently a vertically integrated company, combining overseas purchasing, imports, logistics services and processing. Their import share was 75.1% prior to the administrative change and 80.4% thereafter (see Table 8, “Importer 1”). Therefore, with more historical allocation, this company could further strengthen its almost monopolistic role. The other importers are also private companies, of which the largest one hast lost some market share (from 11.1% to 6.5%). The composition of the remaining importers, all with market shares below 5%, seems very stable. No major importer has entered or exited the market.

[14] Note that average rents reflect the situation of active importers who obtained quota shares through historical allocation or auctions, as was prevalent in the respective quarter. Marginal rents capture the situation of the last importer to enter the market in a given quarter. In the case of a filled and binding quota, this is typically an importer who pays the over-quota tariff.

Table 7. Key market figures for high-quality beef / sirloin strips in-quota imports.

High Quality Beef / Sirloin	2012-14 (90% Auctions 10% Historic domestic purchasing)	2015-17 (50% Auctions 40% Historic slaughtering 10% Historic domestic purchasing)	Change (+/-/o)**
Fill rate (avg.)	100%	100%	o
Regular quota volume (t/year)*	varying	varying	o
Avg. trade volume (t/year)	4'950 t	5'525 t	+
Importer concentration (HHI)	0.58 (high)	0.66 (high)	+
Country concentration (CR4)	77%	69%	-
Country concentration (CR2)	50%	45%	-
Avg. IUV (CHF/kg)	18.97	18.78	o

Source: Swiss Federal Office for Customs and Border Security, tariff nr. in-quota: 0201.2091(-016/-018/-019/-916/-918/-919), 0201.3091(-015-/-016/018/-019), 0202.2091(-018/-019), 0202.3091 (-016/-018/-019), over-quota: 0201.2099(-013/-014/-913/-914), 0201.3099(-013/-014/-913/-914), 0202.2099(-913/-914), 0202.3099(-013/-014/-913/-914). Statistical keys (last 3 digits) ending in 13, 15, 16 indicate sirloin strips. Keys ending in 14, 18, 19 indicate high-quality beef.

* Sub quotas of the "red meat" TRQ no.5, without individual sub quota notification to the WTO.

**Change is considered pos. or neg., if significant on a 5%-level based on Wilcoxon rank sum test. Old administration method spans from 2015 - 2017, new administration method from 2018-2020. IUV = Import unit value. HHI= Herfindahl-Hirschman-Index, CR4/2= Market share of Top 4/Top 2 countries

Table 8. List of top importing companies for high-quality beef / sirloin strips.

Before (2012-2014)			After (2015-2017)		
Importer	Total imports (t)	(%)	Importer	Total imports (t)	(%)
Importer 1	11'756	75.1%	Importer 1	14061	80.4%
Importer 2	1'743	11.1%	Importer 2	1140	6.5%
Importer 3	538	3.4%	Importer 3	719	4.1%
Importer 4	496	3.2%	Importer 5	703	4.0%
Importer 5	305	1.9%	Importer 4	229	1.3%
Importer 6	243	1.5%	Importer 6	157	0.9%
Importer 7	182	1.2%	Importer 8	140	0.8%
Importer 8	123	0.8%	Importer 10	60	0.3%
Importer 9	76	0.5%	New Importer	51	0.3%
Importer 10	57	0.4%	Importer 9	49	0.3%
others (16)	144	0.9%	Others (21)	188	1.1%
Number of importers: 26			Number of importers: 31		
HHI	0.579			0.654	

Source: Swiss Federal Office for Customs and Border Security, HHI = Herfindahl-Hirschmann-Index. Importers are anonymized, numbers refer to their import share rank in the before-period. *New importers* refers to actors not present in the before-period. Note: "others" count all other actors that imported at the in-quota tariff in the respective period.

Furthermore, we observe a slight increase in the concentration of countries of origin after the administration change (see Table 9). Uruguay remains at the top with a decreased market share from 34.9% to 27.6%, followed by Australia (15.5% to 17.8%). Paraguay appears as a new country of origin, accounting for 14.2% of the import volume in the new administration scheme. Brazil lost some market share, because imports stopped almost completely after a meat

scandal in 2017. As a safety measure, Switzerland had banned imports from several Brazilian meat processing facilities (Reuters, 2017). Further, the countries of origin differ greatly between high-quality beef (mostly from Australia, the USA and Ireland) and sirloin strips (mostly from Uruguay and Paraguay).

The average import unit value (IUV) remained stable. The slight decrease from 18.97 to 18.78 CHF/kg is not statistically significant when Wilcoxon rank sum tests are applied. Splitting the sample into high-quality beef (HQB, with keys ending in 18 and 19) and sirloin strips (with keys ending in 15 and 16) shows that the IUV also remained stable for HQB, at around 28.85-28.90 CHF/kg. Sirloin strips, however, experienced a small price decrease (from 14.67 CHF/kg to 13.58CHF/kg). Following economic theory, this is what we would expect in the new administration scheme: With less auctions, importers have lower costs due to less payments for quota shares. However, this effect is apparently very small, or is outweighed by other factors, such as an increase in quality, a change in product composition, or other market developments. Yet, this remains speculative.

Table 9. High quality beef / sirloin strips import distribution by country of origin.

Before (2012-2014)		**After (2015-2017)**	
Country	Import share (volume)	Country	Import share (volume)
UY	34.9%	UY	27.6%
AU	15.5%	AU	17.8%
BR	14.7%	PY	14.2%
US	11.9%	BR	9.0%
AR	10.4%	IE	7.7%
IE	5.0%	AR	7.3%
UK	4.1%	US	7.3%
CA	2.0%	UK	4.5%
NL	0.6%	NL	1.3%
DE	0.4%	CA	1.0%
Others	0.6%	Others	2.3%
CR2	0.50	CR2	0.45
CR4	0.77	CR4	0.69

Source: Swiss Federal Office for Customs and Border Security, CR2/4= Market share of Top 2/Top 4 countries.

For **table potatoes**, the newly introduced auction for 50% of the annual quota did not go along with a change in any major market outcomes. Table 10 summarizes key figures in the period before (2015-2017) and after the administration change (2018-2020). The quota is still filled and binding. We see a somewhat decreased importer concentration (HHI decreases from 0.21 to 0.17), potentially suggesting enhanced market competition. And indeed, we see that the former leading importer, who benefited the most from the historical allocation system, saw a drop in import shares, from 35.4% down to 22.1% (Table 11). The former second and third largest importers could increase their import shares. Importer 4 (previously 5.5% market share) no longer appears in the Top 10 importer list.

Table 10. Key market figures for table potato in-quota imports.

Table Potatoes	2015-17 (Historic domestic purchasing, 100%)	2018-20 (Auction 50%, Historic market share 50%*)	Change (+/-/o)**
Fill rate (avg.)	100%	100%	o
Regular quota volume (t/year)	6'500 t	6'500 t	o
Avg. trade volume (t/year)	18'948 t	11'282 t	-
Importer concentration (HHI)	0.21 (moderate)	0.17 (moderate)	-
Country concentration (CR4)	80%	85%	+
Country concentration (CR2)	51%	58%	+
Avg. IUV (CHF/kg)	0.68	0.73	+

Source: Swiss Federal Office for Customs and Border Security, tariff nr. 0701.9010-912 and -914. The statistical key (last 3 digits) changed end of 2017 from 912 to 914 (key 913 = processing, excluded).

* Temporary quota increases are distributed based on historic market shares.

** Change is considered pos. or neg., if significant on a 5%-level based on Wilcoxon rank sum test. Old administration method spans from 2015 - 2017, new administration method from 2018-2020. IUV = Import unit value. HHI= Herfindahl-Hirschman-Index, CR4/2= Market share of Top 4/Top 2 countries

Table 11. List of top importing companies for table potatoes.

Before (2015-2017)			After (2018-2020)		
Importer	Total imports (t)	(%)	Importer	Total imports (t)	(%)
Importer 1	19'977	35.4%	Importer 2	14'424	30.4%
Importer 2	14'641	25.8%	Importer 1	10'467	22.1%
Importer 3	4'311	7.6%	Importer 3	6'052	12.8%
Importer 4	3'143	5.5%	Importer 5	2'843	6.0%
Importer 5	2'954	5.2%	Importer 8	2'464	5.2%
Importer 6	2'371	4.2%	Importer 6	2'368	5.0%
Importer 7	1'801	3.2%	Importer 11	2'156	4.5%
Importer 8	1'660	2.9%	New Importer	1'419	3.0%
Importer 9	1'570	2.8%	Importer 9	1'201	2.5%
Importer 10	1'096	1.9%	New Importer	840	1.8%
others (24)	3'320	5.8%	others (67)	3'144	6.6%
Number of importers: 34			Number of importers: 77		
HHI	0.209		HHI	0.171	

Source: Swiss Federal Office for Customs and Border Security, HHI = Herfindahl-Hirschmann-Index. Importers are anonymized, numbers refer to their import share rank in the before-period. *New importers* refers to actors not present in the before-period.

However, given that under the old system, only packaging companies had access to quota shares, and now any player could auction shares, there are surprisingly few new players. Only about 5% of the import volume in the new administration scheme can be attributed to new market entrants. When auctions were first introduced in 2018, 15 different bidders participated. This figure reduced to 13 in 2019 and further down to 11 in 2020. The relative importance of auctions has also decreased during this period. In 2018, no additional quota shares were released, meaning that 50% of the annual import quota was auctioned. However, in subsequent years, large additional quotas

were released due to poor domestic potato harvests, meaning that the amount auctioned annually (3,250 tons net) only accounted for 19% or 14% of the total in-quota imports in 2019 and 2020, respectively. During these years, distribution according to historical market share dominated overall potato imports. This reduces the importance of auctions within the applied mixed method for table potatoes.

Examining the country-of-origin concentration, a slight increase was observed (see Table 12). The top two countries now account for 58% of the import volume, compared to 51% previously. This is primarily due to Egypt's rapid rise as the top exporter. The shift in imports from Israel (IL) to Egypt (EG) is a general European trend that is most likely unrelated to the TRQ administration. Over the observation period, potato imports from Israel have become more expensive: The average producer price in Israel increased from 0.59 CHF/kg in 2015 to 0.82 CHF/kg in 2020 (FAOSTAT, item code 01510). However, Egyptian production prices have also increased, albeit at a lower level (from 0.19 CHF/kg in 2015 to 0.49 CHF/kg in 2020). Furthermore, Egypt is a much larger producer, with an annual production of around 5 million tons compared to Israel's 0.5 million tons (FAOSTAT, 2025). Only a small proportion of this price increase can be attributed to the strong appreciation of the Swiss franc.

The bulk of the potato imports concentrate in the spring months, mostly early harvest potatoes from Southern countries such as Israel and Egypt. Over the observation period, imports from March until June account for 87% of the yearly imports on average.

Swiss retail prices for new potatoes have also increased over time, from 2.05 CHF/kg in 2015 to 3.15 CHF/kg in 2020. Hence, the increased average import unit value (from 0.68 to 0.73 CHF/kg) may more reflect these overall market developments, including weather conditions, than it is a result of the newly introduced auctions.

The seemingly dramatic decrease of the in-quota trade volume from about 19’000 to 11’000 tons per year can be explained by the exceptionally poor Swiss potato harvest in 2016, which triggered the opening of large additional import quotas to compensate for the domestic production losses. The official, regular quota volume of 6’500 tons net per year, however, did not change.

Table 12. Table potato import distribution by country of origin.

Before (2015-2017)		**After (2018-2020)**	
Country	Import share (volume)	Country	Import share (volume)
IL	29.7%	EG	41.3%
FR	21.5%	FR	16.9%
EG	14.8%	IL	13.5%
ES	13.9%	ES	12.9%
DE	5.6%	DE	5.7%
NL	5.0%	IT	3.5%
CY	3.7%	NL	2.0%
AT	2.7%	PT	2.0%
IT	1.5%	CY	1.5%
MT	0.8%	AT	0.5%
Others	1.0%	Others	0.2%
CR2	0.51	CR2	0.58
CR4	0.79	CR4	0.85

Source: Swiss Federal Office for Customs and Border Security, CR2/4= Market share of Top 2/Top 4 countries.

Overall, these results provide little evidence that a change in the TRQ administration correlates strongly with other market outcomes. Both for beef and potato imports, we saw only minor changes after the respective administration shift. However, we see that auctions go along with a somewhat decreased importer concentration: With less auctions for beef imports (decrease from 90% to 50% of total quota), the top importer could further increase its dominant position, from 75% to 80% of all in-quota imports. For potatoes, where quota access was previously limited to packaging companies, the newly introduced auctions have allowed new importers to enter the market. Yet, overall importer concentration has only decreased marginally (HHI dropped from 0.21 to 0.17). So, while there is an effect, as expected from theory, empirically it is very small. If there are any other significant changes, e.g. in country composition, import prices or trade volumes, they can be plausibly explained by other factors. A cautious interim result would be that the administration method has relatively little influence on market structure and concentration. Please also note that we analyze customs data to show who ultimately used the quota shares. The original allocation in the first TRQ administration step may differ.

4.3.2 Parity Bounds Model results

Applying the PBM confirms the findings from above. Here, we see no major changes before and after the administration shifts, neither for the case of high-quality beef /sirloins, nor for table potatoes. We recall that there are six possible regime outcomes, with rents equal, greater or smaller than zero, in times with or without physical trade flows (recall Table 6). Now, estimating regime probabilities for all points in time (beef: Q1 2012 – Q4 2017; potatoes: Q1 2015 – Q4 2020), we always find there are trade flows and positive rents for importers who have access to quota shares. They use these quota shares and import until the quota is filled: We observe regime 3 with $R_t^{avg} > 0$ and physical trade happening with a probability of 100% (Table 13). None of the other regimes is observed throughout the observation period (0%).

Simultaneously, the model estimates the constant measurement error, α, which can be interpreted as the non-tariff costs of trade and constant level difference between the foreign and the domestic reference price. For high-quality beef / sirloins, α = 37.44; for table potatoes, α = 1.98. However, given our relatively small sample size, this parameter estimate should be regarded as a rough approximation rather than a precise numerical result.[15]

Table 13. Average market outcome for high-quality beef /sirloins and table potato imports (quota-holders): Imperfect integration at all times.

	$R_t^{avg} = 0$		$R_t^{avg} > 0$		$R_t^{avg} < 0$	
Trade	λ_1: perfect integration		λ_3: imperfect integration		λ_5: imperfect integration	
	before	after	before	after	before	after
Beef:	0%	0%	100%	100%	0%	0%
Potatoes:	0%	0%	100%	100%	0%	0%
No Trade	λ_2: segmented equilibrium		λ_4: segmented disequilibrium		λ_6: segmented equilibrium	
	before	after	before	after	before	after
Beef:	0%	0%	0%	0%	0%	0%
Potatoes:	0%	0%	0%	0%	0%	0%
Error term estimates	α	σ_u	σ_v			
Beef:	37.44	3.94	1.07			
Potatoes:	1.98	1.12	0.54			

Source: own calculation (Parity Bounds Model results: Maximum likelihood estimates of regime frequencies for average rents). *Before* refers to Q1/2012-Q4/2014 for beef, Q1/2015-Q4/2017 for potatoes; *after* refers to Q1/2015-Q4/2017 for beef, Q1/2018-Q4/2020 for potatoes.

[15] Since our regime probabilities are so clear (100% / 0%), this is not an issue and even an imprecise α-estimate would not alter this result. For rent estimation (section below), we then relax the assumptions on a point estimate for α and apply a range instead. For explanation on σu and σv, see Appendix B.

At the margin, however, i.e., the one importer paying the highest tariff-rate in a given quarter, the picture looks very different (Table 14). This importer – and any additional importer entering the market – would make a loss (R_t^{marg}<0). For these importers who would have to pay the over-quota tariff, we see no or minor imports.[16] Hence, at the margin, we observe a segmented equilibrium condition (regime 6) with a probability of 100% both before and after the administration shift: It is not profitable to import (R<0) and importers act rationally, by not importing significant amounts. In other words, the quota is filled and binding at all times.

Table 14. Marginal market outcome for high-quality beef / sirloins and table potato imports (over-quota importers): Segmented equilibrium at all times.

	$R_t^{marg} = 0$		$R_t^{marg} > 0$		$R_t^{marg} < 0$	
Trade	λ_1: perfect integration		λ_3: imperfect integration		λ_5: imperfect integration	
	before	after	before	after	before	after
Beef:	0%	0%	0%	0%	0%	0%
Potatoes:	0%	0%	0%	0%	0%	0%
No Trade	λ_2: segmented equilibrium		λ_4: segmented disequilibrium		λ_6: segmented equilibrium	
	before	after	before	after	before	after
Beef:	0%	0%	0%	0%	100%	100%
Potatoes:	0%	0%	0%	0%	100%	100%
Error term estimates	α*	σ_u	σ_v			
Beef:	37.44	3.94	1.07			
Potatoes:	1.98	1.18	0.61			

Source: own calculation (Parity Bounds Model results: Maximum likelihood estimates of regime frequencies for marginal rents). *Before* refers to Q1/2012-Q4/2014 for beef, Q1/2015-Q4/2017 for potatoes; *after* refers to Q1/2015-Q4/2017 for beef, Q1/2018-Q4/2020 for potatoes.

Note: *α-parameter is fixed to the level of the estimation with average rents, as marginal rents do not reflect the actual market outcome.

Importers with access to quota shares capture rents and non-quota holders have no incentive to import. The way the quota is administered does not affect the major market outcome. Also, the results show that auctions do not fully transform importer rents into government revenue. If importers bid based on their marginal willingness to pay for quota shares, they would use all their rent to buy the quota shares. The import transaction itself would then render zero rent, merely allowing to cover all costs. While in economic theory, this is the case on perfect integration (λ_1), this is not what we observe empirically. Acting rationally and strategically, many importers will only bid high enough so they consider their chances of winning high enough. This is what makes auctions and the bidding process so interesting. While importers do have to pay a certain amount for their quota shares – on average 12.46 CHF/kg for beef and 0.19 CHF/kg for potatoes – average rents remain positive, as the following section proves in more detail.

4.3.3 Approximation of rents

Based on the PBM estimation, we can approximate the average importer rents. However, while the PBM estimation and the comparative empirical analysis above focused on a six-year time spans before and after the respective administration change, we now only focus on the observation period with auctions in place (beef 2012-2017, potatoes 2018-2020). Table 15 summarizes the average price and cost parameters for this period. In addition to the alpha parameter estimated in the PBM, we extend the range of possible fixed costs by applying two conditions. Firstly, the quota must remain binding, meaning that over-quota rents must be negative (-0.01 CHF/kg). Secondly, in an auction system, in-quota imports must remain profitable (rent = 0) using the average hammer price (P_Auction) as the assumed quota share price. Consequently, we obtain a fixed cost (α) range of 32.47 – 39.48 CHF/kg for high-quality beef /sirloins and 1.71 – 2.27 CHF/kg for table potatoes.

[16] Import transactions of less than 2 tons are excluded from the PBM analysis, assuming that they are non-commercial or specialty imports (e.g. for trade fairs).

Table 15. Average price and cost parameters throughout the observed auction period.

Parameters (in CHF/kg)	Description	High Quality Beef (CHF/kg)	Table Potatoes (CHF/kg)
P_CH	Domestic reference price	70.84	2.92
P_Foreign	Foreign reference price	17.81	0.40
t_inquota	In-quota tariff rate	1.09	0.06
T_overquota	Over-quota tariff rate	20.57	0.82
P_Auction	Average hammer price	12.46	0.19
Fixcost_estimate (α)	Alpha, as estimated in PBM	35.98	1.98
Fixcost_min	Minimum fixed costs	32.47	1.71
Fixcost_max	Maximum fixed costs	39.48	2.27

Sources: P_CH: FOAG ("Rindsfiletsteak, Grosshandelspreise Fleisch ab Verarbeiter" and "Detailhandelspreis Frühkartoffeln (nicht-bio) "); P_Foreign: USDA («Steak, Sirloin, USDA Choice, Boneless») and FAOSTAT (2025, potato mean producer price EG, IL, FR); i_inquota and T_overquota: TARES, P_Auction: FOAG (average hammer price). Observation period for high-quality beef: 2012-2017, for table potatoes 2018-2020 (no auctions before 2018).

Using the original alpha-estimate as well as the possible range from Fixcost_min to Fixcost_max, we calculate average rents for the different scenarios:

$$R^{avg} = P^{CH} - P^{FOR} - TC^{avg}, \text{ with} \quad (2)$$

$$TC^{avg} = Tariff^{avg} + Fixcost\ (+ P^{avg}_{auction}) \quad (3)$$

R^{avg} are the average importer rents, defined as the domestic-foreign price differential ($P^{CH} - P^{FOR}$) minus average trade costs TC^{avg}, which are composed of the average tariff rate, fixed costs (α or extended range), and the average hammer price for the case of auctions. Table 16 shows the estimated rents resulting from the original alpha value, as well as the minimum and maximum rents for each administration method. For beef imports at the average auction price, the estimated rent is 3.51 CHF/kg (5% of the average retail price). The maximum rent is 7.01 CHF/kg (10% of the retail price) and the minimum is zero by definition. When quota shares are obtained through historical allocation, the estimated rent increases to 15.97 CHF/kg, ranging from 12.46 to 19.47 CHF/kg (equaling 18–27% of the retail price). Regardless of how high true fixed costs may be, the margin in a historical allocation system is always higher than for importers who use auctions to secure quota shares. Due to our restriction of a binding quota, as observed in our data, over-quota imports receive negative rents.

Similar results were found for table potatoes, with less pronounced differences between the auction and historical allocation systems. The estimated rent is 0.29 CHF/kg (10% of the average retail price) for auctioned quota shares and 0.48 CHF/kg (17% of the retail price) for historical allocation. Allowing for the maximum possible range of fixed costs, rents increase to 0.56 CHF/kg (19%) for auctions and 0.75 CHF/kg (26%) for historical allocation.

Table 16. Range of importer rents under different TRQ administrations.

		High Quality Beef		Table Potatoes	
		Total (CHF/kg)	% of retail price	Total (CHF/kg)	% of retail price
Auction (in-quota)	Min. rent	0.00	0%	0.00	0%
	Est. rent	3.51	5%	0.29	10%
	Max. rent	7.01	10%	0.56	19%
Historical (domestic, in-quota)	Min. rent	12.46	18%	0.19	7%
	Est. rent	15.97	23%	0.48	16%
	Max. rent	19.47	27%	0.75	26%
Over-quota	Min. rent	-7.02	-10%	-0.57	-20%
	Est. rent	-3.51	-5%	-0.28	-10%
	Max. rent	-0.01	-0%	-0.01	-0%

Source: own calculation. Est. rent: Estimated value using α; for the calculation of minimum and maximum rents, Fixcost_max and Fixcost_min (Table 15) are used.

Even if we relax the assumptions and deviate from the originally estimated alpha parameter, we can demonstrate that positive rents are maintained for both historical allocation and auctions. However, importers find it much more attractive to obtain quota shares through historical domestic allocation. This method enables importers to retain the entire rent, rather than sharing it with the government by paying the auction price.

4.3.4 Limitations

Using the PBM framework, we can prove the existence of positive rents and approximate them but cannot quantify them with certainty. See Häfner (2023) for another attempt to do so for beef imports.[17] Conceptually, rents decrease when auctions are applied and importers have to pay a price for quota shares. Also in the PBM estimation, trade costs, which consist of the tariff and transport costs, are increased by the average hammer price at the auctions in quarter *t* (see Appendix B, equations B3 and B4). Hence, for the auctioned share of the in-quota imports, importers' average rents decrease, ceteris paribus, by 12.46 CHF/kg for high-quality beef /sirloins and 0.19 CHF/kg for table potatoes, which are average hammer prices in our sample period. Yet, we know too little about the cost side along the supply chain to make precise estimates about the absolute size of the rents.

Moreover, it remains unclear whether these rents are primarily captured by the importing companies themselves or by the downstream sector, particularly retailers. Previous studies have examined TRQ systems in terms of industry competition and market power (e.g., Pouliot and Larue, 2012; Scoppola, 2010). In Switzerland, large retailers import only small amounts directly and hold few import quotas themselves (e.g., Coop for table potatoes). Instead, they are supplied by various importing companies. Due to this vertical integration and multiple supply relationships, we suspect that at least part of the importer rents is captured by downstream retailers.

4.4 Discussion

We conducted two case studies analysing changes in the Swiss TRQ administration system in recent years. For high-quality beef / sirloins, the administration moved away from auctions: previously, 90% of the quota was auctioned and 10% was allocated based on historical domestic purchases. In 2015, this shifted to 50% auctions and 50% historical allocation (40% domestic slaughtering and 10% domestic purchases). In contrast, for table potato imports, new auctions were introduced in 2018. The entire quota no. 14.3 for table potatoes was formerly allocated historically, based on an actor's previous year's domestic purchases. Since 2018, 50% of the quota is auctioned, 50% allocated

[17] For auctioned high-quality beef, Häfner (2023) estimates net margins for imports between CHF 9.72 and 12.75 per kg. Without having to pay the auction prices, this would increase to 22 – 25 CHF/kg. However, the study suffers from some methodological flaws, including a wrong definition of in- and over-quota tariffs (see Appendix A).

historically based on past year's total market share. Theory suggests that increased auctions result in lower rents, more competitive markets, and an importer distribution closer to a free-trade scenario (Skully 1999, 2001).

Both the comparative analysis and the PBM results indicate that changing the administration method does not alter the fundamental market situation: importers continue to capture rents, and quotas remain filled and binding. This is not surprising given that both the notified quota volume and the in-quota and over-quota tariff levels remained unchanged.

However, we can demonstrate that auctions impact importers' rents. In the case of meat, the administration's switch to fewer auctions was favorable overall for importers because they now receive more quota shares "free of charge" based on historical allocation, enabling them to generate higher rents. Conversely, for potato imports, the newly introduced auctions reduce importers' rents because part of these rents now become government revenue in the form of auction bids.

In theory, a change in the allocation method should alter the rules for accessing the desired quota shares and, consequently, the composition of importers. Indeed, we found that more auctions go along with a somewhat decreased importer concentration (beef: HHI 0.58 to 0.66, potatoes: HHI 0.21 to 0.17.) However, this empirical effect (HHI ranges from 0 to 1) is relatively small, probably also because we deal with mixed allocation systems and cannot compare exclusive historical allocation to auction systems. Additionally, we would be cautious about linking concentration rates directly to competition or market power. The overall market structure and the coordinating role of large umbrella organizations (Proviande and Swisspatat) remain unchanged, as does the significant role of a major meat importing company, which imports more than three quarters of the in-quota quantities for high-quality beef.

For other market outcomes, we saw no effects after the administration change. In contrast to import concentration, country-of-origin concentration slightly increased in the years with more auctions. Yet, this effect can be plausibly explained by other (international) market developments. Import price levels and quota fill rates are not affected by the change in quota allocation.

Our findings challenge traditional economic theory regarding the efficiency of quota administration methods. Economic theory posits that auctioning is the most efficient allocation method, capturing importers' willingness to pay, transforming it into government revenue, and reducing deadweight losses in welfare. However, our empirical results suggest that auctions may still generate rents for the importers. Specifically, we observe that rents generated under auction systems are considerably lower than under historical allocation, but remain positive. Conceptually, we could show that rents decrease by the average hammer price paid for the auction shares. Yet, it seems that the remaining rents are large enough to stay profitable. Considering the transaction costs for the government and importers in imperfect markets, auctions are not necessarily the most efficient option. The hammer prices can be seen as an additional surcharge, and hence an additional trade barrier for the agreed in-quota amounts. Economic theory further suggests that historical allocation tends to safeguard large domestic players. While our study does not prove or disprove this hypothesis, it is a plausible mechanism worth monitoring when using historical allocation methods.

In sum, we found that TRQ administration methods do not matter as much as economic theory may suggest, at least for the two observed relatively small markets of high-quality beef / sirloins and table potatoes in Switzerland, which appear to be very stable with well-established importers and strong players coordinating the domestic market and international trade.

5 Conclusion and policy implications

In our empirical case study of Swiss beef and potato imports in Section 4, we found that changes in the TRQ administration methods only slightly affected importer concentration and composition and had no measurable effects on import prices or quota fill rates. Combining these results with the insights gained from comparing the different administrative methods in Section 3, we derive conclusions about which methods are suitable under which market conditions. Because the economic effects of the studied administration changes proved to be rather small, we recommend taking a pragmatic approach and focusing on manageable solutions, instead of striving for a theoretical economic optimum.

We recommend **auctions** as the preferred method for products with high import values, such as the premium beef cuts analyzed in our case study. Due to the high revenues from bids, the fiscal benefits likely outweigh the administrative costs of running auctions. If the number of auctions per year is kept low, the administrative effort required is manageable, especially with long-established electronic auction systems in place.

A **first-come, first-served system** could be a doable alternative for quotas with low demand or low import values. The total quota should be large enough and the difference between the requested and allocated quantities should be small enough to avoid a rush for quotas once the release starts. Therefore, first-come, first-served allocation is not suitable for highly contested or sensitive products. Whether arrival at the border or order of registration at the FOAG is used as the deciding factor can be determined on a product-by-product basis. In an era of customs warehouses and automated data exchange between administrative units, formerly pressing logistical issues have become nowadays less relevant.

For **historical allocation** systems, we find no specific advantages. From a theoretical perspective, they lead to a biased and overly static importer distribution. From an administrative point of view, historical domestic purchases and combined schemes that aim to measure total past market shares require cumbersome market tracking and accounting, leading to high administrative costs. Furthermore, historical allocation, whether based on past imports or domestic purchases, tends to disadvantage new entrants. Therefore, remedial measures are required, such as newcomer shares or mixed allocation rules, which incur additional administrative costs. However, domestic producers may argue that historical allocation based on domestic purchasing provides an incentive for importing companies to buy domestic products – thereby supporting and stabilizing the domestic producer market (Binswanger et al., 2025). Yet, there are certainly more direct and more suitable domestic producer support measures than the administration method of a complex border protection policy like TRQs.

Resale markets, where importers can sell quota shares to each other after the initial allocation, can be a complementary measure to improve distributive efficiency and to ensure high quota fill rates. Switzerland allows such quota transfers (SR 916.01, Art 14), successfully decoupling rents from physical trade. However, the sales revenue on such secondary markets goes to the initial quota holder, i.e. private market actors, and not to the Swiss state. Therefore, simply replacing public auctions with private ones to save administrative costs is not a reasonable option. Also, more research and data are needed to fully understand these resale markets.

In summary, the most suitable administration method must be decided on a case-by-case basis, weighing up the pros and cons of revenue-generating auctions against the ease of first-come, first-served allocation. Ultimately, this is as much a political decision as an economic one. Consequently, there may be tension between administrative bodies, who tend to prioritize administrative simplicity, and policymakers, who advocate auctions as a source of revenue. The recently suggested Swiss federal budget relief package (“Entlastungspaket 2027”, FDF, 2025) is a case in point, as it explicitly states the increase in auctioning of TRQs as a budget measure.

Finally, we would like to emphasize that the administration method does not affect the *effectiveness* of TRQs. In any case, TRQs fulfill their purpose of protecting the domestic market in a World Trade Organization (WTO)-compliant way. If the administration method influences anything beyond administrative costs and potential government revenue, it influences distributional *efficiency*, i.e., the selection of importers. The effectiveness of protecting the domestic market depends on the size of the quota and the level of the over-quota tariff (whether it is prohibitive or not). In the analyzed markets for high-quality beef /sirloins and table potatoes, as in many other markets regulated by TRQs, effective protection is ensured by high over-quota tariffs and binding quotas. Also, the ability to open additional quotas

autonomously when necessary is independent of the administration method. The possibility of compensating for temporary domestic supply shortages with additional in-quota imports is always present.

6 References

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Appendix A: Additional Information

There is a study by Häfner (2023), which analyzed the Swiss auctioning system for beef imports in more detail, using auction data from 39 auctions from 2008 until 2010 (Table A1). During that time, there was a mixed method administration in place: 10% of the total quota was distributed according to domestic purchases (animals acquired at public markets). The study zooms into the remaining 90% of the quota, allocated based on auctioning. The study focuses on high-quality beef only, which is almost exclusively imported from overseas countries such as Australia, Brazil, United States, and Ireland. Looking at Switzerland's total beef consumption, approximately 20% is imported, primarily from Germany (Loi et al., 2016). Other important premium cuts like tenderloin and sirloin steaks are mostly imported from South America (Uruguay, Paraguay, Argentina, Brazil) and not included in this study. Switzerland ranks among the highest globally for beef prices, with an average retail price of 60.67 CHF/kg for sirloin steak during the study period. The quota durations are roughly 30 days, with quotas ranging from 67.5 to 630 tons, averaging 311.5 tons. Over-quota tariffs are prohibitively high at all times, limiting imports of high-quality beef. These auctions function as follows: Bidders can submit up to five bids per auction. A bid consists of a pair of Swiss francs and kilograms (CHF/kg). During the study period, an average of 4.42 bids were submitted for quota auctions for high-quality beef. The average bid-to-cover ratio is 2.96, often exceeding 2, and sometimes reaching over 5, indicating that there is a high demand for quota shares, exceeding the availability by factor 2 to 5.[18] Market-clearing prices range from 3.21 to 14.41 CHF/kg, generating revenues per auction from CHF 0.7 to 8 million, averaging CHF 2.8 million, totaling CHF 107 million across all 39 observed auctions. The bid quantities are relatively small, with 75% submitted average bids below 7.8 tons, less than 3% of the average quota. This bidding heterogeneity reflects the Swiss meat retail market, characterized by a balance of large retailers and smaller butcheries. The average success rate for bidders is 64% per auction, with higher rates for active bidders who participated in several auctions in a year, but regardless of the bidder's size and degree of risk-aversion, indicating equitable opportunities for all participants.

The results of the study should be interpreted with caution. Häfner states that the statistical key 018 stands for the in-quota tariff and 019 for the over-quota tariff, which is not the case. In fact, for the studied products (tariff lines 0201.2091, 0201.3091, 0202.2091, 0202.3091), these keys distinguish whether growth-promoting hormones were used in production (018 an 918) or not (019 and 919). Further, only high-quality beef is included, while sirloin steak (“Nierstücke”), which are a considerable part of this partial TRQ, are excluded. Keeping these methodological flaws in mind, the following paragraph briefly summarizes the findings.

The study finds that despite the auctioning mechanisms, importers capture considerable rents. Häfner’s (2023) estimates on the net margin for imported high-quality beef range between CHF 9.72 and 12.75 per kg. Weighed with the average retail price of sirloin steak during the period (CHF 60.67 per kg, as mentioned above), the average net profit margin would be 16–21%. This is more than for other agri-food imports or for comparable Swiss domestic beef cuts, such as sirloin strips. The study is limited in a way that it only considers auction outcomes. However, auction winners can transfer quota shares to other auction participants, and outcomes after such resale market transactions are unknown. In the high-quality beef sector, a single large company typically handles most imports (75-80% per year). This company does not bid itself but is active in post-auction activities (Loi et al., 2016). Unfortunately, there is a lack of data on such post-auction activities.

[18] The bid-to-cover ratio is computed by dividing the aggregate amount of quantities for which bidders submitted a positive price by the total quota on sale. While Häfner argues that this is a relevant economic measure, we cannot link it to any other measures such as winning bids or market concentration. The fact that it is always greater than one re-affirms the fact that demand for quota shares exceeds their availability.

Table A1. Descriptive statistics of high-quality beef imports (sample data 2008-2010), as published by Häfner (2023).

	Mean	Min	Pctl(25)	Pctl(75)	Max
Quotas (t)	312	68	214	360	630
Bid-to-Cover ratio	3.0	1.8	2.4	3.4	5.4
Number of bidders	72	58	68	76	82
Market clearing price (CHF)	8.2	3.2	6.1	9.5	14.4
Revenue (CHF mio)	2.8	0.7	1.7	3.5	8.0
Average total quantity bid per bidder (t)	8.59	0.03	0.85	7.80	143.07
Share of successful bidders	0.64	0.04	0.44	0.83	0.97
Success rate per bidder	0.60	0.00	0.47	0.84	1.00
Success rate per bidder*	0.71	0.28	0.58	0.85	1.00

Notes: * only includes the 44 most active bidders (min. 35 out of 39 auctions)

In the study, the category of high-quality beef includes four different tariff-numbers with 2 statistical keys each: 0201.2091/018 and 019 (fresh or chilled carcasses and half-carcasses with bone in), 0201.3091/018 and 019 (boneless), 0202.2091/018 and 019 (frozen carcasses and half-carcasses with bone in), 0202.3091/018 and 019 (boneless). Häfner falsely states that 018 stands for the in-quota tariff and 019 for the over-quota tariff. These tariffs are, respectively, 1.59 and 13.68 CHF/kg, 1.59 and 22.12 CHF/kg, 1.59 and 12.33 CHF/kg and 1.09 and 20.57 CHF/kg (cf. https://xtares.admin.ch for the tariffs) However, as described above, these statistical keys in fact determine whether it was produced with growth-promoting hormones (018) or not (019). Note that all other keys (including the ones ending in -15 and -16 for sirloin strips, which belong to the same sub-quota as High-Quality Beef) are excluded. Also, over-quota tariff lines are excluded.

Source: Häfner (2023).

Table A2. List of bilateral Tariff Rate Quotas for Swiss imports (2025, managed by customs).

TRQ Nr.	Product	Trade Partner
32	Dog and cat food	EU
101	Air-dried raw ham	EU
102	Air-dried jerky meat	EU
104	Pome and stone fruit rootstocks and trees, shrubs and perennials	EU
105	Cut flowers 1.5. - 25.10.	EU
106	Tomatoes 21.10. - 30.4.	EU
107	Iceberg lettuce 1.1. - 28.2.	EU
108	Witloof chicory 21.5. - 30.9.	EU
109	Eggplants 16.10. - 31.05.	EU
110	Courgettes 31.10. - 19.4.	EU
111	Apricots 1.9. - 30.6.	EU
112	Strawberries 1.9. - 14.5.	EU
115	Port wine	EU
116	Retsina	EU
119	Horses	EU
120	Chicken breasts, frozen	EU
32-GB	Dog and cat food	GB
104-GB	Rootstocks and trees, shrubs and perennials of pome and stone fruit	GB
105-GB	Cut flowers 1.5. - 25.10.	GB
106-GB	Tomatoes 21.10. - 30.4.	GB
107-GB	Iceberg lettuce 1.1. - 28.2.	GB
108-GB	Witloof chicory 21.5. - 30.9.	GB
109-GB	Eggplants 16.10. - 31.05.	GB
110-GB	Courgettes 31.10. - 19.4.	GB
111-GB	Apricots 1.9. - 30.6.	GB
112-GB	Strawberries 1.9. - 14.5	GB
119-GB	Horses	GB
120-GB	Frozen chicken breasts	GB
121-GB	Cuts and offal of chickens, including livers, excluding breasts, frozen	GB
122-GB	Breasts of turkeys, frozen	GB
123-GB	Pieces and offal of turkeys, including livers, without breasts, frozen	GB
124-GB	Ducks, whole, frozen	GB
	Olive oil	Jordan
A	Palm oil and its fractions, TRQ A	Indonesia
B1	Palm stearin, TRQ B1	Indonesia
B2	Palm stearin, TRQ B2	Indonesia
C1	Palm kernel oil or babassu oil and its fractions, TRQ C1	Indonesia
C2	Palm kernel oil or babassu oil and its fractions, TRQ C2	Indonesia
D	Palm kernel oil or babassu oil and its fractions, ready for consumption, TRQ D	Indonesia
	Grapes, 1.1. - 30.6.	Chile
	Hazelnuts	Chile
	Olive oil	Tunisia
	Potatoes, excluding seed potatoes	Tunisia
	Olive oil	Lebanon
	Grapes, 1.12. - 31.5.	Lebanon
	Peaches, nectarines, brugnoles	Egypt
	Grapes 1.1. - 14.7.	Egypt
	Potatoes, excluding seed potatoes	Egypt

TRQ Nr.	Product	Trade Partner
121	Cuts and offal of chickens, including liver, without breasts, frozen	EU
122	Frozen breasts of turkeys	EU
123	Pieces and offal of turkeys, including livers, without breasts, frozen	EU
124	Ducks, whole, frozen	EU
125	Fat livers of ducks, geese or guinea fowls	EU
126	Cuts and offal of ducks, geese or guinea fowl	EU
127	Meat and edible offal of hares or rabbits	EU
128	Meat and edible offal of game	EU
129	Bird eggs for consumption	EU
130	Acacia honey	EU
131	Other honey	EU
132	Cucumbers for pickling 21.10. - 14.4.	EU
133	Cucumbers for pickling 15.4. - 20.10.	EU
134	Cornichons	EU
135	Hot peppers 1.4. - 31.10.	EU
136	Vegetables and vegetable mixes	EU
137	Onions	EU
138	Peas, for fodder	EU
139	Peas, not for fodder	EU
140	Plums (incl. damsons) 1.7. - 30.9.	EU
141	Strawberries 15.5. - 31.8.	EU
142	Raspberries 1.6. - 14.9.	EU
145	Blueberries, frozen	EU
146	Other fruits, frozen	EU
147	Spices (fruits of the genus Capsicum or Pimenta)	EU
148	Wheat and meslin	EU
149	Maize, for fodder	EU
150	Mushrooms of the genus Agaricus (champignons)	EU
151	Meat from animals of the goat genus	EU
152	Cucumbers 21.10. - 14.4.	EU
153	Walnuts	EU
301	Sausages, incl. coppa, bladder ham, salmon ham	EU

TRQ Nr.	Product	Trade Partner
126-GB	Cuts and offal of ducks, geese or guinea fowl	GB
127-GB	Meat and edible offal of hares or rabbits	GB
128-GB	Meat and edible offal of game	GB
129-GB	Bird eggs for consumption	GB
130-GB	Acacia honey	GB
131-GB	Other honey	GB
132-GB	Cucumbers for pickling 21.10. - 14.4.	GB
133-GB	Cucumbers for pickling 15.4. - 20.10.	GB
134-GB	Cornichons	GB
135-GB	Sweet peppers 1.4. - 31.10.	GB
136-GB	Vegetables and vegetable mixtures	GB
137-GB	Onions	GB
138-GB	Peas, for fodder	GB
139-GB	Peas, not for fodder	GB
140-GB	Plums (incl. damsons) 1.7. - 30.9.	GB
141-GB	Strawberries 15.5. - 31.8.	GB
142-GB	Raspberries 1.6. - 14.9.	GB
145-GB	Blueberries, frozen	GB
146-GB	Other fruit, frozen	GB
147-GB	Spices (fruits of the genus Capsicum or Pimenta)	GB
148-GB	Wheat and meslin	GB
149-GB	Maize, for fodder	GB
150-GB	Mushrooms of the genus Agaricus (button mushrooms)	GB
151-GB	Meat of animals of the goat genus	GB
152-GB	Cucumbers 21.10. - 14.4.	GB
153-GB	Walnuts	GB

TRQ Nr.	Product	Trade Partner
	Olive oil Others	Egypt
	Cheese	Egypt
	Olive oil	Egypt
	Grapes 1.1.- 30.6.	SACU
	Rootstocks and trees	SACU
	Cheese	SACU
	Hazelnuts	SACU
	Dried meat	SACU
	Dog and cat food	Canada
	Gift fruit	Japan
	Olive oil	Albania
	Olive oil, other	Albania
	Sunflower oil or safflower oil	Ukraine
	Peaches, nectarines, brugnoles	Montenegro
	Grapes B, 1.6. - 14.7.	Montenegro
	Grapes A, 15.7. - 31.8.	Montenegro
	Olive oil	Montenegro
	Peaches, nectarines, brugnoles	Bosnia-Herzegovina
	Grapes	Bosnia-Herzegovina
	Olive oil, other B	Turkey
	Olive oil	Turkey
	Grapes B	Turkey
	Olive oil, other A	Turkey
	Grapes A	Turkey
	Lactose and lactose syrup	Israel

Sources: https://quota.bazg.admin.ch/ (accessed 02 September 2025), internal FOAG documents.

Notes: EU = European Union, GB = Great Britain, SACU = Southern African Customs Union

Appendix B: Parity Bounds Model

Trade cost data:

For the PBM estimation, we need detailed data on trade costs. As for the price data, we aggregate all trade data, including trade cost data, on a quarterly level. To then accurately represent the TRQ system with the different in- and over-quota tariff rates, we distinguish between average and marginal tariffs. The average tariff is the volume-weighted effectively paid tariff rate, which we calculate by weighing the tariff rate applied to an individual import transaction *i* by this transaction's share in the overall volume of imports in time (quarter) *t*, and summing over all transactions:

$$Tariff_t^{avg} = \frac{\sum_i (Vol_i * Tariff_i)}{\sum_i (Vol_i)} \text{ for all transactions } i \text{ in quarter } t \quad \text{(B1)}$$

In contrast, the marginal tariff is defined as the highest observed tariff rate that applied to an import transaction in *t*. This is the tariff rate that any additional importer would pay. When quotas are filled, the marginal tariff rate is de facto the over-quota tariff *T*.

$$Tariff_t^{marg} = max_i(Tariff_i) \text{ for all transactions } i \text{ in quarter } t \quad \text{(B2)}$$

Overall trade costs (*TC*) consist of the variable tariff costs, as calculated above, plus other unknown trade costs, such as transport and marketing costs. We assume that these other costs were constant over time over the duration of our sample (*Fixcost*). Also, for the auctioned amount, we add the average hammer price at the auctions ($P_{auction_t}^{avg}$). This is published as a mean annual value by FOAG.

$$TC_t^{avg} = Tariff_t^{avg} + Fixcost + (P_{auction_t}^{avg}) \quad \text{(B3)}$$

$$TC_t^{marg} = Tariff_t^{marg} + Fixcost + (P_{auction_t}^{avg}) \quad \text{(B4)}$$

Note that we do not estimate or approximate fixed costs but include them as a constant measurement error in the model, as explained in the following section.

Model estimation:

The standard PBM defines three scenarios or 'regimes' and estimates the probability of each regime occurring at any given time. In the first scenario, the spatial price differential between two markets, Switzerland (CH) and the foreign reference market (FOR)[19], equals the trade cost (TC), indicating market efficiency with no rents:

$$P_t^{CH} - P_t^{FOR} = TC_t \quad \text{(B5)}$$

Alternatively, the price differential can be smaller than the trade cost, indicating no profitable spatial arbitrage opportunities:

$$P_t^{CH} - P_t^{FOR} < TC_t \quad \text{(B6)}$$

In the third scenario, the price differential exceeds trade costs, suggesting unexploited spatial arbitrage opportunities, positive rents, and market inefficiency:

$$P_t^{CH} - P_t^{FOR} > TC_t \quad \text{(B7)}$$

The inefficiency depicted in equation B7 can arise from various factors such as trade restrictions – in our case TRQs – but also public price support, and non-competitive pricing practices. These equations can also be expressed in terms of rents R_t, which are equal to, less than, or greater than zero for the three cases, respectively.

$$R_t = P_t^{CH} - P_t^{FOR} - TC_t \quad \text{(B8)}$$

These rents explain the spatial efficiency or inefficiency between markets without accounting for trade flows. Following Barrett and Li (2002), we further divide each scenario into two subcategories based on whether trade does or does not occur, resulting in a total of six regimes, each with a probability λ_j (see Table B1).

[19] FOR = USA (Steak, Sirloin, USDA Choice, Boneless) for high quality beef, FOR = average of EG,FR,IL producer price (FAOSTAT, CPC-Code 01510) for potatoes; converted into CHF using exchange rates provided by Swiss National Bank.

Table B1. Six possible regimes in the Parity Bounds Model (identical to Table 6).

	$R_t = 0$	$R_t > 0$	$R_t < 0$
Trade	λ_1 (perfect integration)	λ_3 (imperfect integration)	λ_5 (imperfect integration)
No Trade	λ_2 (segmented equilibrium)	λ_4 (segmented disequilibrium)	λ_6 (segmented equilibrium)

Markets are physically *integrated* when trade occurs. In the absence of trade flows, markets are *segmented*, regardless of efficiency. Regime 1 represents perfect integration with zero rents. Regimes 3 and 5 describe physically integrated markets in *disequilibrium* with positive or negative rents, respectively. Regimes 2 and 6 represent segmented *equilibrium* with zero or negative rents, respectively. Regime 4 describes segmented disequilibrium with unexploited positive rents.

For rent estimation, we incorporate a sampling and measurement error v_t, with mean α and variance σ_v^2. The potentially non-zero mean α accounts for permanent factors like unobservable trade costs and, for the case of potatoes, for the price level differences between retail prices (CH) and producer prices (IL, EG, FR).[20] Variance parameters account for transitory measurement differences. For example, currency conversion errors due to non-immediate exchange rate pass-through result in temporary estimation errors (Liefert and Persaud, 2009).

To estimate the probabilities of regimes, we assume a distribution for the data generating process. Consistent with PBM literature (Baulch, 1997; Barrett and Li, 2002), we assume rents R_t follow a half-normal distribution. For $R_t \neq 0$, we add a positive half-normal error term u_t with variance σ_u^2, independent of the general error v, reflecting additional variation in rents, for instance due to exchange rate fluctuations in time *t*.

$$R_t = \begin{cases} v_t + u_t & (for\ R_t > 0) \\ v_t & (for\ R_t = 0) \\ v_t - u_t & (for\ R_t < 0) \end{cases} \tag{B9}$$

The distribution functions for each regime are then specified as follows:

$$f_t^1 = f_t^2 = \frac{1}{\sigma_v}\varphi\left[\frac{R_t-\alpha}{\sigma_v}\right] \quad \text{(regime 1+2, } R_t = 0) \tag{B10}$$

$$f_t^3 = f_t^4 = \left[\frac{2}{(\sigma_u^2+\sigma_v^2)^{1/2}}\right]\varphi\left[\frac{R_t-\alpha}{(\sigma_u^2+\sigma_v^2)^{1/2}}\right] * \left[1 - \Phi\left[\frac{-(R_t-\alpha)\sigma_u/\sigma_v}{(\sigma_u^2+\sigma_v^2)^{1/2}}\right]\right] \text{(regime 3+4, } R_t > 0) \tag{B11}$$

$$f_t^5 = f_t^6 = \left[\frac{2}{(\sigma_u^2+\sigma_v^2)^{1/2}}\right]\varphi\left[\frac{R_t-\alpha}{(\sigma_u^2+\sigma_v^2)^{1/2}}\right] * \left[1 - \Phi\left[\frac{(R_t-\alpha)\sigma_u/\sigma_v}{(\sigma_u^2+\sigma_v^2)^{1/2}}\right]\right] \text{(regime 5+6, } R_t < 0). \tag{B12}$$

here φ is the standard normal density function and Φ is the standard normal cumulative distribution function. Using these distribution functions, we can calculate the likelihood of observing the sample data $\{R_t,\ Trade_t\}$:

$$L = \prod_{t=1}^{T}(A_t * [\lambda_1 f_t^1 + \lambda_3 f_t^3 + \lambda_5 f_t^5] + (1 - A_t) * [\lambda_2 f_t^2 + \lambda_4 f_t^4 + \lambda_6 f_t^6]). \tag{B13}$$

The variable A_t takes the value one when trade takes place in time *t*, and zero otherwise. λ_k states the probabilities of the six regimes. Maximizing the log-likelihood function in equation (B13) generates estimates for the error parameters α, σ_u and σ_v. To do so we use the *'L-BFGS-B'* method proposed by Byrd et al. (1995) subject to the constraints $0 \leq \lambda_k \leq 1$ and $\sum_k \lambda_k = 1$. As a result of the distributional assumptions and the included error terms, the regimes are separated by parity bounds that allow for some variation, so that even in the zero rents regimes, rents do not need to be precisely zero (see Baulch, 1997).

[20] For beef, both the domestic and the foreign reference price are measured at the wholesale level.

The key variable in this model is the series of quarterly rents (R_t). Due to the non-linearity of the TRQ system, we distinguish between average and marginal rents. For average rents, we consider volume-weighted quarterly average tariff costs ($Tariff^{avg}$). This reflects the average rents realised by the actors who imported potatoes in that period, either at in-quota or over-quota tariffs. In contrast, the marginal rents represent the rents realised by the importer who paid the highest tariff rate in a given quarter ($Tariff^{marg}$). We analyse both types of rents because average rents tell us about the observed market outcome and marginal rents about the outcome for potential market entrants; both under the new and the old quota administration system.

Note that the above maximum likelihood estimation are all time-invariant over the whole sample period. To better understand the regime prevalence before and after the policy change, we construct a time-varying variable $\tilde{\lambda}_t^k$. This binary indicator variable defines which regime *k* has the highest probability of occurring at each point in time *t*. In times of no or negligible trade (A_t=0), we compare the conditional probabilities of regimes 1, 3 and 5. In times of trade (A_t=1), we compare the conditional probabilities of regimes 2, 4 and 6.[21]

Estimation results:

Using the above model specification, we obtained a positive estimate for the constant measurement error, which can be interpreted as fixed costs: α = 37.44 CHF/kg for high-quality beef/sirloin strips, α = 1.98 CHF/kg for table potatoes. These parameters includes fixed transport costs, trade costs other than tariffs, and the constant differences between foreign and domestic reference prices. For instance, we compare (foreign) producer and (domestic) consumer prices for the case of potatoes. For beef, we compare a somewhat higher quality (beef tenderloin steak, domestic) to a less expensive category (sirloin steak boneless, foreign). Both differences lead to a constant price gap, captures in the α-parameter, not further influencing the further estimation of regime-probabilities.

When we estimate time-varying probabilities for both products, we observe regime 3 for average rents with $R_t^{avg} > 0$, and physical trade occurs with a 100% probability at all points in time (Figure B1). The probability of observing any other market outcome is 0%.

However, at the margin – i.e., the one importer paying the highest tariff rate in a given quarter – the picture looks very different (Figure B2). Here, we observe regime 6, with negative rents, and no or minor physical trade flows under these conditions, with a probability of 100% at all times.

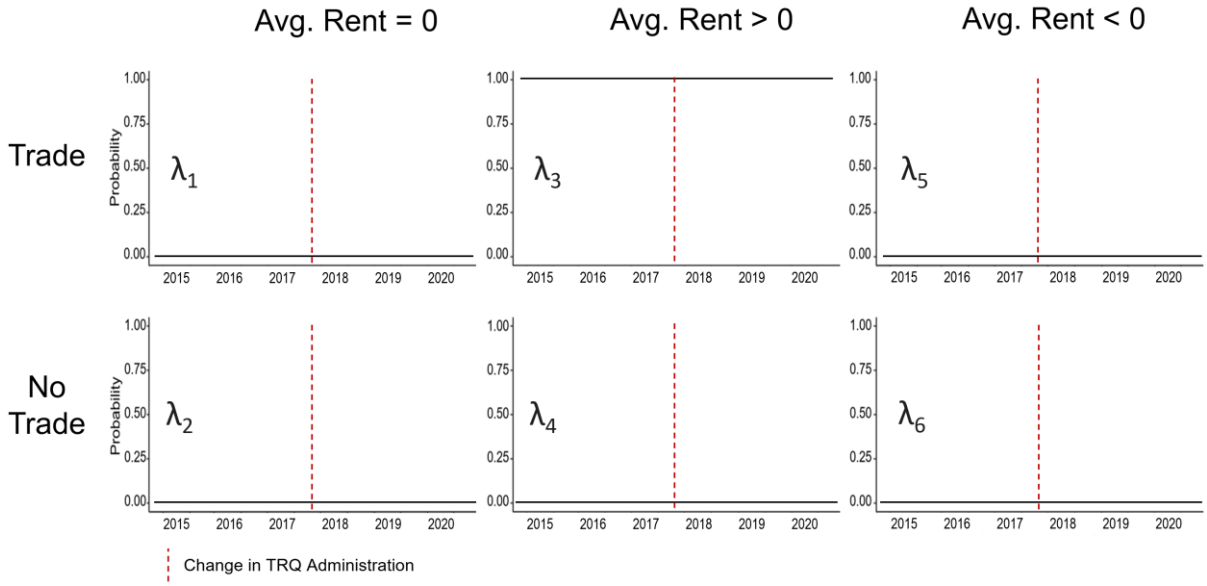

Figure B1. Average market outcome for table potato imports (quota-holders): Probabilities over time. Source: own calculation (Parity Bounds Model results).

Notes: For high-quality beef and sirloin strips, the identical results apply, but with a time period from 2012-2017, with the TRQ administration change in the beginning of 2015.

[21] The exact construction of the variable is derived in Barrett and Li (2002), p. 289.

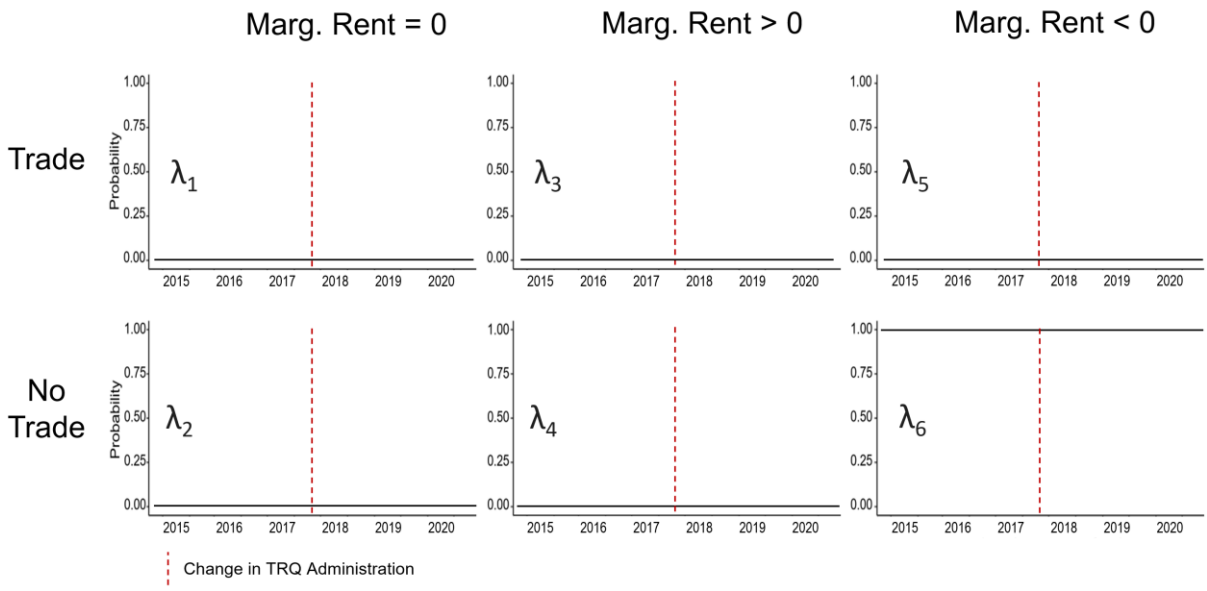

Figure B2. Marginal market outcome for table potato imports (over-quota importers): Probabilities over time. Source: own calculation (Parity Bounds Model results).

Notes: For high-quality beef and sirloin strips, the identical results apply, but with a time period from 2012-2017, with the TRQ administration change in the beginning of 2015.