The US Lamb Meat Industry: A Partial Equilibrium Analysis of Potential Trade Policy Impacts in the 2020s

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Abstract

There have been consistent calls for import relief by the US Sheep industry, dating back to 1960, due to the surge in lamb meat imports from Australia and New Zealand. The most recent call for import relief was a petition letter submitted by R-CALF USA to the US Trade Representative in 2023. This petition letter requested the initiation of a global safeguard investigation and requested the imposition of a trade policy that would increase the domestic production's market share to 50%. The main concern highlighted in the letter was the dominance of imports, which accounted for approximately 70% of the market share, thereby limiting domestic production to 30% in 2022. Using a baseline scenario analysis, dependent on base values from 2022, to determine the target tariff rate or its equivalent pure quota volume that would increase the domestic production's market share to 50%, showed that the target trade policy is extremely restrictive, leading to an increase in producer surplus, but significant decline in consumer surplus. In addition to the above, this paper aims to assess the impact of two hypothetical tariff rates; an inflation adjusted tariff rate, 21%, and Former President Trump's proposed 10% ad valorem tariff rate, using a static numerical simulation model. Under the simulation model, with declining supply and expanding demand, the effectiveness of the hypothetical tariff rates is limited and only causes temporary relief to the industry. If supply is anticipated to witness positive growth which is still slower than demand, this would increase the effectiveness of the hypothetical tariff rates, causing a significant initial jump in the domestic production's market share in the first year of its implementation, compared to the initial jump under shrinking supply. This initial jump significantly slows down the decline in the domestic production's market share, which provides room for breath for the industry.

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I thank my advisor, Rita, for guiding me through the whole process of writing this thesis, even though it has not been an easy ride.

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I am grateful to have gone through this journey as a Fulbright scholar, hence, I thank The Fulbright Program for providing me with this fruitful opportunity.

I also thank my professors and colleagues in the department for making the journey more fun and easier to go through.

Dedication

I dedicate this thesis to my unwavering support system.

First of all, I express my heartfelt gratitude to my mother and grandparents who have not forgotten me in their prayers during this journey and their complete and utter trust in my potential.

I extend my deepest appreciation to my two younger sisters; Nour and Kenzie, who have supported me emotionally and mentally, up until the last point of editing through this thesis.

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Chapter 1: Introduction

The US sheep industry has been notably shrinking since the end of World War II (Jones, 2004). Even though the industry's contributions account for less than 1% of the livestock industry receipts, it is considered a significant driver of the economies of several states (United States Department of Agriculture, 2020). As of January 2023, the top 5 states with respect to sheep and lamb numbers were Texas with 675,000 head, California with 550,000 head, Colorado with 415,000 head, Wyoming with 335,000 head, and Utah with 280,000 head (United States Department of Agriculture, 2023a). The regional distribution of sheep operations has remained consistent since the early 1900s, with it being mainly concentrated in the Western States and the Corn Belt (Jones, 2004; United States Department of Agriculture, 2020; United States International Trade Commission, 1995). Accordingly, the continuous decline in the industry could threaten the economies of those states.

Alongside various factors that will be addressed in subsequent chapters, the primary alleged reason behind the shrinkage of the industry has been attributed to the low-cost lamb meat and mutton being imported from Australia and New Zealand (Jones, 2004; R-CALF USA, 2023a; United States Department of Agriculture, 2014; United States International Trade Commission, 1995). Lamb meat is that of a younger sheep, usually under 12-14 months (United States International Trade Commission, 1990 & 1995). Meanwhile, mutton is meat of an older mature sheep (Jones, 2004).

Lamb meat and mutton domestic production has dropped from 227 million pounds in 2001 to 136 million pounds in 2022. Meanwhile, lamb meat and mutton imports have more than doubled from 146 million pounds in 2001 to 358 million pounds in 2022, where they mainly originate from Australia and New Zealand (United States Department of Agriculture, 2024b). Australia has been the major exporter to the US, representing 78% of the lamb meat and mutton imports in 2022 (United States Department of Agriculture, 2024b). Meanwhile, New Zealand has been the second major exporter to the US, representing 20% of the lamb meat and mutton imports in 2022 (United States Department of Agriculture, 2024b). This structure has remained relatively consistent over the years (United States Department of Agriculture, 2024b). Lamb meat and mutton imports have been traded duty free, since 2005, under the Australia-United States Free Trade Agreement (AUSFTA) (Australian Government, 2024; United States Customs and Border Protection, 2023a). Meanwhile, imports from New Zealand are subject to a negligible Most Favored Nation (MFN) specific tariff rate of 0.7 cents/kg for lamb meat and 2.8 cents/kg for mutton, since 2000 (United States International Trade Commission, 2024).

Prior to 2011, consumption of lamb meat and mutton had been either relatively stable or declining (United States Department of Agriculture, 2023a). However, it witnessed a significant shift in its trend

since 2011, where it has been consistently increasing (United States Department of Agriculture, 2023a). Consumption of lamb meat and mutton increased from 295 million pounds in 2011 to 484 million pounds in 2022 (United States Department of Agriculture, 2023a).

Rising consumption trends coupled with decreasing production levels have accelerated the displacement of domestic production of lamb meat and mutton by imports. This is reflected through the increase in the imports' share of lamb meat and mutton consumption, and consequently the drop in the domestic production's market share. Between 2010-2012, imports of lamb meat and mutton represented roughly 50% of consumption, however this share increased to 74% in 2022 (R-CALF USA, 2023a; United States Department of Agriculture 2023a, 2023b).

In light of the increase in the imports' market share, R-Calf USA, a non-profit organization representing the United States' cattle and sheep producers (R-CALF USA, 2023a), wrote an import relief letter to the US Trade Representative, Katherine Tai, in August 2023, (R-CALF USA, 2023a). This import relief letter highlighted the alleged harm done by New Zealand and Australian lamb meat and mutton imports and requested two main things (R-CALF USA, 2023a). The first request is the initiation of a global safeguard investigation, by the United States International Trade Commission (USITC) to prove and quantify the injury done to the industry by lamb meat and mutton imports. Meanwhile, the second request calls for implementing tariffs and a tariff rate quota (TRQ) on lamb meat and mutton imports, which would curb imports up to the point where domestic production accounts for a 50% market share in comparison to imports (R-CALF USA, 2023a).

In December 2023, a supplement to the import relief letter containing support from Members of Congress from California, Colorado, Idaho, Montana, Nevada, South Dakota, and Utah, was sent to the US Trade Representative (R-CALF USA, 2023b). It re-stated the request for the initiation of a global safeguard investigation and asked for the implementation of tariffs, TRQs or any form of quantity control to protect the domestic industry (R-CALF USA, 2023b). However, neither the main nor the supplement petition letter outlined any specific trade policy structure (R-CALF USA, 2023b, 2023a). Thus far, R-CALF USA have not received a response from the Trade Representative.

One of the highlighted points in the supplement to the import relief letter is that the US Congress has not adjusted tariff rates for lamb meat and mutton since 1930 to account for inflationary pressures (R-CALF USA, 2023b). With the current MFN specific tariff rates, it is clear that they have declined rather than increased. Under the Tariff Act of 1930, the imposed new tariff rates were 7 cents/lb for lamb meat and 5 cents/lb for mutton (R-CALF USA, 2023b). It was, therefore, pointed out in R-CALF USA's

supplement that adjusting the 1930 tariff rates for inflation should reflect a specific tariff rate of $1.25/lb for lamb meat and $0.89/lb for mutton, in 2022 (R-CALF USA, 2023b).

In light of the above, this thesis aims to contribute to the literature by pinpointing the pure tariff rate or its equivalent pure quota volume that would increase domestic production's market share to 50%, starting from approximately 30% in 2022. This is carried out utilizing baseline scenario analysis dependent on production, consumption, and price values from 2022. The reason behind choosing 2022 is that it is the year upon which R-CALF USA based their import relief letter, where it reflects their main concern surrounding the increasing imports' market share to approximately 70%. An ad valorem equivalent for the target trade policy is illustrated to be able to link it to a potential tariff rate quota. After the determination of the target trade policy, a welfare analysis is illustrated.

With no trade policies suggested and the high uncertainty regarding the petition letter's outcome, this thesis assumes two hypothetical tariff rates. The first tariff rate is the inflation adjusted tariff rate highlighted in R-CALF USA's supplement to the petition letter, which reflects a specific tariff rate of $1.25/lb for lamb meat. Using the world price of lamb meat in 2022 of $5.96/lb, the ad valorem equivalent of the inflation adjusted tariff rate is approximately 21%. The second is Former President Trump's potential 10% ad valorem tariff on all imported goods, as a part of his 2024 presidential campaign (Stein, 2023). R-Calf USA has been a strong supporter of Former President Trump's past trade policies, which focused on protecting US producers from unfair trade and import surges (R-CALF USA, 2018). It has also been a strong advocate for the imposition of tariffs on cattle, beef, and lamb imported from countries that are allegedly harming US producers (R-CALF USA, 2018). First, the impacts of the hypothetical tariff rates are illustrated using the baseline scenario analysis. Second, the thesis aims to determine the expected impact of the hypothetical tariff rates on the domestic production's market share over time. This is done through introducing growth rates of supply and demand and a time index, using a simple numerical simulation model.

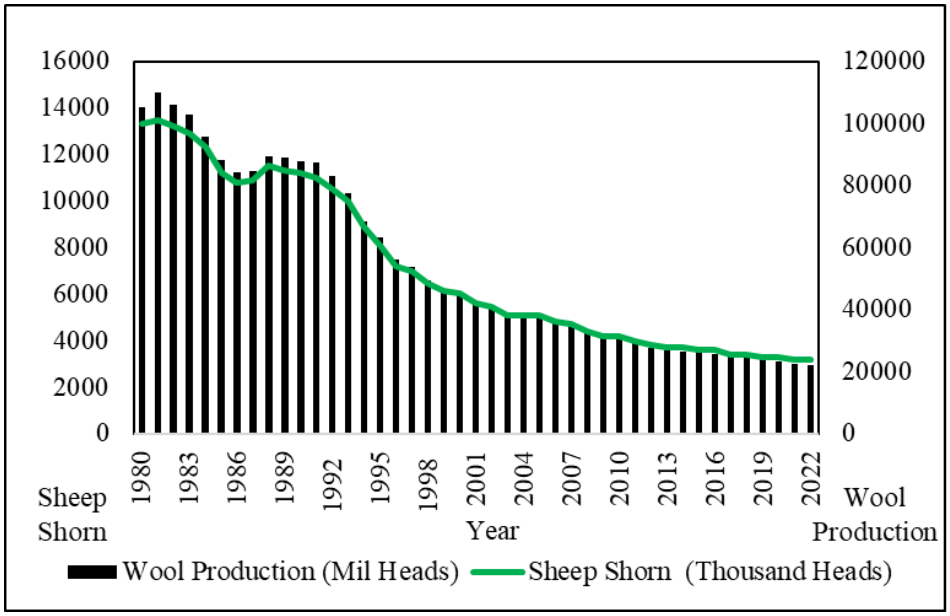
This thesis starts by shedding light on the overall US Sheep industry and the trend of various indicators over time, alongside a review of all industry actions taken towards curbing imports in Chapter 2. A comprehensive review of the literature related to tariff rate quotas and their emergence, and the lamb meat literature, including supply, demand, and trade studies, is illustrated in Chapter 3. The utilized conceptual model and the setup is explained in Chapter 4. Chapter 5 explains the data and the data sources utilized to generate results guided by the conceptual model. The results of the model are discussed in Chapter 6. Finally, Chapter 7 concludes with a discussion about the main findings and the research limitations, in addition to suggestions for future research areas.

Chapter 2: The US Sheep Industry

2.1 Industry Overview

The US sheep industry's main emphasis product has historically been wool with meat – lamb & mutton- considered a byproduct of wool (National Research Council, 2008; United States Department of Agriculture, 2020). However, two main factors are believed to have been drivers behind the drop in wool production as illustrated in Figure [2-1]. The first factor is the termination of the National Wool Act in 1993 (Jones, 2004; National Research Council, 2008). Under the introduction of this Act in 1955, wool producers were provided with direct payments through government programs, as a means of income support (American Sheep Industry, 2018; Jones, 2004; National Research Council, 2008). The termination of this program is believed to not only have driven the decline in wool production, but also the production of lamb & sheep (American Sheep Industry, 2018; National Research Council, 2008). The second factor behind wool production's decline is believed to be the introduction of synthetic fibers, a cheaper alternative to wool (United States Department of Agriculture, 2020). The drop in wool production has been translated into smaller operation sizes and declining wool revenues (Jones, 2004; United States Department of Agriculture, 2020).

Figure 2-1: US Wool Production and Sheep Shorn (1980-2022)



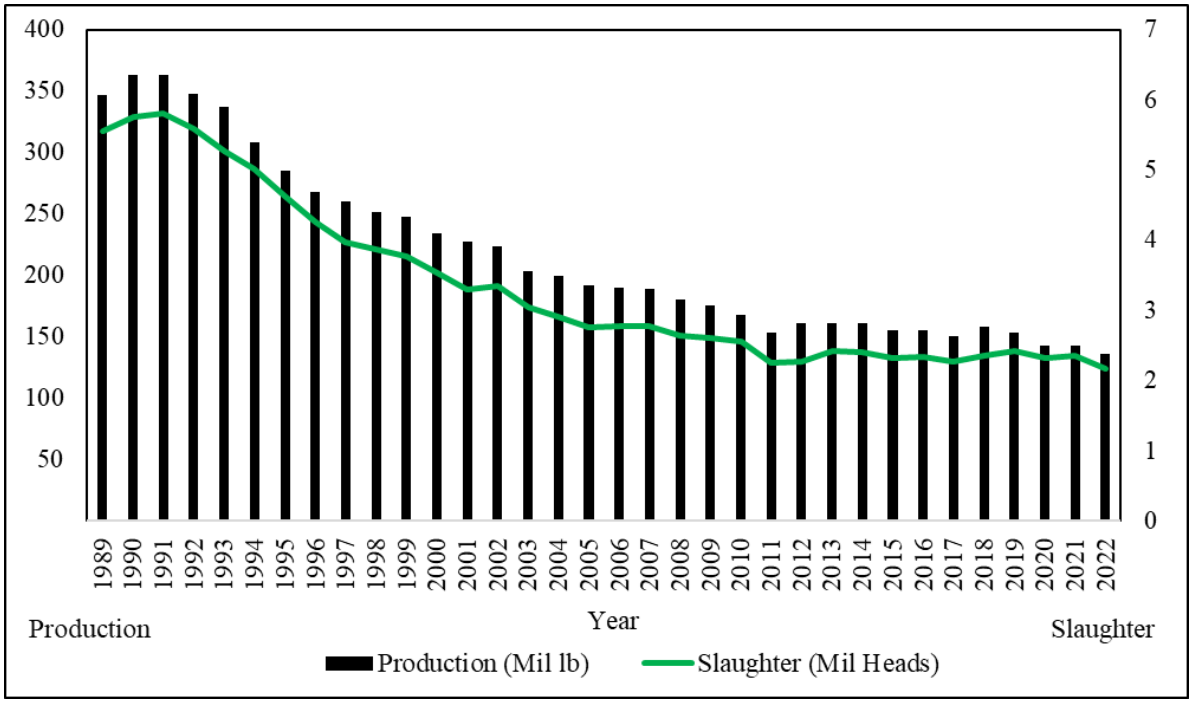
Source: United States Department of Agriculture, Economic Research Service (2023b)

Accordingly, the industry shifted its focus from wool production to meat production (Jones, 2004). However, meat production, lamb meat and mutton, has also been facing a decline as illustrated in Figure [2-2]. Slaughter dropped after 1991, after it had hit a peak of 5.81 million head (United States

Department of Agriculture, 2024c). It has not significantly risen since 1991, yet after an observable drop in 2011, it has been relatively stable compared to the prior period (United States Department of Agriculture, 2024c). With production tied to slaughter, it has also witnessed a similar trend. Domestic production hit a peak in 1991 with a production level of 363 million pounds, after which it has been observed to continue declining (United States Department of Agriculture, 2024a). However, the decline has been relatively slower since 2011.

Slaughter and production of lamb meat has consistently been significantly higher than mutton, where it represents around 96%-97% of total slaughter and production respectively (Livestock Marketing Information Center, 2023; United States Department of Agriculture, 2024a & 2024c).

Figure 2-2: US Lamb Meat and Mutton Slaughter and Production (1989-2022)

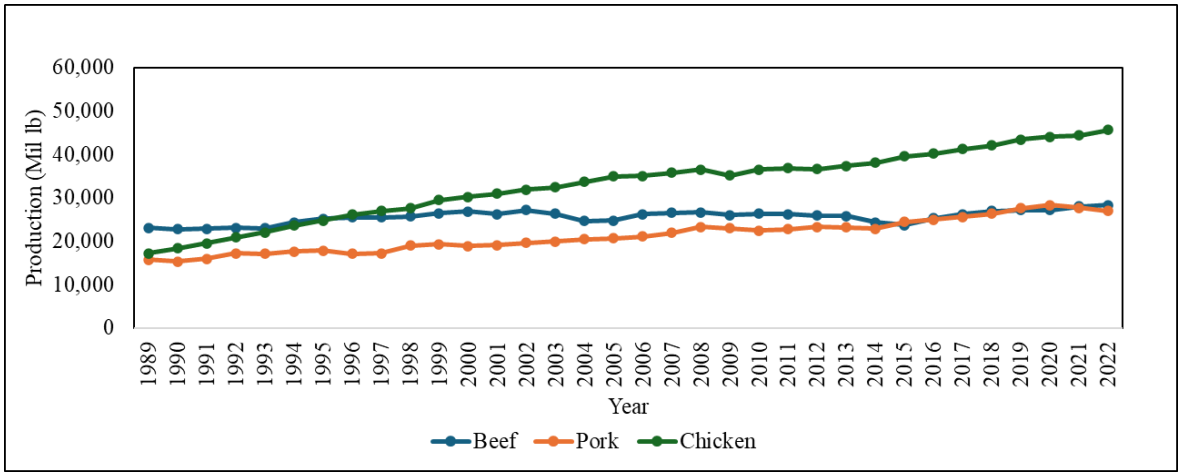


Source: United States Department of Agriculture, Economic Research Service (2024a) and National Agricultural Statistics Service (2024c)

The decline in lamb meat and mutton production is observed, not only in the industry over time, but also in comparison to other meat types; pork, beef, and chicken (United States Department of Agriculture, 2024a). Production of lamb meat and mutton is insignificant compared to total meat production (United States Department of Agriculture, 2024a). As shown in Figure [2-3], levels of production for beef, pork and chicken are at significantly higher levels compared to lamb & mutton. Production of beef has been relatively stable, while pork and especially chicken have been rising since

1989. As of 2022, production of chicken, beef, and pork were approximately 46, 28, and 27 billion pounds respectively.

Figure 2-3: US Production of Pork, Beef, and Chicken (1989-2022)



Source: United States Department of Agriculture, Economic Research Service (2024a)

In addition to the above, digging into the concentration of lamb and sheep packers adds another insight into the industry. There are no published values or firm-level data for the concentration measures by any official institutions, prior to 2010. However, it was documented in the literature that between 1980 and 1992, the four firm concentration ratio of lamb and sheep processors increased from 55% to 70% (Brester & Musick, 1995). And according to Paarlberg and Lee (2001), concentration was increasing during the 1990s.

According to the 2020 annual report published by the Packers and Stockyards division, it has been observed that the four firm concentration ratio of lamb and sheep packers has been declining as shown below in Table [2-1] (United States Department of Agriculture, 2021). The Four- Firm Concentration ratio has been lower than 60% between 2013 and 2019, while the Herfindahl-Hirschman Index (HHI) has been below 1,500 between 2015 and 2019, reflecting a low concentration market (United States Department of Agriculture, 2021).

It is important to note that one-third of lambs are slaughtered through the non-traditional lamb market, which is not included in the calculation of the official concentration values (United States Department of Agriculture, 2021). Hence, the real concentration values are actually less than those observed (United States Department of Agriculture, 2021).

Table 2-1: Concentration Measures- Lamb & Sheep Packers

Year	Herfindahl-Hirschman Index (HHI)*	Four- Firm Concentration Ratio
2010	-	65%
2011	-	67%
2012	-	62%
2013	-	59%
2014	-	55%
2015	1,093	56%
2016	1,324	59%
2017	1,210	56%
2018	1,077	55%
2019	1,059	53%

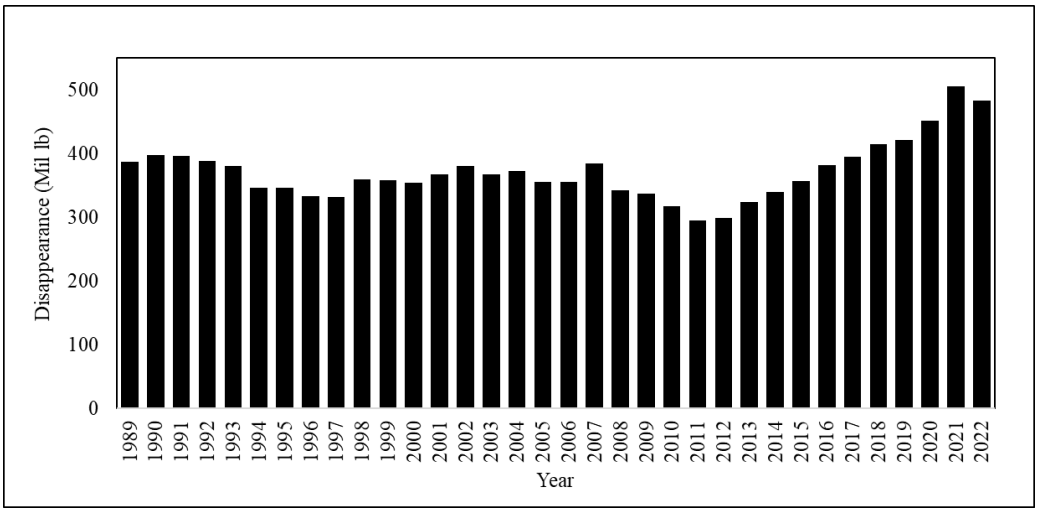
*<1,500: Unconcentrated, 1,500-2,500: Moderately Concentrated, >2,500: Highly Concentrated

Source: United States Department of Agriculture, Agricultural Marketing Service (2021)

As for the disappearance of lamb meat and mutton, which is used as a proxy for consumption, it has ranged between 300-400 million pounds prior to 2011 (United States Department of Agriculture, 2024a). It dropped in 2011 to 295 million pounds from 317 million pounds in 2010. However, since 2011, it has witnessed an upward trend as shown in Figure [2-4] (United States Department of Agriculture, 2024a). This represents a major structural change since it has been observed to be either stable or declining prior to 2011. Moreover, similar to the pattern in slaughter and production, lamb meat has a significantly higher level of consumption relative to mutton (United States Department of Agriculture, 2024a).

It has been observed that demand for lamb meat and mutton for developed economies, such as the United States and the United Kingdom is no longer driven by the expansion in household incomes and population growth rates, unlike developing countries (Meat & Livestock Australia, 2021). It is believed that demand for lamb meat and mutton is less affected by purchasing power but driven by the quality of meat and consumer preferences (Meat & Livestock Australia, 2021). This is evident in lamb meat demand studies that have concluded that income is not a significant driver of lamb meat consumption (Byrne et al., 1983; Purcell, 1989; RTI International, 2007; Williams et al., 2010).

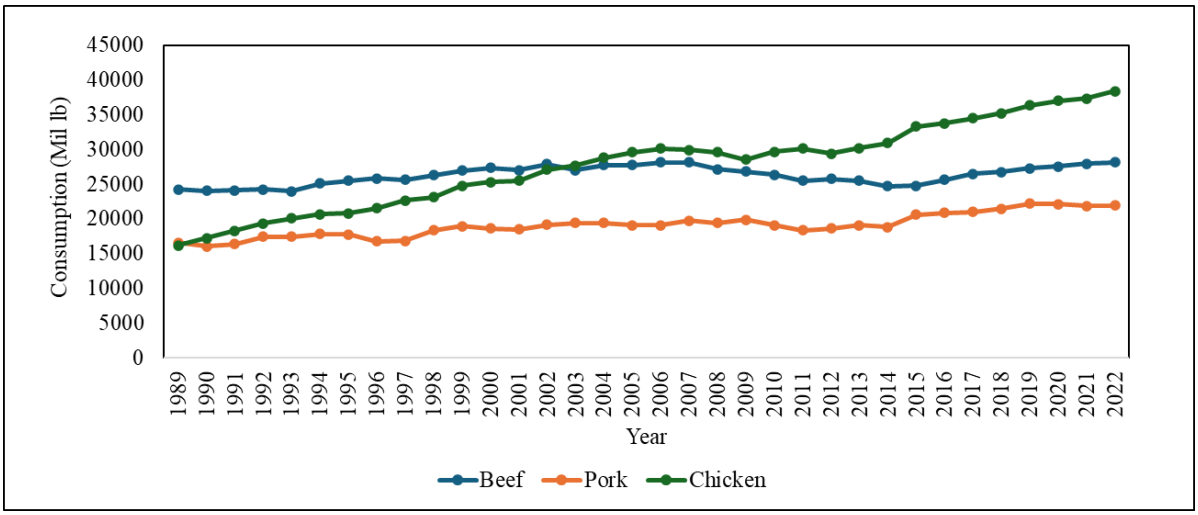
Figure 2-4: US Lamb Meat and Mutton Disappearance



Source: United States Department of Agriculture, Economic Research Service (2024a)

Comparing the consumption of lamb and mutton to other meat types; pork, beef, and chicken, reflects that it is also insignificant. Consumption of pork and beef has been relatively stable, but chicken has been increasing since 1989 as illustrated in Figure [2-5]. As of 2022, consumption of chicken, beef, and pork were approximately 38, 28, and 22 billion pounds respectively.

Figure 2-5: US Disappearance of Pork, Beef, and Chicken (1989-2022)

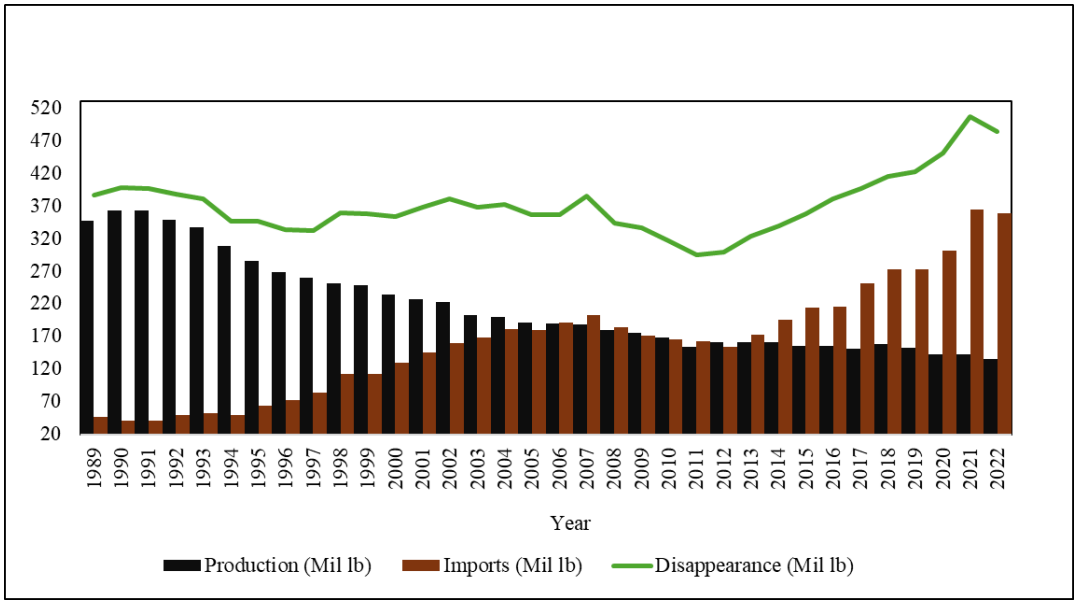


Source: United States Department of Agriculture, Economic Research Service (2024a)

Looking at production, consumption, and imports of lamb and mutton's interaction over the years, as illustrated in Figure [2-6], it reflects that any excess demand was met through importing. Imports of lamb meat and mutton more than doubled between 2001 and 2022, where it started at 146 million pounds in 2001 and skyrocketed to 358 million pounds in 2022 (United States Department of

Agriculture, 2024a). Between 2010-2012, imports of lamb meat and mutton represented roughly 50% of consumption, however this share increased to 74% in 2022 (R-CALF USA, 2023a; United States Department of Agriculture 2023a, 2023b). Moreover, comparing lamb meat and mutton, lamb meat imports represented 78% of the total lamb meat and mutton imports in 2022.

Figure 2-6: US Lamb and Mutton Production, Disappearance, and Imports (1989-2022)



Source: United States Department of Agriculture, Economic Research Service (2024a, 2024b)

With lamb meat representing the vast majority of slaughter, production, consumption, and import levels, in comparison to mutton, and the focus of all import relief calls being on lamb meat only, as will be further elaborated in the next section, it is important to note that the analysis in this thesis will focus on lamb meat and disregards mutton. A detailed data description and deeper analysis of the variable trends will be tackled in Chapter 5 for lamb meat only.

2.2. Industry Action

With lamb meat imports being the alleged culprit behind the shrinkage of the US sheep industry, there have been multiple attempts by the industry to call for import relief. This pattern is traced back to 1960, when the Tariff Commission conducted an escape clause investigation, but the results did not reflect significant harm to the industry due to the imports (United States International Trade Commission, 1990).

This was followed by another petition claiming that lamb meat being imported from New Zealand is being subsidized and called for the imposition of a countervailing duty (United States International Trade Commission, 1990). However, the petition was withdrawn, and the investigation was terminated.

A similar petition was filed three years later, but investigations concluded that the imports were not materially injuring the domestic industry (United States International Trade Commission, 1990). Another attempt was made in 1985, however it was successful and countervailing duties were imposed on New Zealand lamb meat imports from 1985 until 1995 (United States International Trade Commission, 1990). Opposite to the industry's expectations, the imposition of the countervailing duties did not have the expected significant structural change in the industry, due to trade diversion (Babula, 1997). With US consumers considering lamb meat imported from Australia and New Zealand as close substitutes, there was a shift in importing patterns from New Zealand to Australia (Babula, 1997).

Three years later, in 1998, a group of lamb growers and lamb processors filed a petition with the USITC, claiming that the increase in the lamb meat imports from both Australia and New Zealand is injuring the domestic industry and import relief was requested through the imposition of a TRQ (Paarlberg & Lee, 2001; United States International Trade Commission, 1999). In response to this petition, the USITC initiated an investigation, which concluded that the industry was significantly materially injured due to the imports, and three alternative trade policies were recommended to President Clinton (Paarlberg & Lee, 2001; United States International Trade Commission, 1999). In 1999, President Clinton gave the order to impose a three-year TRQ on lamb meat, which was believed to be more restrictive than the initial USITC's recommendations (Paarlberg & Lee, 2001; World Trade Organization, 2000, 2001)

The TRQ was met with an objection from New Zealand and Australia in the World Trade Organization (WTO) (United States International Trade Commission, 2002; World Trade Organization, 2000, 2001). It was outlined in Australia's submission to the WTO that the USITC failed to correctly define the domestic market and prove that significant injury was detected, which meant that the TRQ did not satisfy global safeguard rules, outlined by the WTO (World Trade Organization, 2000). In 2001, the TRQ was terminated by President Bush to comply with the WTO's dispute panel ruling (Paarlberg et al., 2001; United States International Trade Commission, 2002).

Studies analysing the effectiveness of the implemented 1999 TRQ indicated that it did not lead to the intended significant outcome in the industry (Jones, 2004; Paarlberg et al., 2001; R-CALF USA, 2023a). This was mainly drawn back to the depreciation of the Australian and New Zealand currencies against the US dollar during the period of the TRQ's implementation, which offset any expected impacts (Jones, 2004; Paarlberg, Lee, & Eales, 2001; R-CALF USA, 2023a).

Moving forward to 2023, given the significant surge in the volume of imports accompanied by continuous price under-cutting, there were suspicions that dumping is present in the US lamb industry

(American Sheep Industry, 2023a). Dumping is defined as '*the export of a commodity below cost or the sale of the commodity at a lower price abroad than domestically*'(Salvatore, 2013). Accordingly, in May 2023, the American Sheep Industry (ASI) funded a preliminary investigation, with the support of a law firm, Kelly Drye and Warren, to conclude whether the injury done to the lamb industry is due to dumping or not (American Sheep Industry, 2023a). This was to assess the possibility of filing a trade case calling for the imposition of an anti-dumping duty (American Sheep Industry, 2023a).

The memorandum provided by the law firm, in December 2023, indicated that there was injury to the domestic industry, but there were no significant dumping margins that reflect trade law violations (American Sheep Industry, 2023b). In addition to the above, it clearly stated that the imposition of any trade policy would not lead to significant impacts in the industry (American Sheep Industry, 2023b). Not only would the imposition of trade policy be ineffective, but there is a legislating restriction when it comes to the implementation of a tariff or a quota through the US congress (American Sheep Industry, 2023b). Based on the investigation results, ASI decided against pursuing a trade case, given the high costs of a trade case compared to its expected outcome (American Sheep Industry, 2023b).

In parallel to ASI's investigations, R-CALF USA submitted their petition letter; as of yet, the Trade Representative has not responded.

Chapter 3: Literature Review

3.1 The Introduction of TRQs

A tariff rate quota (TRQ) is a trade policy tool that combines a tariff and a quota, commonly referred to as 'a two-tiered tariff system'. It specifies a volume of imports of a good, 'quota', and two tariff rates: an in-quota tariff rate and an over-quota tariff rate (Skully, 2001). An in-quota tariff rate is a lower tariff rate imposed on the volume of imports until the specified quota (Skully, 2001). Meanwhile, an over-quota tariff rate is a higher tariff rate imposed on the volume of imports exceeding the specified quota (Skully, 2001). TRQs were introduced into the agricultural trade scene after the 1994 Uruguay Round Agreement on Agriculture (Boughner et al., 2000; Herrmann et al., 2001). Prior to the Uruguay Round, agricultural tariff rates were set at their highest levels and there was a significant existence of non-tariff trade barriers (Abbott, 2002). The main objective of this round was to liberalize trade in the agriculture sector, through replacing non-tariff trade barriers and quantitative restrictions with tariffs, alongside reducing the existing high tariff rates (Boughner et al., 2000; Herrmann et al., 2001; Skully, 2001). To avoid converting the non-tariff barriers into extremely high tariffs, 'dirty tariffication', and to guarantee a minimum level of market access, TRQs were introduced as a new tool in agricultural trade (Boughner et al., 2000; Carter & Li, 2005; Herrmann et al., 2001; Lim & Babula, 2012).

The introduction of TRQs in 1994 was considered a compromise for the exporters of goods that were seeking more market access and those that viewed tariffication as an important means towards liberalizing agricultural trade (Abbott & Morse, 2000). When a TRQ was imposed on a good, the country would set up a country notification schedule to the WTO specifying the specified quota, the lower tariff rate, and the Most favored Nation tariff rate acted as the higher tariff rate (Abbott, 2002). As for the level of the quota under the TRQs, it was usually set between 3%-5% of consumption or current level imports, whichever was of a higher level (Abbott, 2002). Moreover, it was left to the discretion of each country the method of TRQ administration as long as it was clearly outlined in the notification schedule (Abbott, 2002). The introduction of TRQs in the Uruguay Round was expected to act as a potential future negotiation basis for further liberalization (Beckman et al., 2021).

One of the first studies that simulated the impact of implementing a TRQ, was a study by Abbott and Paarlberg (1998), which focused on the pork industry in the Philippines. Abbott and Paarlberg (1998) utilized a simple linear partial equilibrium simulation model and concluded that the TRQ is expected to lead to small initial increases in imports, which would then expand over the 10- year simulated period. This is expected to be coupled with declining domestic prices. Their model depended on linear supply and demand functions, which were benchmarked to a base year scenario, an autarky scenario in their case. This is drawn back to the imposition of an import ban prior to adopting the TRQ. Moreover,

it included the growth rate of supply, to indicate the expanding supply. On the other hand, since the Philippines was exhibiting exponential increase in income and population at the time of the study, they were incorporated as drivers of demand growth. The main findings of their study estimated that imports under a TRQ were expected to increase compared to an autarky scenario, however, with the demand growing at a faster rate than the supply, the specified quota became an irrelevant tool and only the higher tariff rate was the significant trade policy in this industry (Abbott & Paarlberg, 1998). In addition to the above, they also concluded that the existence of quota rents under a TRQ and uncertainty about the allocation mechanism for the TRQ will affect the timing of the imports, since importers have the incentive to purchase the good before the quota is reached, then sell it afterwards when it hits the higher domestic price (Abbott & Paarlberg, 1998).

Boughner et al. (2000) highlighted that to achieve the maximum trade liberalization impact intended through setting the TRQ, it was important for policy makers to state which tool under the TRQ is effective; the low tariff rate, the high tariff rate, or the quota. This is consistent with the results obtained by Abbott and Paarlberg (1998). Moreover, a portion of the impact of a TRQ lies in the clarity of the TRQ's administration method, which then clearly outlines the allocation of the quota rents (Boughner et al., 2000). This maximizes economic welfare and helps minimize the inefficiencies associated with TRQs (Boughner et al., 2000).

All previously cited studies assumed perfect competition scenarios and disregarded any vertical linkages between the industries. Chang and De Gorter (2004), however, simulated the impact of imposing a TRQ in the rice industry in Taiwan, under the assumption that rice processors had oligopoly power. They also incorporated the downstream and upstream linkage, the farm level, and the consumer level (Chang & De Gorter, 2004). Taiwan joined the WTO in 2002 and switched from an import quota regime into a TRQ regime (Chang & De Gorter, 2004). Their main findings were that the market structure plays an important role in the likely impact of a TRQ on domestic production and prices. When processors have a high degree of market power, both domestic production and prices tend to decrease. This leads to a high level of imports, exceeding the specified quota and hence, the out of quota tariff rate is effective. The opposite impacts are expected with a lower degree of market power.

3.1.1 TRQs in the US

Even though TRQs were originally introduced as a trade liberalization tool, it is also imposed as a protectionist trade policy, aiming to curb imports. The United States has imposed TRQs on various agricultural imports over the years, such as beef, lamb meat, dairy products, sugar, and peanuts (Beckman et al., 2021; Brester & Musick, 1995; Orden, 2001; Skully, 1999). However, the aim of imposing TRQs in different markets is not the same. The imposition of TRQs on beef (Brester &

Musick, 1995), sugar (Orden, 2001), and peanut imports (Skully, 1999) was in line with calls for the further liberalization of trade, after the introduction of TRQs in the 1994 Uruguay round. Meanwhile, its imposition on lamb meat imports aimed to protect the domestic industry from the import surge (Paarlberg & Lee, 2001).

After the imposition of the lamb meat TRQ in 1999, Paarlberg and Lee (2001) simulated the impact of six different trade policy scenarios in their study, through a quantitative partial equilibrium model setup. The six trade policy scenarios included the base tariff rate, the USITC's three recommended trade policy scenarios, the petitioner's requested trade policy, and the implemented TRQ, announced by President Clinton. They conducted their analysis on a quarterly basis, assuming the TRQ would adjust quarterly. Moreover, they considered two aspects; the first is the possible existence of market power, oligopsony and/or oligopoly, by lamb meat packers, the second is the vertical interlinkage of the lamb meat production with slaughter. Their main finding highlighted the fact that if the 2001 trade policy, represented in a $0.008/kg specific tariff rate, continues, the lamb industry is expected to continue shrinking, with increasing lamb prices. Moreover, the president's TRQ that was implemented is expected to benefit the packers, but harms the lamb growers, especially during the first two simulated years, since the TRQ is binding, where imports are exactly equal to the specified quota (Skully, 2001). When TRQs are binding, packers realize their market power and intentionally reduce slaughter to increase the market price of lamb meat. However, this reduced slaughter represents a reduced demand on lamb, which reduces the price of lambs, and hence, harms the lamb producers. In doing so, they estimated a simple lamb meat demand function on a quarterly basis and generated a price elasticity of demand of -0.437, which is considered the lowest value in the literature.

A follow up study was done by Paarlberg, Lee and Eales (2001) after additional information regarding the TRQ emerged. The main observed difference was that the actual TRQ was imposed annually rather than quarterly. Re-simulating the Paarlberg and Lee (2001) model showed that annual quotas limit the packers' exploitation of market power. Another difference observed is that the US was requested to terminate the TRQ by the WTO, in response to an objection from Australia and New Zealand to the US policy. Simulating the termination of the TRQ in the third year of implementation showed magnified lamb producer welfare loss. Consistent with Paarlberg, Lee and Eales (2001) finding, Jones et al. (2003) and Jones (2004) concluded that the TRQ did not have its intended impact, especially on domestic prices, due to the appreciation of the US dollar against Australia and New Zealand's currencies.

To the best of my knowledge, Paarlberg and Lee's (2001) paper was the only study in the lamb meat's trade policy literature to analyse the expected impacts of the three forms of trade policy in the industry. In addition to the above, it could be inferred that all the studies in the TRQ literature had already existing

TRQ setups to incorporate in their analysis, either though WTO notifications (Abbott & Paarlberg, 1998; Chang & De Gorter, 2004) or USITC investigation outcomes (Paarlberg & Lee, 2001).

3.2 US Lamb Meat Industry

Studies on the US lamb meat industry have been extremely limited and outdated, to some extent. Also, findings have been inconsistent across different studies. This is drawn back to two main reasons. The first reason is related to the data. Given the relatively small size of the lamb meat industry, data is not readily and publicly available to support consistent research. Production and Disappearance data, illustrated in the previous chapter, is reported by the United States Department of Agriculture (USDA), however it bundles lamb meat and mutton together. The only institution that reports production data for lamb meat separately is the Livestock Information Marketing Center, which is a private institution that provides data based on membership. Moreover, the available data, especially for prices, suffers immensely from either a relatively significant gap in data observations or it has witnessed a change in its calculation method or reporting institution. This means that every study overcame the data deficiency in a different manner, depending on different methodologies, leading to different results. The second reason behind the different findings is the different frequencies incorporated in the studies; bimonthly, monthly, quarterly, and yearly.

One of the most important indicators, required for industry analysis that has suffered from the above-mentioned limitations is the retail price of lamb meat (National Research Council, 2008; Purcell, 1989). It was observed that the USDA reported lamb meat retail prices until 1981, then ASI started contracting it to a private firm in 1987, but it did not continue reporting it for a long period of time (Byrne et al., 1993). The USDA's Agricultural Marketing Service resumed reporting and publishing it starting in 2017 (United States Department of Agriculture, 2024d). Researchers have overcome the limitations by using the wholesale price (Byrne et al., 1993; Purcell, 1989), or the Bureau of Labor Statistics retail lamb meat price, which has been terminated, (Schroeder et al., 2001; Shiflett et al., 2007) as either proxies of the retail lamb price or as a base to impute the missing observations. One of the most representative wholesale prices for the retail price of lamb meat was the price of East Coast Lamb, however, it has also been discontinued by the USDA after the first quarter of 2017 (United States Department of Agriculture 2007, 2024a). Due to the small number of packing plants reporting back to the USDA in the lamb meat market, official statistics are occasionally withheld to follow the '3/70/20' confidentiality guideline under the Livestock Mandatory Reporting Act (Jones, 2004; United States Department of Agriculture, 2001). This is an issue, not only for research progress, but also for the information availability among the participants in the industry. In 2018, a report was prepared by the USDA and submitted to Congress discussing potential solutions in data collection and confidentiality

thresholds, to deal with the spotty price data series, especially those related to the livestock and wholesale sector of the lamb industry (United States Department of Agriculture, 2018b).

3.2.1 Lamb Meat Demand

Lamb meat demand studies have been consistent with respect to the significance of the price of lamb meat on lamb consumption. Earlier studies concluded that the demand for lamb meat was price elastic (Debertin et al, 1983; George & King, 1971), but the most recent studies have concluded that it is, in fact, price inelastic (Byrne et al., 1993; Ghosh & Williams, 2016; Paarlberg & Lee, 2001; Purcell 1989; RTI International, 2007; Shiflett et al., 2007; Williams et al., 2010). The range of price elasticity of demand in the literature for recent studies, disregarding outliers, is between -0.437 generated by Paarlberg & Lee (2001) and -0.75 by Williams et al. (2010). However, results have been inconsistent regarding the possible substitutes and complements, as well as income. Table [3-1] summarizes the frequency, years covered and the generated elasticity values for each study.

Studies in the lamb meat demand literature can be divided into two groups, based on their research objectives. The first group of studies aimed to determine the main drivers behind lamb meat consumption and generate their respective elasticities. One of the earliest studies in the literature to study consumer's demand for different food commodities, including lamb meat was George and King's (1971) study. They concluded that demand for lamb meat was price elastic at -2.63. They included the interaction with other related products and income; however, they didn't report their significance. Consistent with George and King (1971), Debertin et al. (1983) concluded that demand for lamb meat was price inelastic at -2.137. Their main finding indicated that lamb meat and beef were substitutes. Moreover, they concluded that seasonality was a significant driver of lamb meat consumption since they analyzed lamb meat consumption on a monthly basis.

In contrast to George and King (1971) and Debertin et al. (1983), Purcell (1989) concluded that demand for lamb meat was price inelastic at -0.511. One of his main findings indicated that income and meat consumption had a positive relationship, yet it is not a significant driver of lamb consumption. He also concluded that lamb meat had no substitutes. Similar to Purcell (1989), Byrne et al. (1993) concluded that demand for lamb meat was price inelastic at -0.62 and income does not significantly drive consumption. They also concluded that pork was a substitute for lamb meat.

Shiflett et al. (2007) also concluded that demand was price inelastic at -0.66, which is a close value to that generated by Byrne et al. (1993). They concluded that both beef and pork were substitutes for lamb meat. Consistent with Byrne et al. (1993) and Debertin et al. (1983), they also concluded the

significance of seasonality. Moreover, they concluded that lamb meat is a normal good with income being a significant driver of lamb meat consumption.

It is important to note that one study by Schroeder et al. (2001) generated an outlier price elasticity of demand of -1.09, which has been questioned in other studies (Williams et al., 2010; Shiflett et al., 2007). Schroeder et al. (2001) concluded that there was a significant inverse relationship between lamb meat and income, indicating that lamb meat is an inferior good. It was pointed out in later studies that the methodology used by Schroeder et al. (2001) suffered from model misspecification, causing biased results due to multicollinearity (Williams et al., 2010; Shiflett et al., 2007).

The second group of studies in the lamb meat demand literature had different research objectives compared to the first group. It was observed that the second group aimed to analyze the impact of previously neglected factors on lamb meat consumption. The different factors included in the most recent studies were the impact of alternative marketing arrangements (RTI International, 2007), lamb promotion and marketing activities (Ghosh & Williams, 2016; Williams et al., 2010), and ethnic minorities through consumer survey studies (Shiflett et al., 2010; Williams et al., 2011). A comprehensive industry report conducted by RTI International (2007) for the Grain Inspection, Packers and Stockyard administration aimed to analyze the impact of alternative marketing arrangements on the livestock and lamb meat industry. Alternative marketing arrangements are procurement alternatives to the cash market, which refers to the means by which livestock and meat in the industry are marketed for every subsequent level of processing in the industry (Koontz & Lawrence, 2010; RTI International, 2007). This was the only study in the literature to differentiate in its analysis between domestic and imported lamb meat. RTI International (2007) concluded that there is an expectation that the dependence on alternative marketing arrangements would increase in the industry as a means of facing the industry's contraction and import competition. Moreover, they concluded that any restrictions in the usage of alternative marketing arrangements lead to small, but statistically significant impacts in the industry. This is observed through a decline in the quality of lamb meat, a reduction in domestic retail demand of lamb meat, and an increase in processing costs. In doing so, they generated a price elasticity of domestic demand of -0.523 and concluded that chicken was a substitute for lamb, which was a different finding compared to previous studies.

In 2002, the 'American Lamb Checkoff' program was created, after the issuance of the Lamb Promotion, Research, and Information Order, by the Agriculture Marketing Service (Jones, 2004; United States Department of Agriculture, 2002). This program is directed by the American Lamb Board (ALB) (American Lamb Board, 2024; United States Department of Agriculture, 2002). Under the program, assessment fees are collected at the time of sale of all sheep or lambs of any age. This collected

fee is then utilized in 3 main focus areas for lamb: (1) Lamb Promotion. (2) Research. (3). Information Exchange and Dissemination between producers and consumers (American Lamb Board, 2024; United States Department of Agriculture, 2002). Both Williams et al. (2010) and Ghosh and Williams (2016) used promotion expenditure data, provided by the ALB and ASI, to study the impact of promotion and marketing on lamb meat consumption. They both concluded that promotion and marketing activities have had a significant impact, not only on increasing the overall demand for lamb meat, but specifically on the demand for domestically produced lamb meat. This is in line with ASI's claim that the industry, represented by the sheep ranchers, lamb feeders and lamb meat processors, has significantly benefited from the promotion of lamb meat (American Sheep Industry, 2024a). The industry had suffered under the absence of American lamb promotion (American Sheep Industry, 2024a). Accordingly, it is clear that promotion and marketing expenditures are significant drivers of lamb meat consumption.

In reaching their conclusion, Williams et al. (2010) generated the highest value for the price elasticity of demand of -0.75. They reached consistent results regarding pork and beef being substitutes for lamb meat as Shiflett et al. (2007). However, they concluded that income was not a significant driver of consumption. Ghosh and Williams (2016) generated a price elasticity of demand of -0.62. Moreover, consistent with lamb being a normal good, there is a positive and significant relationship between income and demand with an income elasticity of 0.25. However, the authors reported that the income's coefficient had a relatively high p-value, indicating it is not a highly significant driver of lamb meat consumption.

Shiflett et al. (2010) concluded that ethnic minorities in the US accounted for more than 50% of lamb meat consumption in 2008. It was expected that the expansion in ethnic minorities would lead to exponential growth in consumption (National Research Council, 2008; Shiflett et al., 2010; Williams et al., 2011). With the lack of official demographic statistics on ethnic consumers, Williams et al. (2011) conducted a survey study targeting five ethnic groups: Muslims, Jews, Asians, Hispanics, and Greeks. It was clear from the survey that the price of lamb meat was an important driver of consumption. Moreover, more than half of the respondents were not aware of the origin of the lamb purchased. This research was prepared for ALB to utilize findings related to buying patterns and lamb preparation, in their marketing and promotion strategies.

This further supports the findings of National Research Council's (2008) study which analyzed the impact of Orthodox and Muslim holidays on lamb slaughter. They concluded that religious holidays had significant positive impacts on slaughter. Accordingly, it is also clear that ethnic minorities drive the consumption of lamb meat.

Table 3-1: Summary of Demand Elasticity Values from the Literature

Study	Frequency & Years	Own - Price	Cross- Price			Income	Advertising
			Beef	Pork	Chicken		
Ghosh & Williams (2016)	Annual (1987-2013)	-0.62	0.46	0.47	ns	0.25	0.037
Williams et al. (2010)	Annual (1978-2009)	-0.75	0.626	0.405	ns	ns	0.040
RTI International (2007)	Annual (1970-2003)	-0.523	ns	ns	0.350	ns	-
Shiflett et al. (2007)	Quarterly (1980-2005)	-0.665	0.486	0.179	ns	0.684	-
Schroeder et al. (2001)	Quarterly (1978- 1999)	-1.09	0.57	ns	ns	-0.54	-
Paarlberg & Lee (2001)	Quarterly (1989-1998)	-0.437	-	-	-	-	-
Byrne et al. (1993)	Bimonthly (1978-1990)	-0.5671	ns	0.1187	-	ns	-
Purcell (1989)	Annual (1970-1987)	-0.511	ns	ns	ns	ns	-
Debertin et al. (1983)	Monthly (1964-1980)	-2.137	1.518	ns	ns	-	-
George & King (1971) *	Annual (1946- 1968)	-2.63	0.589	0.891	0.234	0.571	-

ns= not significant, - = not included in the analysis, *= significance not reported.

Source: Williams et al (2010) and author's literature review.

3.2.2 Lamb Meat Supply

There is a gap in studies analyzing the supply of lamb meat in the US and its structure. The industry is considered one of the most complex industries, despite its relatively small size (National Research Council, 2008). The only study in the literature that generated a value for the supply elasticity of lamb meat price was RTI International (2007). This value was 0.15. It is consistent with the expectation that supply of lamb meat would be inelastic due to its dependence on slaughter and the lamb cycle (Jones, 2004; RTI International, 2007). This makes it difficult to significantly change lamb meat output due to a price change. RTI International (2007) pointed out that one of the main limitations of modeling

livestock-meat supply functions often result in negative values of meat supply elasticities of price. This is drawn back to the existence of multicollinearity or problems with the units of measurement for the observations used in the data set (RTI International, 2007). This is a potential explanation behind the lack of studies on the supply of lamb meat and the corresponding price elasticity estimates. To avoid multicollinearity issues in their supply of retail lamb meat function, they imputed the value of the elasticity, based on the elasticity of feeder lamb supply and the price transmission between the feeder lamb price and retail meat price (RTI International, 2007).

There are a number of issues facing the supply side of the industry, which have been considered reasons behind its decline alongside the surge of imports. It is clear that the US has a relative disadvantage when it comes to the production of sheep (Muhammad et al., 2007). The first aspect is the rising costs of producing sheep. In Australia and New Zealand, sheep producers are able to use pastures for the sheep's entire production cycle, due to its low cost compared to grain feeding (Muhammad et al., 2007). Meanwhile, US sheep producers rely on pastures for the first stage of lamb production then they are moved to feed grains, which comes at a relatively high cost (Muhammad et al., 2007). There is a limit on the availability of pastures for use in the US, due to the existence of grazing permits and restrictions (National Research Council, 2008). Moreover, since lamb are grain-fed, there is also the problem of leading to excessive fats or 'the over-finished' problem in lamb production (Jones, 2004; Muhammad et al., 2007).

Another significant issue is the death of lamb and sheep. The US has a significantly high rate of deaths and losses (Jones, 2004). Two main reasons cause this high rate of loss; disease spread and predators (Jones, 2004; R-CALF USA, 2023a). Disease spread among lamb is traced back to poor hygiene management of the flock (Jones, 2004). This significantly harms the productivity of the flocks, the potential to export livestock and meat and increases production costs even further (Jones, 2004). Even though disease exists among flocks in Australia and New Zealand, it is more closely monitored than the US, further supporting their export flows (Jones, 2004).

Loss to predators also counts as a high production cost, mainly due to the mechanisms of dealing with natural predators (Gee et al., 1977; Jones, 2004; National Research Council, 2008). This issue has been persistent and has been traced back in the literature to 1974 (Gee et al., 1977). Predators of US lamb are mostly coyotes, followed by dogs, foxes, mountain lions, bobcats, and eagles (Gee et al., 1977; Jones, 2004). In the US, there is a restriction on the usage of chemicals in controlling predators, especially compound 1080 or what is known as 'lethal baiting (Government of South Australia, 2024; R-CALF USA, 2023a). It is restricted only to the usage in livestock protection collars for coyotes. There are other non-lethal methods in predator control, such as fencing, guardian animals, shed lambing and

herding, however for producers with larger flock sizes, it is not as efficient (Jones, 2004; National Research Council, 2008). Meanwhile, in Australia, there are also regulations regarding the usage of lethal baiting, but it is more widely used (Government of South Australia, 2024).

One other factor cited in the literature as a reason behind the decline of the industry was the termination of the National Wool Program, which was introduced in 1955 (National Research Council, 2008). With its termination in 1993, the industry declined at an even faster rate (National Research Council, 2008). In addition to the above, concentration among lamb meat processors was claimed to be one factor behind the industry's decline, yet studies have not proved that it was a significant driver (Jones, 2004; National Research Council, 2008; United States International Trade Commission, 1999).

Hence, it is clear that despite the small size of the industry, it has complex interlinkages leading up to the production of meat, which requires further research to model. Moreover, it could be concluded that there are persistent issues facing the supply side of the industry, regardless of the import surge.

3.2.3 Lamb Meat Trade

It has been concluded that domestic and imported lamb meat are perceived as close substitutes by multiple USITC (1990, 1995, 1999, & 2002) investigation reports as well as RTI International (2007). To generate results for USITC 's 1995 Report, which was analyzing the conditions of the lamb meat market, a survey was sent out to a group of representative respondents asking about the domestic and imported lamb meat (United States International Trade Commission, 1995). The questionnaire included questions related to the quality, the palatability, the fat content, the consistency of product specifications, the shelf-life availability, and many other factors (United States International Trade Commission, 1995). The results of this questionnaire proved that domestic and imported lamb meat are considered substitutes, with no significant signs of heterogeneity (United States International Trade Commission, 1995). It is important to note that studies in the literature have not generated a value for the elasticity of substitution between domestic and imported lamb meat imports. Moreover, there have also been no consumer choice studies.

Two studies analyzed the import demand for both lamb meat and mutton. Jones et al. (2003) was the first to study the US demand for imported lamb meat and mutton with the aim of generating own and cross price elasticities. They differentiated the imports based on their origin, New Zealand & Australia. One of their main findings was that demand for meat- lamb & mutton- is inelastic regardless of the source, with New Zealand being highly inelastic. Moreover, they also concluded that whenever the US increases its total demand for meat, the share of Australia and New Zealand from total demand will more than proportionately increase, meanwhile the US domestic demand's share will less than

proportionately increase. Jones et al. (2003) explicitly mentioned that one of their study limitations was the usage of wholesale prices, due to the absence of a consistent retail price series. However, one of their main findings was that the imports of lamb meat from New Zealand and Australia are close substitutes (Jones et al., 2003). Muhammad et al. (2007) further differentiated the demand by their quality; chilled or frozen. Consistent with Jones et al.'s (2003) findings, Muhammad et al. (2007) also found that the demand for lamb meat from New Zealand was the most inelastic. Their main findings related to the different lamb meat cuts showed that the demand for chilled lamb was elastic from both New Zealand and Australia, and the demand was also elastic for frozen lamb from Australia, however it was closer to being a unit elastic value (Muhammad et al., 2007). Moreover, they concluded that lamb quality is an important factor in the US lamb meat market, with chilled imports preferred over frozen imports (Muhammad et al., 2007).

Only three studies have analyzed trade policy impacts on the industry. The first study is by Babula (1997), which aimed to assess the economic impact of the countervailing duty imposed on lamb meat imports from New Zealand in 1995 after its termination. Babula (1997) concluded that the countervailing duty did not lead to the anticipated structural change in the industry. This was drawn back to the substitutability of lamb meat imports from New Zealand and Australia, rendering a one-sided trade policy essentially ineffective (Babula, 1997). The second study is that of Paarlberg and Lee (2001), previously discussed under the TRQ section. The third study is an assessment conducted by the USDA (2007) after proposing to add the Patagonia South region of Argentina to the regions free of Foot-Mouth Disease and Rinderpest. This assessment included both lamb meat and mutton, where it aimed to estimate the welfare impacts of allowing different import quantities of lamb meat and mutton from the Patagonia South region of Argentina. The analysis depended on a quantitative partial equilibrium model, utilizing base values of production, consumption, and prices of lamb meat and mutton from 2005 and price elasticity values for supply and demand borrowed from the literature. They concluded that the increase in the level of imports would decrease the domestic price of lamb meat and accordingly, increases consumer surplus and decreases producer surplus, leading to a net welfare gain. The setup of this study is analogous to a baseline analysis version of Abbott and Paarlberg's (1998) numerical simulation model.

3.3 Study Design Implications

Due to a number of reasons, the model utilized by the USDA's (2007) assessment will be the basis of this thesis' methodology, to initially solve for the target pure tariff rate or its equivalent pure quota volume and quantitatively illustrate its potential welfare impacts. The target here is defined as the tariff rate or the quota volume that increases domestic production's market share to 50% as requested by R-

CALF USA (2023a) from approximately 30% in 2022. This has not been tackled in the literature before. An ad valorem equivalent is calculated to indicate that an equivalent TRQ would also be successful in achieving the same objective. Moreover, it will also be utilized to illustrate the potential impacts of the two hypothetical tariff rates, as well as a welfare analysis. The thesis then introduces growth rates and a time index, adjusting the numerical simulation utilized in Abbott and Paarlberg's (1998) study to fit the lamb meat industry. This is to illustrate the impacts of the trade policy over future simulated years. The analysis in this thesis depends on a partial equilibrium model. The reason behind choosing this methodology and its assumptions are further elaborated in the next chapter.

An attempt was made to follow the methodology by Paarlberg and Lee's (2001) model, but two main issues arose. The first was that simple lamb meat production function depending on slaughter did not yield significant results, using annual data. This was an indication that it required a more complex representation of the supply of lamb meat rather than solely depending on slaughter. However, with the complexity of the supply chain of lamb meat and the distinct model setup, there was lack of guidance in the theoretical literature explaining means by which the model could be adjusted. Another issue was the utilized lamb meat demand function. With recent studies adding more significant variables such as marketing and promotion expenditures, the same problem of integrating it into the model arose. Paarlberg and Lee (2001) intentionally disregarded the price of substitutes in their model since including them made '*the economic interpretations and modelling implications of their resulting estimates troublesome*' (Paarlberg & Lee, 2001). Adding to the above, a trial to build a comprehensive model integrating the whole supply chain of lamb meat with the demand of lamb meat to link it with trade impacts, would require more extensive research and a comprehensive dataset to integrate all of the supply interlinkages. This is a potential future research area.

The above modelling restrictions were coupled with information unavailability. Regarding the trade policy scenarios, the petition letter by R-CALF USA, (2023a, 2023b) did not make any explicit requests as the previous petition in 1998. Due to the complex nature of TRQs, it is impossible to solve for an optimal or a target TRQ, unlike a tariff or a quota. Also, due to the large number of possible TRQ setups, through setting different levels of in-quota tariff rates, over-quota tariff rates, and the level of the quota, it is impossible to hypothetically assume a TRQ setup. It is also important to note that the impacts for TRQs cannot be generalized, due to the outcome depending solely on the interaction between the import demand and the different components of the TRQ guiding the excess supply function position.

Accordingly, this thesis assumed two hypothetical tariff rates. The first is adjusting the tariff rate to reflect inflation, as outlined in the supplement to the petition letter by R-CALF USA (2023b). The

inflation adjusted tariff rate is a specific tariff rate of $1.25/lb, which is equivalent to a 21% ad valorem tariff. To maintain consistency and facilitate comparability across the two hypothetical tariff rates, the ad valorem equivalent of the specific tariff will be utilized in the analysis. The second hypothetical tariff rate is Former President Trump's potential 10% ad valorem tariff. It is important to note that the numerical simulation used in this thesis is a simplified and static representation of the industry, yet it yields consistent results with the law firm's memorandum provided to ASI. The next chapter explains in further detail the utilized conceptual model.

Chapter 4: Conceptual Model

4.1 Methodology Choice and Model Assumptions

Conducting an ex-ante analysis of trade policy changes is done either through a general or a partial equilibrium model (Bacchetta et al., 2012). General equilibrium models account for all the interlinkages between the sectors of the economy, and it depends on a Social Accounting Matrix in its analysis, which accounts for households, firms, the government, and the rest of the world (Bacchetta et al., 2012; Reinert & Roland-Hoist, 2012). It reflects an economy-wide analysis of the likely impacts of a change in the trade policy (Bacchetta et al., 2012; Gohin & Moschini, 2006). General equilibrium models are generally utilized under studies with a larger scope and when it is expected that the changes in the trade policy for one sector in the economy will have significant spillover effects (Bacchetta et al., 2012).

On the other hand, partial equilibrium models focus on one sector in the economy, assuming that the changes in this sector will have small insignificant spillover effects on the rest of the sectors in the economy (Bacchetta et al., 2012). It should be noted that some studies incorporate more than one sector and one region or country in their partial equilibrium studies, however, the analysis focuses on the interlinked industries under analysis and ignores their impacts on the rest of the sectors in the economy (Bacchetta et al., 2012; Thomsen, 2023). Adding additional markets to the analysis might not be feasible under certain scenarios, which is why single markets are sometimes assessed in isolation (Thomsen, 2023). Compared to general equilibrium models, partial equilibrium models have smaller data requirements specific to the sector under analysis and they rely on elasticity values (Bacchetta et al., 2012).

Consistent with the two studies conducted for ex-ante trade policy analysis for lamb meat in the literature (Paarlberg & Lee, 2001; United States Department of Agriculture, 2007), this thesis will depend in its analysis on a partial equilibrium model. This is also consistent with the relatively small size of the lamb meat industry, indicating that any changes from the trade policy imposition would not lead to significant impacts on other sectors in the economy. From the demand side, the consumption of lamb meat and mutton is insignificant relative to total meat consumption, where it represents only 0.5% (United States Department of Agriculture, 2024a). Moreover, regarding lamb meat substitutes, results in the literature have been inconsistent regarding the relationship between lamb meat and other meat types; mainly pork, beef, and chicken. It has also been observed that lamb meat or even both lamb meat and mutton, tend to be ignored in meat demand studies (Chavas, 1983; Lusk & Tonsor, 2016; Paarlberg & Lee, 2001; Tonsor et al., 2021). It indicates, therefore, that changes in the lamb meat market will not have a significant impact on other meat markets.

From the supply side, lamb meat production is also insignificant relative to total meat production (United States Department of Agriculture, 2024a). This is drawn back to the smaller proportion of supply of live lambs compared to other livestock (United States Department of Agriculture, 2024a). This shows that changes in the lamb and lamb meat market will not have a significant impact on the other livestock and meat markets.

Due to the previously mentioned modelling restrictions and the inconclusive results regarding lamb meat's substitutability, this model will analyse the lamb meat market in isolation, without explicitly modelling the vertical interlinkage or including other potentially linked markets. This is a limitation of the model and a future research area improvement.

Three simplifying assumptions are imposed under the partial equilibrium model. These assumptions are consistent with the literature findings and the lamb meat market trend, as well as the assumptions imposed under Paarlberg and Lee's (2001) model. The first assumption, as pointed out earlier is the distinction between lamb meat and mutton. Hence, this model is specific to lamb meat and disregards mutton. The second assumption is that lamb meat is perceived as a homogenous good; there is no difference between the domestic and imported lamb meat. There have been no consumer studies in the literature indicating any preference for one type over the other or any form of observed heterogeneity. Moreover, this is consistent with multiple USITC investigation findings (United States International Trade Commission, 1990, 1995, 1999, & 2002) and RTI International (2007).

The third assumption is that the United States is assumed to be a small importing nation, where it lacks the ability to significantly influence the world price of lamb meat. According to a recent study by López et al. (2020), there are two major exporters driving the global trade of lamb meat; Australia and New Zealand, and the major importer of lamb meat is China. In 2022, China's lamb meat imports represented approximately 50% of the global trade in lamb meat, followed by the United States representing only 15% (Tridge, 2023). Unlike China, the United States has no significant impact on the world price (Meat & Livestock Australia, 2021). The implication of this assumption is a perfectly elastic excess supply function facing the United States in the world lamb meat market, making the world price of lamb meat exogenous.

4.2 Baseline Scenario Analysis

The model starts by setting up simple linear demand (D) and supply (S) functions for lamb meat, as illustrated in expression [1] and [2], where Y_d and Y_s represent the quantities demanded and supplied respectively, and P_d represents the domestic price.

$$Y_d = a - b.P_d \quad [1]$$

$$Y_s = c + d.P_d \quad [2]$$

The generation of the slopes (b and d) and the coefficients (a and c) is done through the usage of elasticities, for both supply (ε_{sp}) and demand (ε_{dp}), and base values for production (Y_{s0}), consumption (Y_{d0}) and the domestic price (P_{d0}). This is illustrated below in expressions [3]- [6].

$$b = \frac{\partial Y_d}{\partial P_d} = \varepsilon_{dp} \cdot \frac{Y_{d0}}{P_{d0}}, \varepsilon_{dp} < 0 \quad [3]$$

$$a = Y_{d0} + b.\, P_{d0} \quad [4]$$

$$d = \frac{\partial Y_s}{\partial P_d} = \varepsilon_{sp} . \frac{Y_{s0}}{P_{d0}}, \ \varepsilon_{sp} > 0 \quad [5]$$

$$c = Y_{s0} - d.\, P_{d0} \quad [6]$$

The base values for production (Y_{s0}), consumption (Y_{d0}) and the domestic price (P_{d0}) correspond to their values in 2022, which is the base year in this analysis. Moreover, given that the majority of lamb meat is imported duty free, and the remainder is subject to a negligible specific tariff rate, the base scenario is assumed to be a free trade scenario. The implication of this is that the base domestic price (P_{d0}) is equivalent to the world price of lamb meat (P_w) as illustrated in expression [7]. The utilized proxy for the world price of lamb meat is the cif import unit value of lamb meat measured in $/lb (United States International Trade Commission, 2023). It is important to note that even though the exchange rate isn't explicitly utilized in this model, due to the dependence on a proxy, it impacts the movements in the world price of lamb meat. Hence, it could be inferred that it is exchange rate adjusted.

$$P_{d0} = P_w \quad [7]$$

Under trade, imports (M) correspond to the difference between consumption (Y_d) and production (Y_s) as illustrated in expression [8].

$$M = Y_d - Y_s \quad [8]$$

Accordingly, an import demand function, M (P_d) can also be defined as the difference between the demand and supply function as illustrated in expression [9].

$$M = Y_d(P_d) - Y_s(P_d) \quad [9]$$

This setup is in line with the methodology utilized by the USDA's (2007) assessment. It is also a baseline analysis version of the supply and demand functions utilized in Abbott and Paarlberg's (1998) numerical simulation.

4.2.1 Target Trade Policy

The first step towards solving for this target tariff rate or its equivalent pure quota volume is generating the domestic price of lamb meat (P_d) that equates production with 50% of consumption as shown below in expressions [10]-[12]. The target tariff rate (t^*) would then be the difference between the higher domestic price of lamb meat (P_d) and the base domestic price (P_{d0}) as shown in expression [13]. The setup is also illustrated graphically below in figure [4-1].

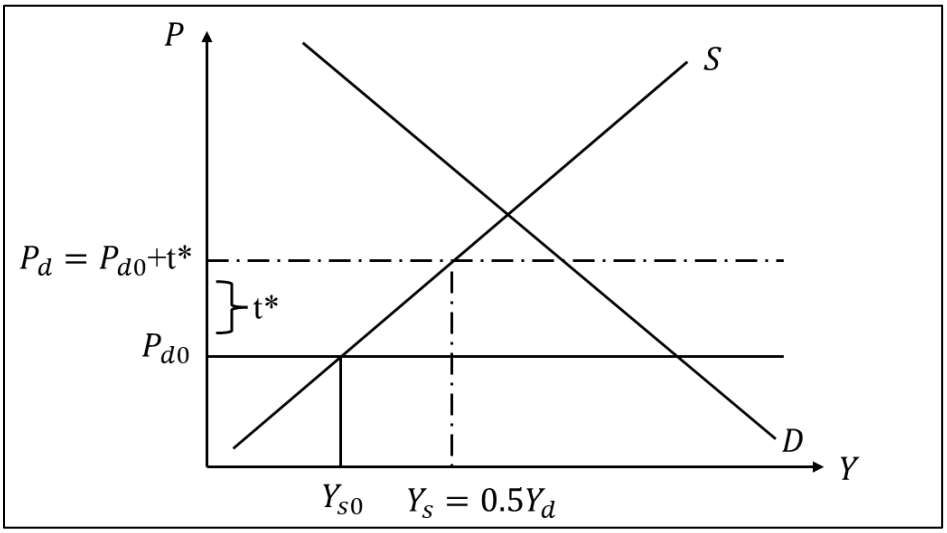
$$Y_s = 0.5\, Y_d \quad [10]$$

$$c + d.\, P_d = 0.5[\, a - b.\, P_d] \quad [11]$$

$$P_d = \frac{0.5a - c}{d + 0.5b} \quad [12]$$

$$t^* = P_d - P_{d0} \quad [13]$$

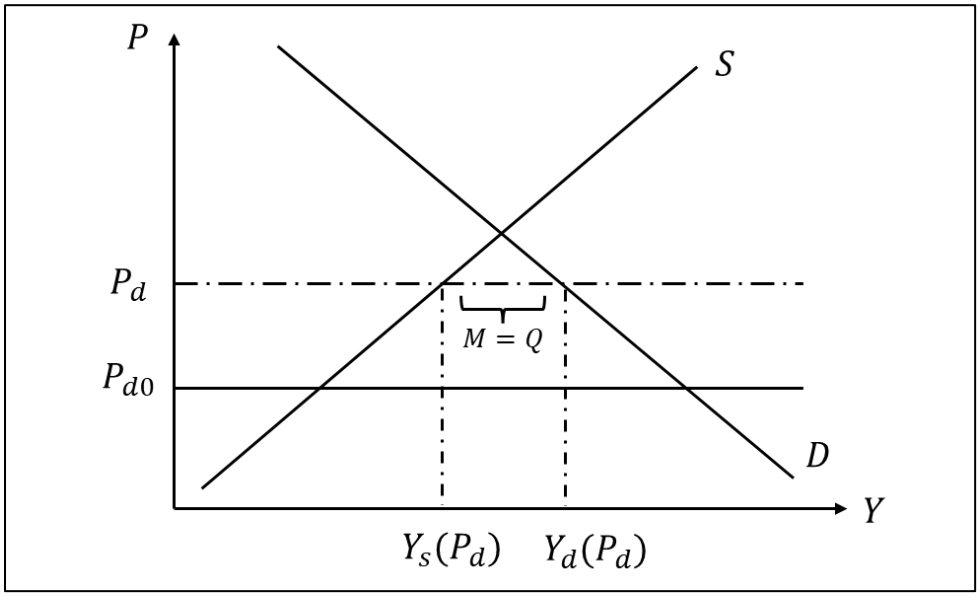
Figure 4-1: Target Pure Tariff Rate- Graphical Representation



Since we are solving for the same 50 % market share objective, the volume of the equivalent pure quota (Q) is equal to the level of imports (M) at the generated domestic price (P_d). This is calculated as the difference between consumption and production at the generated new price in expression [12]. This is shown graphically in Figure [4-2] and illustrated in expression [14].

$$Q = M\,(P_d) = Y_d(P_d) - Y_s(P_d) \quad [14]$$

Figure 4-2: Target Pure Quota- Graphical Representation



4.2.2 The Hypothetical Tariff Rates

The mechanism of quantifying the effects of a tariff is the reverse of solving for the target tariff. It is important to note that the two hypothetical tariff rates utilized in this analysis will be expressed in terms of an ad valorem tariff. Since the value of the tariff (t) is known, it is possible to generate the domestic price (P_d) as the world price of lamb meat (P_w) multiplied by one plus the ad valorem tariff rate (t) as illustrated in expression [15]. After calculating the new price, it is then substituted back into the supply (S) and demand (D) functions to generate the new consumption, production and import levels. This is illustrated in expressions [16] – [18].

$$P_d = P_w(1+\mathrm{t}) \quad [15]$$

$$Y_d(P_d) = \mathrm{a} - \mathrm{b}.P_d \quad [16]$$

$$Y_s(P_d) = \mathrm{c} + \mathrm{d}.P_d \quad [17]$$

$$\mathrm{M} = Y_d - Y_s = (\mathrm{a}-\mathrm{c}) - (\mathrm{b}+\mathrm{d})P_d \quad [18]$$

4.2.4 Welfare Analysis

A standard welfare analysis was conducted for the target trade policy and the hypothetical tariff rates. The changes in welfare are benchmarked against the baseline scenario. The first welfare indicator is the change in consumer surplus. Consumer surplus is typically defined as the difference between what consumers are willing to pay and what they end up paying for a commodity (Appleyard & Field, 2014;

Salvatore, 2013; Samuelson & Nordhaus, 2010). Applying this to our analysis, the change in consumer surplus would be expressed as the difference between the consumer surplus at the price including the trade policy intervention (P_d) and the consumer surplus at the base price (P_{d0}). Hence, the typical result associated with a tariff and quota imposition is a drop in the consumer surplus (Appleyard & Field, 2014; Salvatore, 2013; Samuelson & Nordhaus, 2010). The change in consumer surplus (ΔCS) is represented by the area (a+b+c+d) in figure [4-3]. Algebraically, this corresponds to expression [19]. Y_d represents the level of consumption at the higher domestic price with the trade policy intervention (P_d).

$$\Delta CS = -\frac{1}{2}(Y_{d0} + Y_d)(P_d - P_{d0}) \quad [19]$$

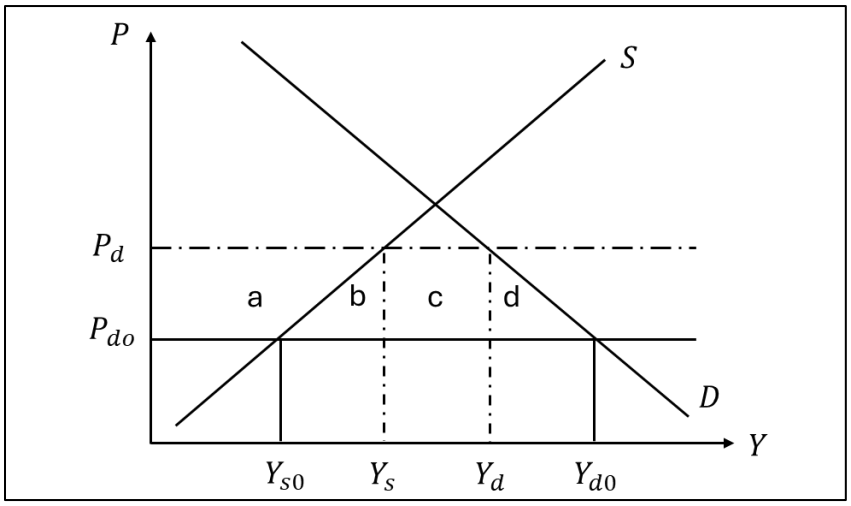
The second indicator is the change in producer surplus. Producer surplus is the difference between producer's sales revenue and cost (Appleyard & Field, 2014; Salvatore, 2013; Samuelson & Nordhaus, 2010). Applying this to our analysis, the change in producer surplus would be expressed as the difference between the producer surplus at the price including the trade policy intervention (P_d) and the producer surplus at the base price (P_{d0}). Hence, the typical result associated with a tariff and a quota imposition is an increase in the producer surplus (Appleyard & Field, 2014; Salvatore, 2013; Samuelson & Nordhaus, 2010). The change in producer surplus (ΔPS) is represented by the area (a) in figure [4-3]. Algebraically, this corresponds the expression [20], where Y_s represents the level of production at the higher domestic price with the trade policy intervention (P_d).

$$\Delta PS = \frac{1}{2}(Y_{s0} + Y_s)(P_d - P_{d0}) \quad [20]$$

The third indicator is the government revenue (GR) -or quota rent, under a pure quota-. This represents the generated revenue by the government, as a result of the trade policy. This revenue is in the form of tariff revenue under a tariff and quota licensing revenue under a quota (Appleyard & Field, 2014; Barkley, 2023; Salvatore, 2013; Samuelson & Nordhaus, 2010). Quantifying it includes multiplying the difference between the domestic price with the trade policy intervention (P_d) and the base domestic price (P_{d0}) by the level of imports (M) as illustrated in expression [21]. This corresponds to the area (c) in figure [4-3].

$$\Delta GR = (P_d - P_{d0})M \quad [21]$$

Figure 4-3: Welfare Implications of Pure Tariff/Quota- Graphical Illustration



4.3 Numerical Simulation Model

The second portion of the analysis in this thesis introduces the growth rate of supply and demand and a time index to analyze the impact of the hypothetical tariff rates over time. The supply and demand setup is borrowed from Abbott and Paarlberg's (1998) study and adjusted to fit with the lamb meat industry as illustrated in expression [22] and [23]. Setting the time index to 0, reflecting the base year would shift the functions back to those derived under the baseline scenario analysis in expression [1] and [2].

$$Y_d = Y_{d0}(1+G_d)^T\left[1+\left(\frac{\varepsilon_{dp}}{P_{d0}}\right)(P_d - P_{d0})\right],\ \varepsilon_{dp}<0 \qquad [22]$$

$$Y_s = Y_{s0}+\varepsilon_{sp}\left(\frac{Y_{s0}}{P_{d0}}\right)(P_d - P_{d0})+G_s Y_{s0} T,\ \varepsilon_{sp}>0 \qquad [23]$$

G_s and G_d represent the growth rates of supply and demand respectively and T is a time index changed for every simulated year. Demand is assumed to grow exponentially, which is consistent with the recent trend of consumption, meanwhile supply grows in a linear manner. The analysis under this model is static, where it assumes that supply and demand grow at a constant rate over the simulated years, relative to the base year. Moreover, it does not incorporate any changes that could potentially happen in the world price. Similar to baseline scenario analysis, base values for production (Y_{s0}), consumption (Y_{d0}) and price (P_{d0}), as well as price elasticities of supply (ε_{sp}) and demand (ε_{dp}), are required for the supply and demand functions. Since this includes the impact over time, it also integrates the growth rate of supply (G_s) and demand (G_d). Therefore, to generate values of production (Y_s) and consumption (Y_d), the time index (T) is changed for every simulated year and the respective domestic price of lamb (P_d) is incorporated.

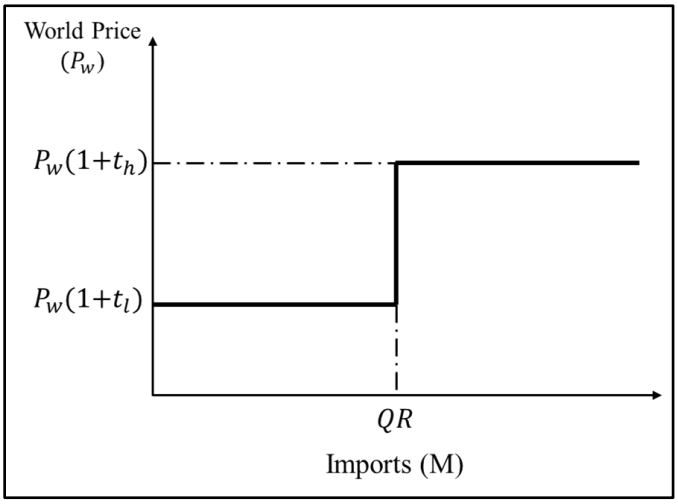
4.4 TRQs

Given the absence of an investigation of the lamb meat industry until now, coupled with the nature of complexity surrounding the TRQs, the empirical analysis will not include the impact of this trade policy. The previously recommended and implemented TRQs cannot be used as a guide to follow, since they are set based on a comprehensive investigation by the USITC at a specific point of time in the industry. Adding to the above, the published USITC investigation findings with the TRQ recommendation do not include explicit explanations behind the exact setup of the TRQ, which makes it difficult to assume a hypothetical TRQ (United States International Trade Commission, 1999). If in the future an investigation is conducted and the recommendations of TRQs are published, the analysis would follow the below structure. This also follows Abbott and Paarlberg's (1998) simulation model. The model uses the supply and demand illustrated in expressions [22] and [23] to generate an import demand function as illustrated in expression [9]. Using the low in-quota (t_l) and high over-quota tariff rates (t_h), two border prices (P_b) are calculated to setup the step excess supply function (ES). This is calculated as the given world price (P_w) multiplied by one plus the imposed tariff; low or high, as illustrated in expression [24].

$$P_b = P_w\ (1+\mathrm{t}) \qquad [24]$$

The two border prices represent the two horizontal lines of the excess supply function before and after the quota (Abbott & Paarlberg, 1998). Meanwhile, at the specified level of the quota (QR), a vertical line is drawn between the two border prices as shown in the right panel of Figure [4-4] (Abbott & Paarlberg, 1998).

Figure 4-4: TRQ Setup



Source: Abbott & Paarlberg (1998) and Skully (2001)

Hence, the impact of a TRQ depends on the position of the import demand function compared to the specified quota (Abbott & Paarlberg, 1998; Skully, 2001). For every given time, the behavior of the supply and demand will drive the resulting import demand function (Abbott & Paarlberg, 1998; Skully, 2001). The setup of the TRQ in this manner indicates that there are three possible scenarios, as long as excess demand is sufficient enough to support imports at the world price (Skully, 2001).

As shown in panel (a) in Figure [4-5], if the import demand function (M (P_d)), intersects the excess supply function (ES), at the level of the specified quota (QR), this is called a 'binding' scenario, where the imports are exactly equal to the specified quota. The TRQ in this scenario operates in the same manner as a pure quota. The equilibrium domestic price (P_d) is generated at the point of intersection between the import demand function (M (P_d)) and the level of the quota (QR) as illustrated in expression [25]. The generated domestic price is a price between the low and high border prices.

$$\begin{aligned} M{=}QR{=}\ Y_d(P_d){-}\ Y_s\ (P_d) \\ P_w(1+t_l) \le P_d \le P_w(1+t_h) \end{aligned} \qquad [25]$$

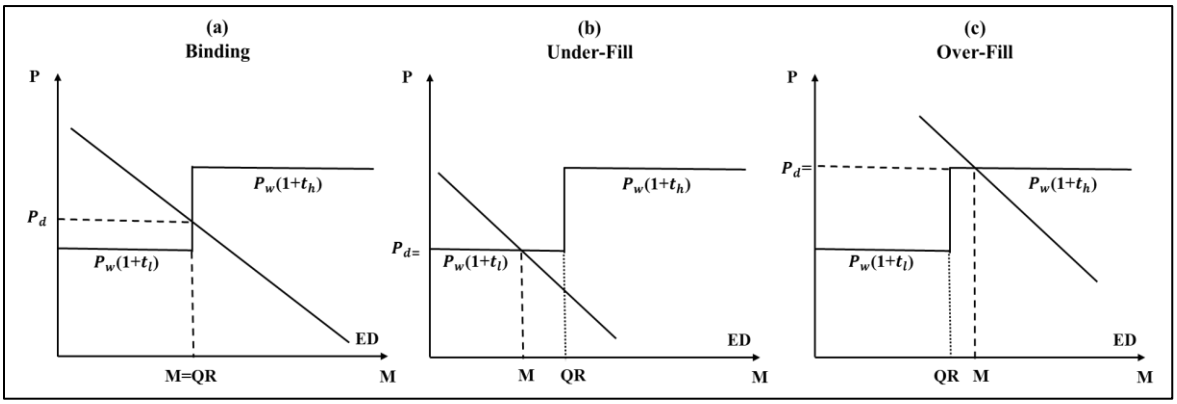
If, however, the import demand function (M (P_d)), intersects the excess supply function (ES) at a level below the specified quota (QR) this is an 'under-fill' scenario, as shown in panel (b) in Figure [4-5]. The TRQ operates in the same manner as a pure tariff. Since imports (M) are below the quota (Q), the lower in-quota tariff rate (t_l) is effective and the generated domestic price is the lower border price as illustrated in expression [26].

$$\begin{aligned} M{=}\ Y_d(P_d){-}\ Y_s\ (P_d)\ \ < QR \\ P_d = P_b{=}\ P_w(1+t_l) \end{aligned} \qquad [26]$$

The final possible scenario is the 'over-fill' scenario, when the import demand function (M (P_d)), intersects the excess supply function (ES) at a level higher than the specified quota (QR) as shown in panel (c) in Figure [4-5]. In this scenario, the higher over-quota tariff rate (t_h) is effective and the generated domestic price is the higher border price as illustrated in expression [27].

$$\begin{aligned} M{=}\ Y_d(P_d){-}\ Y_s\ (P_d)\ \ > QR \\ P_d = P_b{=}P_w(1+h). \end{aligned} \qquad [27]$$

Figure 4-5: TRQ Possible Scenarios



Source: Abbott & Paarlberg (1998)

Using the simulation model equations, a supply and demand function are generated for each simulated year by changing the time index. Then, an import demand function is derived by their difference as specified in equation [8]. This import demand function, along with the step excess supply function, determines the level of imports and the domestic price. The domestic price then determines the corresponding level of supply and demand.

Chapter 5: Data Sources and Descriptive Statistics

5.1 Data Sources

The data utilized in the empirical analysis is extracted from various sources for the years between 1998 and 2022. Lamb Meat Production, measured in million pounds was compiled from the Livestock Marketing Information Center (LMIC) (2023). Production is reported quarterly by the LMIC, through multiplying quarterly slaughter of lamb meat, measured in thousand heads by the average dressed weight, measured in pounds. Quarterly production of lamb meat was then summed up to represent annual production levels of lamb meat.

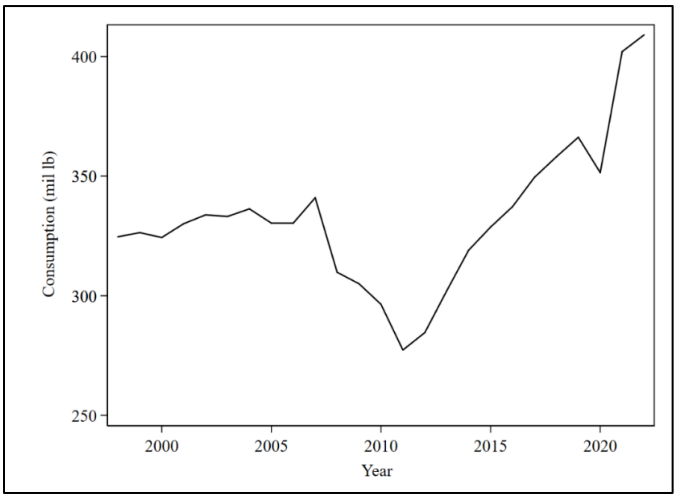
Disappearance of lamb meat is used as a proxy for domestic consumption of lamb meat (Paarlberg & Lee, 2001). This is calculated as domestic production plus imports less exports (Paarlberg & Lee, 2001). Annual export and import data of lamb meat is extracted from the USDA's (2024b) Livestock and Meat International Trade Dataset. It is important to note that exports have consistently been a significantly low percentage of production.

The cif unit import value is used as a proxy for the given world price under the model (Paarlberg & Lee, 2001). This is calculated by dividing the cif import value by the import quantity. Both values were extracted from the USITC's (2023) trade database. Values were then converted from price per kilogram to price per pound, to remain consistent with the measurements of production and consumption. Disposable income per capita and population growth rates are obtained from The Federal Reserve Bank of St. Louis (2022, 2024) to observe their interaction with the changes in the consumption of lamb meat.

5.2 Descriptive Statistics

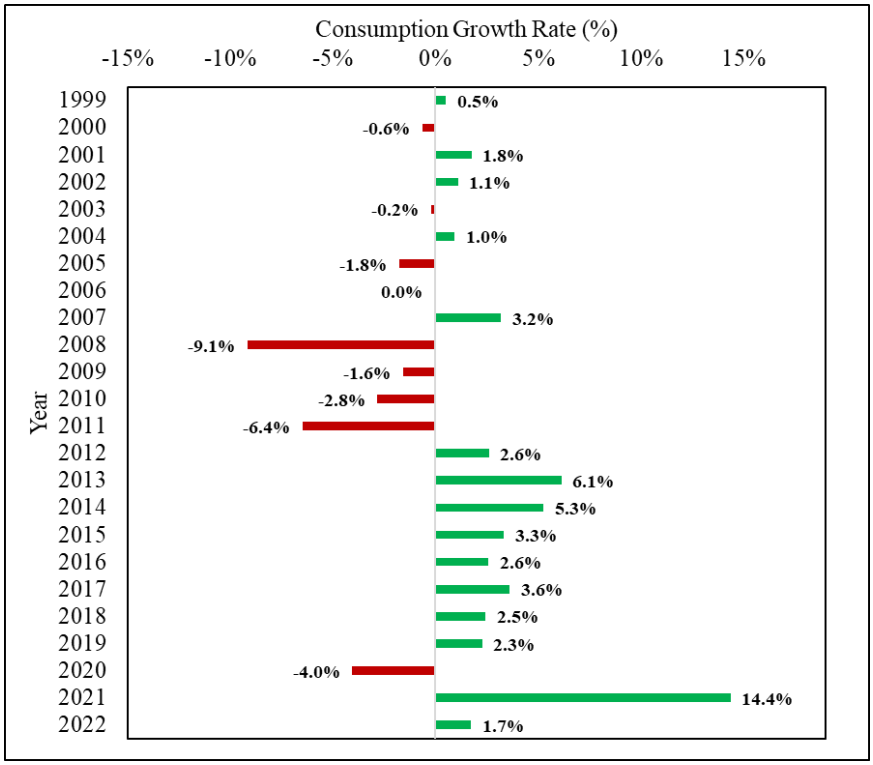
From Figure [5-1] and [5-2] below, it could be observed that 2011 was a turning point year for the lamb meat industry. Between 2011 and 2012, lamb meat consumption increased by 2.63% after it had been shrinking since 2008. From Table [5-1] at the end of this subsection, it could be observed that the average consumption between 2012-2022 was higher than that of 1998-2011. As illustrated in Figure [5-2], consumption has been exhibiting relatively consistent growth rates after 2011, indicating signs of exponential growth. Consumption dropped in 2020, but it recovered and grew at 14%, between 2020 and 2021. It maintained its increasing trend prior to COVID-19 pandemic as shown in Figure [5-1].

Figure 5-1: US Lamb Meat Consumption (1998-2022)



Source: Author's calculations from Livestock Marketing Information Center (2023) and United States Department of Agriculture, Economic Research Service (2024b)

Figure 5-2: US Lamb Meat Consumption Growth Rates (1999-2022)

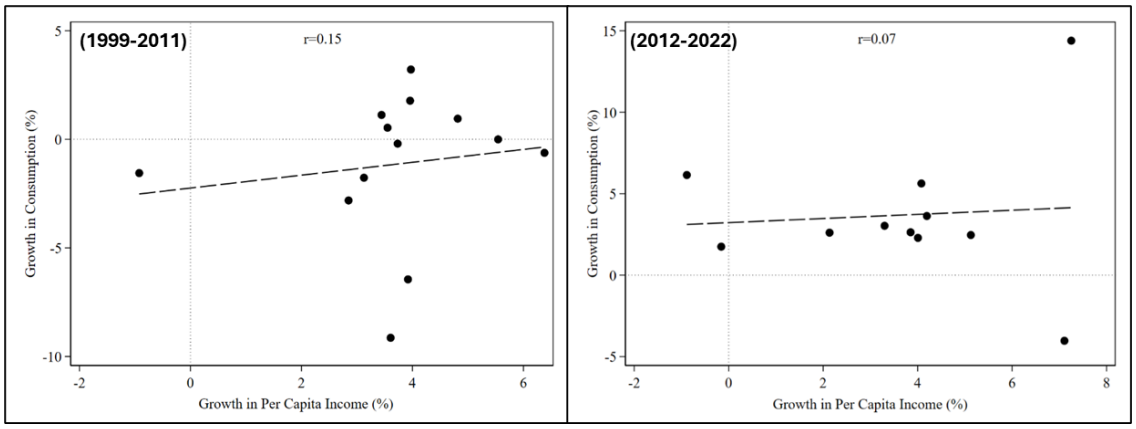


Source: Author's calculations from Livestock Marketing Information Center (2023) and United States Department of Agriculture, Economic Research Service (2024b)

Lamb meat consumption growth in the US, as most of the studies have pointed out, is not significantly driven by income nor population (Byrne et al., 1993; Williams et al., 2010; Ghosh & Williams, 2016;

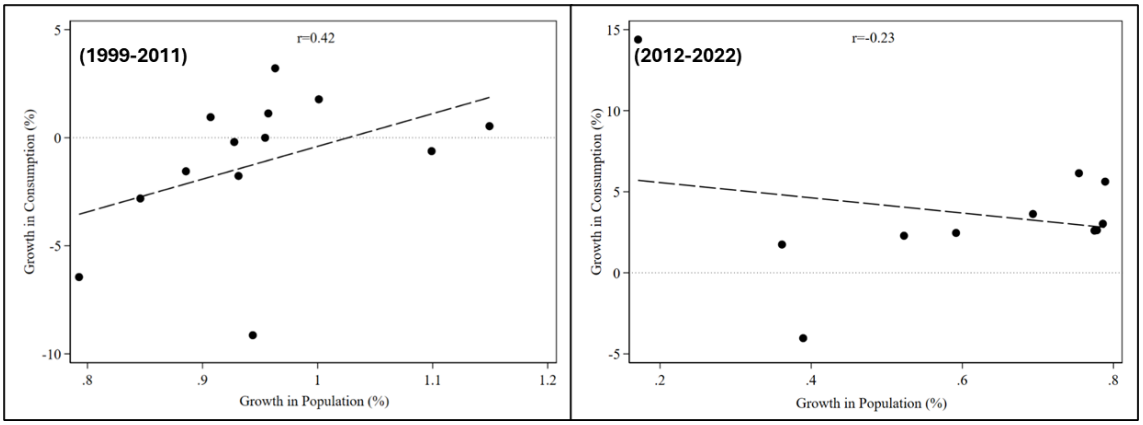
Purcell, 1989). The opposite scenario can be detected in developing countries, where the expansion of household income is a major driver of lamb meat consumption (Meat & Livestock Australia, 2021). One explanation provided by Meat and Livestock Australia (2021) is that since the US is a developed country, it has reached a level where purchasing power and population levels are no longer a determinant of consumption, yet it depends on other factors. This is further backed by the illustrated Figures [5-3] and [5-4], where there is a significantly weak relationship between the growth rate of consumption of lamb meat, and income for the two periods. Population growth rate had a slightly high positive correlation coefficient for the first period only, yet the relationship was still weak. In the second period, there was a negative weak correlation.

Figure 5-3: Scatter Plot between Growth in Per Capita Income and Lamb Meat Consumption



Source: Author's calculations from Federal Reserve Bank of St. Louis (2024), Livestock Marketing Information Center (2023), and United States Department of Agriculture, Economic Research Service (2024b)

Figure 5-4: Scatter Plot between Growth in Population and Lamb Meat Consumption

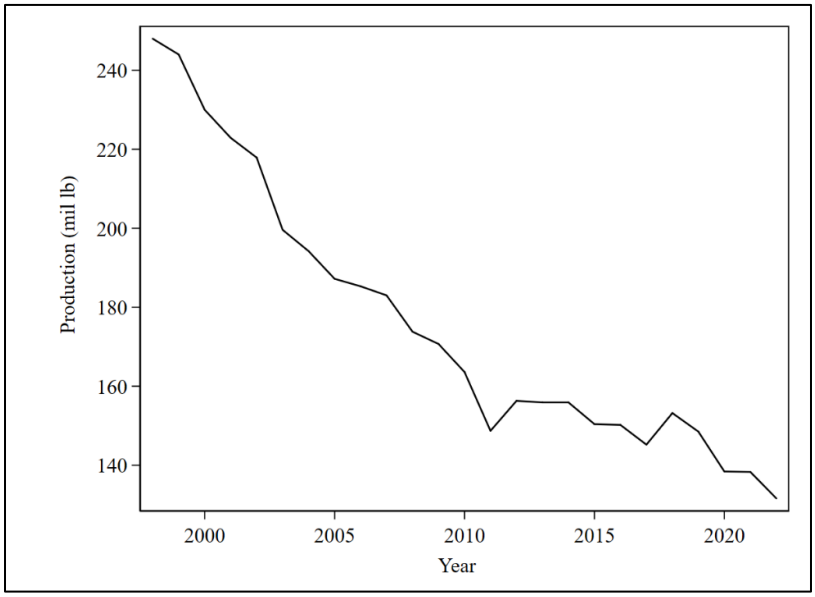


Source: Author's calculations from Federal Reserve Bank of St. Louis (2022, 2024b), Livestock Marketing Information Center (2023), and United States Department of Agriculture, Economic Research Service (2024b)

A minor shift can also be detected in the behaviour of lamb meat production as illustrated in Figure [5-5] and [5-6]. Production was shrinking annually by 3.4%, on average prior to 2011. Yet, between 2011 and 2012, production grew by 5.1%, which was an unprecedented growth rate. Production continued to decline during the period after 2012, yet the rate of decline was lower at 1.0%. This shift in the production was traced back to an industry policy introduced in 2011, called 'Let's Grow' program, which encouraged producers to increase their flock sizes (United States Department of Agriculture, 2011). It then dropped in 2017, and this was traced back to a sudden drop in the inventory of lamb (United States Department of Agriculture, 2017).

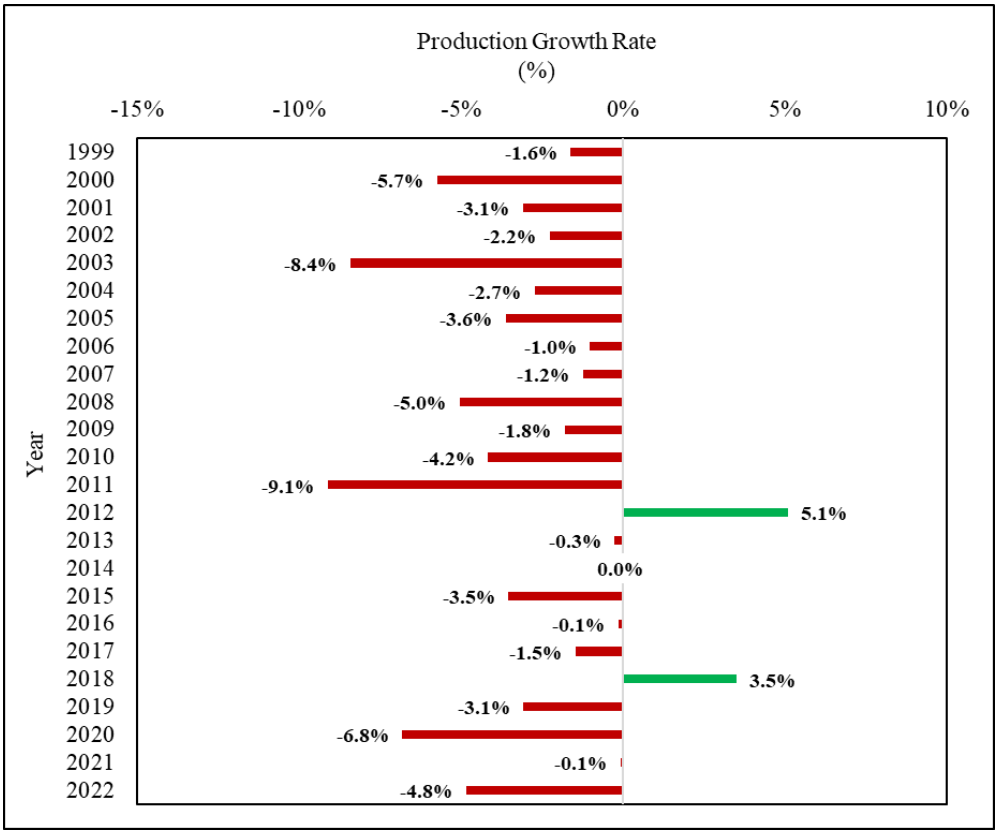
Production recovered between 2017 and 2018 and grew by 3.5%. Usually, producers increase their production in anticipation of the increased consumption during Easter and Passover holidays (United States Department of Agriculture, 2016). It was observed that Easter and Passover arrived early in the first quarter of 2018, which significantly increased production, compared to the previous year, even if it had witnessed declines in the rest of the quarters in 2018 (United States Department of Agriculture, 2018). With the pandemic, production declined in 2019 by 3% and a further 6.8% in 2020. It continued in its downward decline as shown in Figure [5-5]. It is clear, however, that even though production has been declining, it has witnessed improvements and relatively smaller declines since 2011 up until the year before the pandemic.

Figure 5-5: US Lamb Meat Production (1998-2022)



Source: Livestock Marketing Information Center (2023)

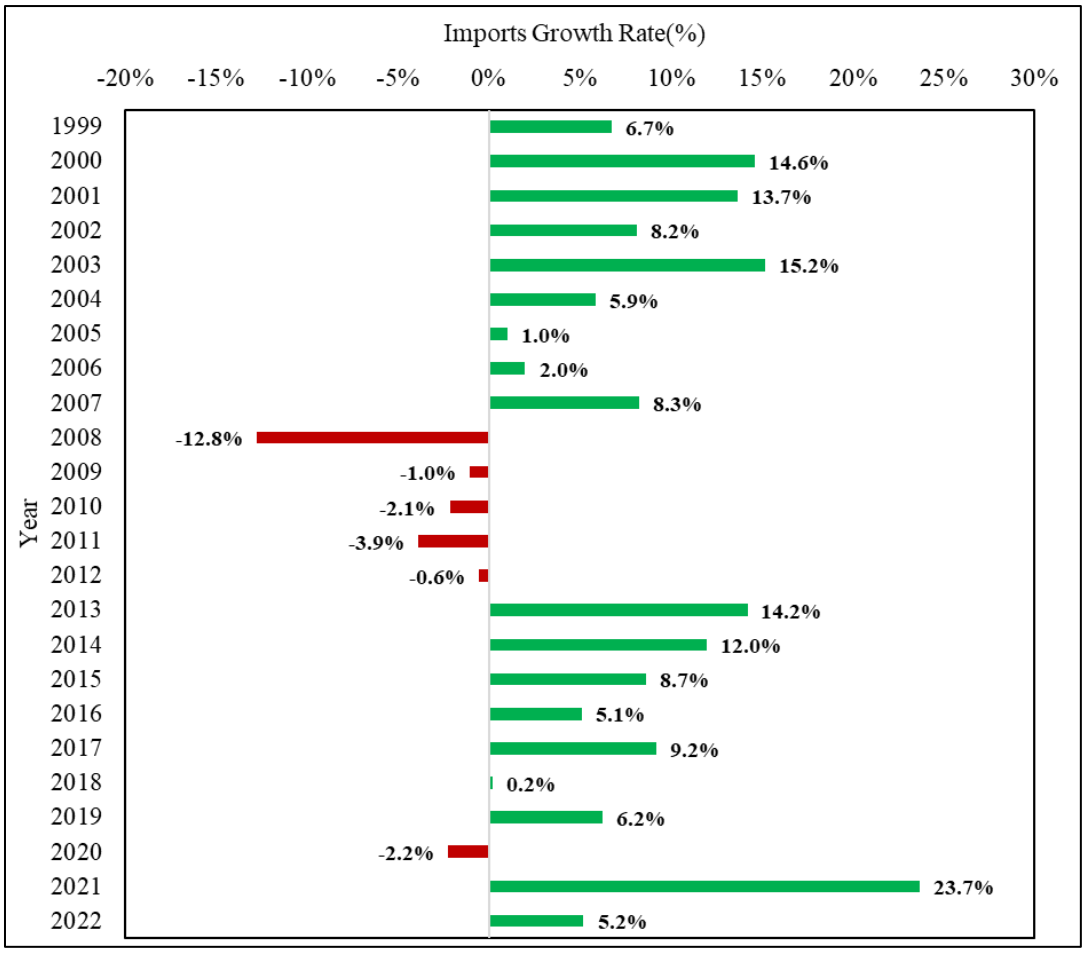
Figure 5-6: US Lamb Meat Production Growth Rates (1999-2022)



Source: Author's calculations from Livestock Marketing Information Center (2023)

With declining domestic production and increasing consumption, imports were observed to have surged. The difference in the average level of imports, included in Table [5-1], between the two time periods is significant, from an average of 125 million pounds to approximately 199 million pounds. As illustrated in Figure [5-7], lamb meat imports went through three different changes. Imports were increasing up until 2007, growing roughly by an average annual rate of 8.4%. The drop in imports growth rates between 2008 and 2011 coincides with the decline in consumption as illustrated in Figure [5-2]. One of the reasons why imports declined after 2007 is the widespread drought in Australia between 2007-2012 (R-CALF USA, 2023). Imports fell by -2% between 2019 and 2020, however, it quickly recovered, similar to consumption and grew by 23.7% between 2022 and 2023. Figure [5-7] illustrates its annual growth rate between 1999- 2022.

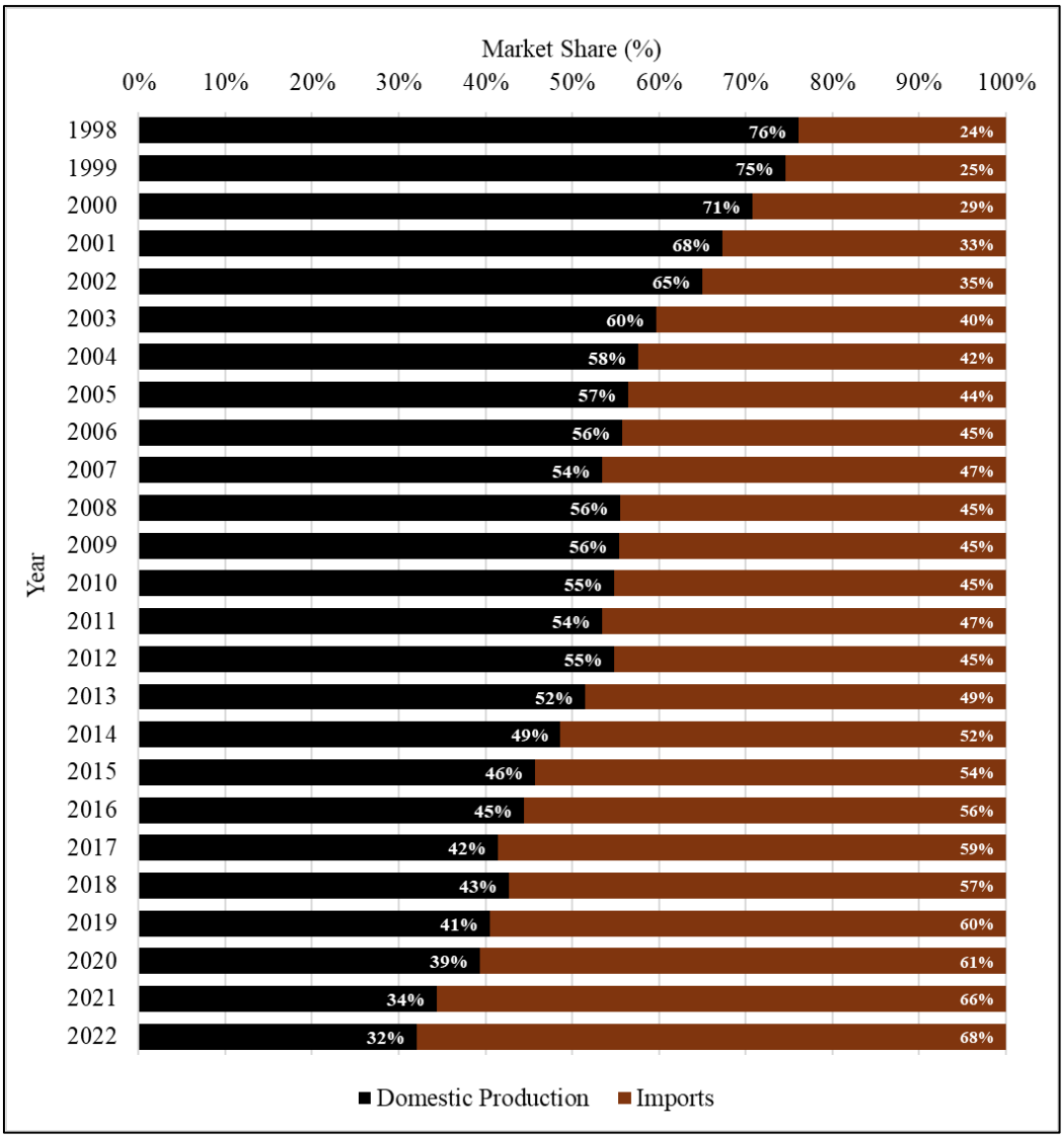
Figure 5-7: US Lamb Meat Imports Growth Rate (1999-2022)



Source: Author's calculations from United States Department of Agriculture, Economic Research Service (2024b)

Consequently, the market share of domestic production has been declining since 1998 as shown in Figure [5-8]. There have been slight increases in some years, yet the domestic production's market share continues to contract. In 2022, imports represented roughly 70% of the market share.

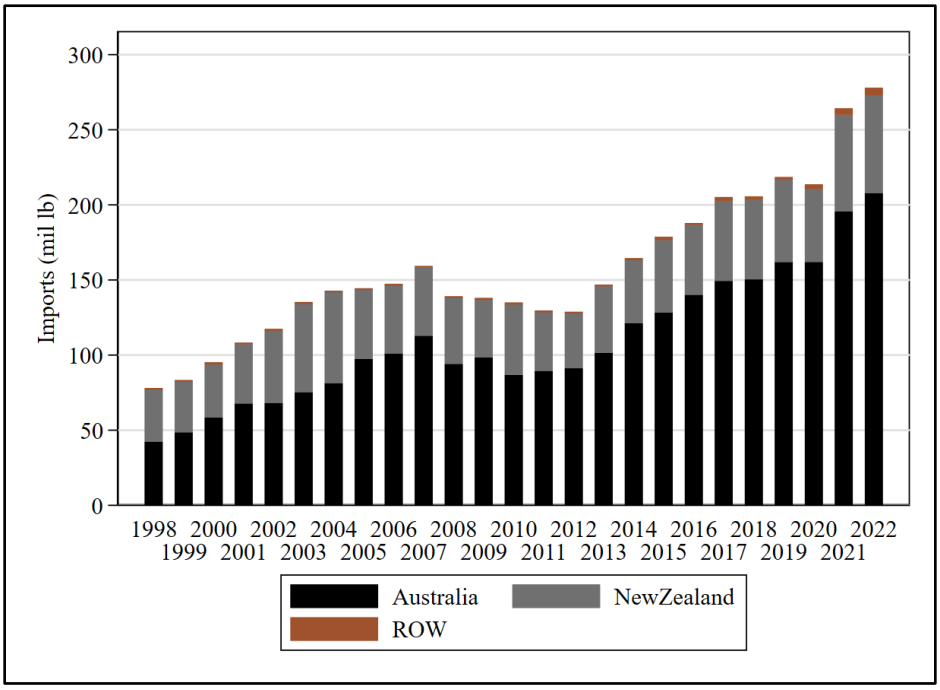
Figure 5-8: Domestic Production and Import Market Shares (1998-2022)



Source: Author's calculations from Livestock Marketing Information Center (2023) and United States Department of Agriculture, Economic Research Service (2024b)

The larger portion of lamb meat imports is mainly from Australia, followed by New Zealand as illustrated below in Figure [5-9]. Over the past few years, approximately 75% of lamb meat imports have been from Australia, and 25% from New Zealand, with negligible and inconsistent amounts from the rest of the world.

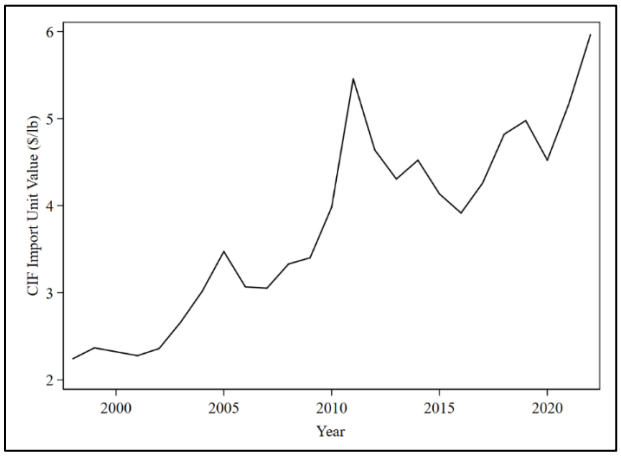
Figure 5-9: US Lamb Meat Imports Origin (1998-2022)



Source: United States Department of Agriculture, Economic Research Service (2024b)

The world price, measured through the CIF import unit value shows fluctuations from one year to the next and it has an overall upward trend. It hit a peak of $5.48/lb in 2011, after which it declined to relatively lower levels as illustrated in Figure [5-10]. Then, it reached another peak at $5.963/lb in 2022. Yet, looking at its average between our two periods, as shown in Table [5-1], it had a relatively steady increase from $3.1 to $4.7.

Figure 5-10: CIF Import Unit Value (1998-2022)



Source: Author's calculations from United States International Trade Commission (2023)

Table 5-1: Summary Statistics

	(1998-2011)				(2012-2022)			
	Mean	Std. Dev	Min	Max	Mean	Std. Dev	Min	Max
Production (mil lb)	197.8	30.5	148.7	248.0	147.6	8.3	131.6	156.3
Consumption (mil lb)	321.4	17.9	277.3	341.0	346.2	38.1	284.6	409.1
Imports (mil lb)	125.0	25.0	77.8	159.3	199.3	45.3	128.6	278.0
World Price ($/lb)	3.1	0.9	2.2	5.5	4.7	0.6	3.9	6.0

Source: Author's calculations from Livestock Marketing Information Center (2023), United States International Trade Commission (2023) and United States Department of Agriculture (2024b)

5.3 Model Data Requirements

To generate results according to the outlined conceptual model, it is important to explicitly outline the data requirements for each analysis. For the baseline scenario analysis, as well as, the simulation model, the chosen base year to benchmark the changes against was 2022. The main reason behind choosing this year is, it is the year upon which R-CALF USA's petition letter based their main complaints. It represents the scenario where the domestic production's market share is approximately 30% and imports share is 70%. Hence, the baseline values for production, consumption, and given world price are their values from 2022. Since the larger portion of imports are traded duty free, while the rest is imported under a negligible specific tariff rate, the baseline scenario is assumed to be a free trade scenario.

This analysis borrows elasticity values for supply and demand from the literature. There is only one study in the literature that generated a price elasticity of supply for lamb meat of 0.15 (RTI International, 2007). This is the chosen elasticity for supply in the model. Meanwhile, for demand, the chosen elasticity was the value generated by Ghosh & Williams (2016) of -0.62. This choice was due to two main reasons. The first reason is the frequency and coverage of their study. This is the most recent study in the literature covering the years between 1987-2013. Also, they depended on annual data, which is consistent with this thesis. The second main reason is that it is one of the recent studies that included the promotion and marketing expenditures, provided to them by both ALB and ASI, as a driver of demand in their regression. This gives their results further validation relative to older studies. A

sensitivity analysis was conducted for the simulation model and generated results using the lowest generated elasticity in the literature, which was -0.437 by (Paarlberg & Lee, 2001) and the highest elasticity in the literature, which was -0.75 by Williams et al. (2010).

Before generating results with 2022 as the base year, to validate that the simulation explains the trend in the data, it was applied first using 2011 as the base year. This was used to generate simulated results for 2012-2022. The main reason behind choosing 2011-2022, is that the industry witnessed a shift in the behaviour relative to the period prior to 2011. Between 2011-2022, production had shrunk, on average by 1% and consumption grew on average by 3.7%. After validating the model, assuming the industry will maintain the same trend between 2011-2022, the model was then used to simulate production and consumption levels with 2022 as the base year. This is referred to as scenario (A) in Table [5-2] below. In addition to the above, two hypothetical scenarios for supply growth are assumed, Scenario (B) is where supply is assumed to shrink at an even faster rate of 3% and Scenario (C) assumes an industry policy was introduced that would give a nudge to supply, causing it to witness growth, yet still lower than demand's growth. This scenario assumed that supply grew at a rate of 2%.

The two hypothetical tariff rates utilized in the analysis are the inflation adjusted tariff rate, $1.25/lb, expressed as an ad valorem equivalent of 21%, and the potential 10% ad valorem tariff by Former President Trump. Table [5-2] below highlights the main data utilized for each analysis.

Table 5-2: Model Data Requirements

Variables	Baseline Analysis	Model Validation	Model Analysis		
			Scenario (A)	Scenario (B)	Scenario (C)
Base Year	2022	2011	2022	2022	2022
P_{d0}: Price	5.96	5.46	5.96	5.96	5.96
Y_{s0}: Production	131.6	148.7	131.6	131.6	131.6
Y_{d0}: Consumption	409.07	277.31	409.07	409.07	409.07
ε_{dp}: Demand Elasticity	0.62	0.62	0.62	0.62	0.62
ε_{sp}: Supply Elasticity	0.15	0.15	0.15	0.15	0.15
G_d: Demand Growth	-	3.7%	3.7%	3.7%	3.7%
G_s: Supply Growth	-	-1%	-1%	-3.0%	2.0%

Chapter 6: Empirical Analysis

6.1 Baseline Scenario Analysis

6.1.1 The Target Trade Policy

From the model results illustrated in Table [6-1], it could be deduced that achieving a 50% domestic market share would occur at a domestic price of $8.93, which corresponds to a pure tariff rate of $2.97. At this high tariff rate, imports would drop from 278 million pounds to approximately 141 million pounds. Accordingly, the pure quota that would also lead to the same effect should be set at the level of imports of 141 million pounds, which is extremely restrictive compared to the 2022 level of imports at 278 million pounds.

A simple ad valorem equivalent of this specific tariff rate, $2.97, can be calculated by dividing it by the free trade world price, $5.96 (Bouet et al., 2005; World Trade Organization, 2004). This is equivalent to a 50% ad valorem tariff rate, which is considered a relatively restrictive tariff rate. From Table [6-1], it could also be observed that achieving the target market share will cause consumption to drop by almost 30%. In contrast, supply will only increase by roughly 7%.

Table 6-1: Model Results- The Target Pure Tariff/Quota

Scenario	Price ($/lb)	Production (mill lb)	Consumption (mill lb)	Imports (mill lb)	Domestic Market Share (%)
Baseline Scenario	5.96	131.60	409.07	278	32%
50% Share Objective	8.93	141.42	282.85	141.42	50%

Source: Baseline scenario analysis.

If a TRQ is imposed and has an ad valorem equivalent of 50%, it would also be successful in achieving the desired objective (Bouet et al., 2005; Jafari et al., 2021). One of the most comprehensive databases that covers all trade policies across 152 importing countries and 189 exporting countries, the MAcMap-HS6, converts them into an ad valorem equivalent (AVE) to make them comparable across countries and time (Bouet et al., 2005). The method of calculating an ad valorem equivalent for a TRQ depends on the fill rate, which represents the ratio of the imports to the level of the specified quota under the TRQ (Bouet et al., 2005). The ad valorem tariff is then defined as a shadow tariff, which essentially is the tariff rate that leads to the same level of imports under the TRQ (Bouet et al., 2005).

The chosen shadow tariff depends on the fill rate; if it is less than 90%, the low in-quota tariff is chosen. If it falls between 90%-99%, an arithmetic average of the low in -quota tariff and high over-quota tariff is chosen. If it is higher than 99%, the high over-quota tariff is chosen (Bouet et al., 2005).

The interaction of the import demand and the extent of restrictiveness of the TRQ's setup would guide the fill rates. For example, if we assume a TRQ is imposed and an over quota tariff rate is set at 50%, the TRQ would achieve the desired objective, only if the fill rate is higher than 99%. The inferences made about the possible impacts of a TRQ should be taken with great care, since it is only valid under specific strict assumptions about the fill rates and the setup of the TRQ.

The reason behind classifying the target trade policy as restrictive can be traced back to three main reasons. The first reason is looking at the previously implemented TRQ for lamb meat, the over-quota tariff rate for the first year was set at 40%, and this was already viewed as restrictive (Paarlberg & Lee, 2011; United States International Trade Commission, 1999; World Trade Organization, 2000). The second reason is looking at the TRQs implemented for a similar product, such as beef, the highest over quota tariff rate for beef has been set at 26% (Beckman et al., 2021). The third reason is that one of the commodities that was observed to have a 50% over quota tariff rate was imposed for washing machines in 2018 by Former President Trump (United States Customs and Border Protection, 2023b), which is different in its nature compared to lamb meat.

Illustrating the welfare implications of implementing the target trade policy shows results consistent with the expected impacts for a small importing nation, where consumer surplus decreases, producer surplus increases and government collects revenues, causing an overall drop in welfare in the economy (Appleyard & Field, 2014; Salvatore, 2013). Implementing the target tariff would cause a significantly high level of loss in consumer surplus of $1.026 billion. This represents more than double the increase in the producer surplus.

Under a pure quota, the net welfare impact would depend on the allocation of the quota rent (Salvatore, 2013). If the government imposed a quota and auctioned off licenses, this value would be government rent, and the net welfare impact would be equivalent to the pure tariff impacts (Salvatore, 2013). If, however, the arrangement was such that this was a voluntary export restraint (VER), the value would be allocated to the exporting country and hence, the net welfare loss would be higher than under a pure tariff (Salvatore, 2013). It has been observed that foreign exporters under a VER end up filling the quota with higher quality goods of a higher price, which would further harm the importing nation (Salvatore, 2013). This was observed under the Japanese VER with the US for automobiles (Feenstra, 1984).

Table 6-2: Welfare Analysis- The Target Pure Tariff/Quota

Changes in Welfare (mill $)	Pure Tariff/Quota
Consumer Surplus	-1,026.68
Producer Surplus	405.12
Tariff Revenue/Quota Rent	419.69
Net Welfare Loss	-201.87

Source: Baseline scenario welfare analysis.

Hence, it is clear that a 50% market share can be achieved, but only through setting an extremely restrictive level of imports or implementing a relatively high tariff rate. This is associated with significant harm to the consumers in the economy, compared to the smaller level of benefit accrued by producers. The harm to consumers has to be taken into account, since the industry has been exerting significant efforts to promote US lamb meat and trigger consumption. Imposing the target trade policy could potentially more than offset the effectiveness of the industry efforts. For a long period of time, one of the main concerns, alongside shrinking supply, was the declining consumption. However, it has recently shifted its trend. Accordingly, the repercussions of artificially increasing the price through the tariff and harming consumer surplus have to be taken into great consideration.

6.2 The Hypothetical Tariff Rates

Assessing the impact of the two hypothetical tariff rates, illustrated in Table [6-3], shows that due to the 21% ad valorem tariff rate being higher than the 10% ad valorem tariff, it causes a higher increase in the domestic price of lamb meat, leading to a higher increase in the domestic production's market share. Comparing the impacts on consumption of the hypothetical tariff rates to the target trade policy shows significantly lower declines.This, consequently, means that the hypothetical tariff rates are expected to lead to significantly lower magnitudes of loss in consumer surplus compared to the target trade policy, as illustrated in Table [6-3].

It is clear that by imposing a tariff, the inevitable impact would be an increase in the price. This is always an issue for consumers, a relief for producers, and a source of revenue for the government. Accordingly, this raises the moral question of whose welfare is a priority in the industry.

Table 6-3: Model Results- The Hypothetical Tariff Rates

Scenario	Price ($/lb)	Production (mill lb)	Consumption (mill lb)	Imports (mill lb)	Domestic Market Share (%)
Baseline Scenario	5.96	131.60	409.07	278	32.2%
Inflation Adjusted, 21%	7.21	135.74	355.90	220.17	38.1%
Trump's Tariff, 10%	6.56	133.57	383.71	250.13	34.8%

Source: Baseline scenario analysis.

Table 6-4: Welfare Analysis- The Hypothetical Tariff Rates

Changes in Welfare (mill $)	Inflation Adjusted, 21%	Trump's Tariff, 10%
Consumer Surplus	-478.11	-236.37
Producer Surplus	167.09	79.06
Tariff Revenue	275.21	149.16
Net Welfare Loss	-35.82	-8.15

Source: Baseline scenario welfare analysis.

There are a few considerations that need to be pointed out regarding the hypothetical tariff rates. First, there is a lack of clarity regarding the potential changes in the trade policy for the US lamb industry. Regarding the 10% ad valorem tariff rate, it is contingent on Trump winning the upcoming election as well as its mechanism. It is unclear whether it is planned to be imported on every single imported commodity or if it would provide exceptions to commodities that operate under free trade agreements. If it is applied on all commodities, this would cause major trade distortions and possible trade wars. This would impact not only the lamb meat industry, but all of the industries in the economy.

If, however, commodities under free trade agreements are excluded from the adjustment, it is expected to cause a trade diversion impact. Doing so would increase the tariff imposed on lamb meat imports from New Zealand, making them relatively more expensive. With consumers in the US perceiving lamb meat imports from New Zealand and Australia as close substitutes, trade would divert from New Zealand to Australia, since lamb meat is imported duty free under the Australia Free Trade Agreement (Babula, 1997; U.S. Customs and Border Protection, 2023a). This was the observed outcome from the imposition of the countervailing duty on lamb meat imports from New Zealand between 1985-1990, rendering the overall impact of the duty ineffective (Babula, 1997).

Regarding the inflation adjusted tariff rate, it could be introduced as an adjustment to the Most Favored Nation tariff rate, which would have the same trade diversion impact illustrated above. Moreover, as pointed out by the law memorandum provided to ASI, there is a legislating restriction when it comes to the imposition of tariffs or quotas by the US Congress.

The impact and welfare analysis of the two hypothetical tariff rates could still be applied in general terms, to assess the overall effectiveness of tariffs in the industry. This could also be the expected impact under a TRQ, if a strict 'underfill' or 'overfill' scenarios are assumed and either of the assumed tariffs is set as the low in-quota or the high over-quota tariff rates.

6.3 Numerical Simulation Model Results

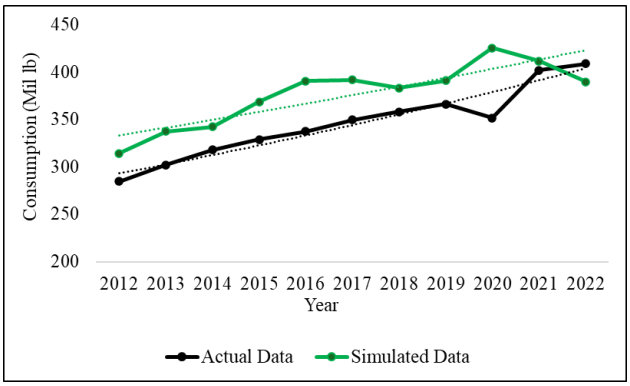
6.3.1 Model Validation

Before using the numerical simulation model to generate the possible impacts benchmarked against 2022, model validation was first carried out using 2011 as a base year. Base values for production, consumption, and price for 2011, were used in expressions [22] and [23] illustrated in Chapter 4. To generate production (Y_s) and consumption levels (Y_d) for each year, the time index (T) was changed and the actual value of the domestic price (P_d) for each year was included.

From Figure [5-1] below, it is observed that the model is able to detect the trend of both production and consumption fairly well. The correlation coefficient between real and simulated data was 0.79 and 0.78 for consumption and production respectively. It should be noted that it is not a completely perfect fit, due to the simplified assumptions of the industry under the simulation model. However, it reflected the trend of the actual data fairly well, except for the post COVID outlier years. The same was detected for the corresponding simulated and actual domestic production market share. The model tends to underestimate production and overestimate consumption, but proportionally maintains the correct trend and movements in the market share as illustrated in Figure [6-3]. This is why it is important to note that the focus in the upcoming analysis will be on the directional impacts and relative scale of impacts, rather than the absolute values.

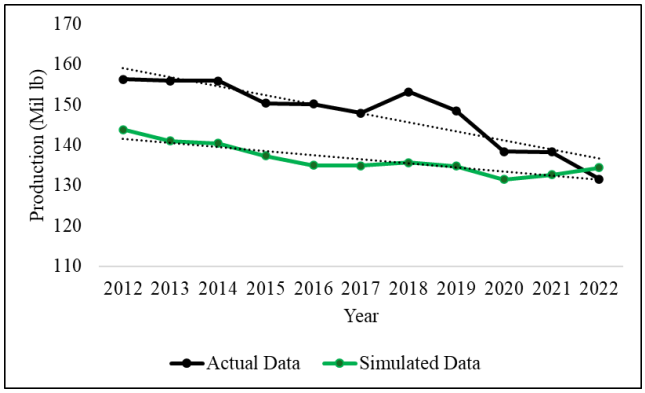
One conclusion that could be drawn from the model validation is the significant negative impact of the pandemic on industry. With production witnessing positive growth higher than that of consumption in 2018, it slightly increased the domestic market share. The simulation shows that market share was expected to continue increasing, but in real life, production was significantly impacted more than consumption causing the actual domestic market share to decline.

Figure 6-1:Simulated vs. Actual Consumption (2012-2022)



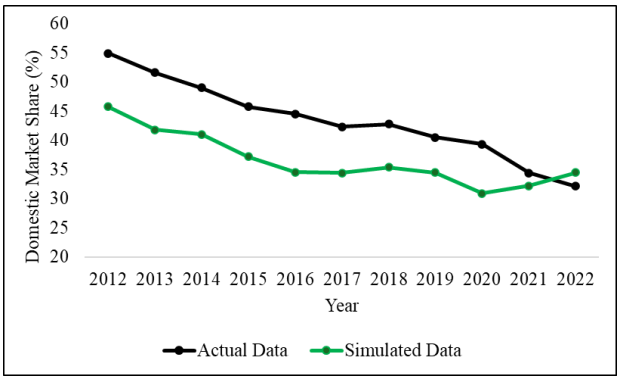
Source: Numerical simulation model results and Author's Calculations from Livestock Marketing Information Center (2023) and United States Department of Agriculture, Economic Research Service (2024b)

Figure 6-2: Simulated vs. Actual Production (2012-2022)



Source: Numerical simulation model results and Livestock Marketing Information Center (2023)

Figure 6-3: Simulated vs. Actual Domestic Market Share (2012-2022)



Source: Author's calculations from numerical simulation model results, Livestock Marketing Information Center (2023) and United States Department of Agriculture, Economic Research Service (2024b).

6.3.2 Status Quo

After validating the model, it was re-calibrated to reflect 2022 as a base year and the same growth rates between 2011-2022 were assumed. Table [6-5] shows the expected trend in the industry, with the continuation of its current status. If no change is introduced, with supply declining and demand growing, the industry will continue to shrink even further and increase its dependency on imports for lamb meat consumption. Hence, the domestic market share will also continue to decline.

Table 6-5: Model Results- Status Quo

Year	Consumption (mil lb)	Production (mil lb)	Imports (mil lb)	Domestic Market Share (%)	
Base	409.07	131.6	278.0	32.2%	
1	424.2	130.3	293.9	31%	▼-1.5%
2	439.9	129.0	310.9	29%	▼-1.4%
3	456.2	127.7	328.5	28%	▼-1.3%
4	473.1	126.3	346.7	27%	▼-1.3%

Source: Numerical simulation model results

6.3.3 The Hypothetical Tariff Rates

Table [6-6] and [6-7] show the impact of imposing the inflation adjusted 21% ad valorem tariff rate and Trump's proposed 10% tariff. The main finding is that the imposition of the hypothetical tariff rates would increase the domestic production's market share for the first year only, then it will continue to decline. The higher the tariff rate, the higher the initial jump of the domestic production's market share. This reflects that the imposition of the hypothetical tariff rates would provide temporary support and only slow down the decline in the domestic production's market share, compared to the base scenario. It is important to note that this finding is tied to the model being static, where the world price is constant and accordingly, the domestic price is only affected by movements in the tariff. Moreover, the model setup assumes supply and demand grow at a constant rate over the simulated years, relative to the base year. Since tariffs are usually structured to be constant or decreasing over time, imposing the hypothetical tariff rates will provide temporary relief compared to the baseline scenario, however, in the long run, it does not support a consistent increase in the domestic production's market share. In the first year of the imposition of the hypothetical tariff rates, the change in the domestic price of lamb meat relative to the base price was greater in magnitude compared to the shrinkage in production, causing supply to increase. However, after the first year, the magnitude of shrinkage in production is greater compared to the change in domestic price of lamb meat relative to the base price, causing supply to decline. Accordingly, the domestic production's market share is expected to decline after the first

year of implementation. Figure [6-4] shows the trend in domestic market share for the three scenarios; the status quo, the inflation adjusted 21% ad valorem tariff rate, and the 10% ad valorem tariff rate.

Table 6-6: Simulation Model Results- Inflation Adjusted Tariff, 21%

Year	Consumption (mil lb)	Production (mil lb)	Imports (mil lb)	Domestic Market Share (%)	
Base	409.1	131.6	278.0	32.2%	
1	369.1	134.4	234.7	36.4%	▲4.3%
2	382.7	133.1	249.6	34.8%	▼-1.6%
3	396.9	131.8	265.1	33.2%	▼-1.6%
4	411.6	130.5	281.1	31.7%	▼-1.5%

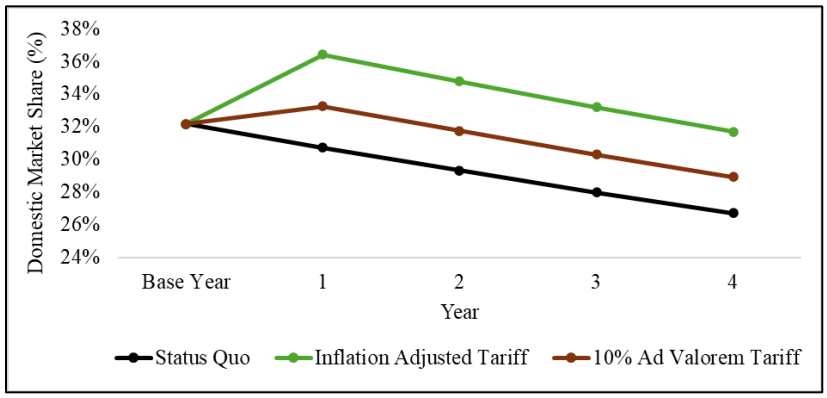
Source: Numerical simulation model results

Table 6-7: Simulation Model Results- Trump's Tariff, 10%

Year	Consumption (mil lb)	Production (mil lb)	Imports (mil lb)	Domestic Market Share (%)	
Base	409.1	131.6	278.0	32.2%	
1	397.9	132.3	265.6	33.2%	▲1.1%
2	412.6	130.9	281.7	31.7%	▼-1.5%
3	427.9	129.6	298.3	30.3%	▼-1.4%
4	443.7	128.3	315.4	28.9%	▼-1.4%

Source: Numerical simulation model results

Figure 6-4: Domestic Market Share For The Three Scenarios



Source: Numerical simulation model results

6.3.4 Hypothetical Supply Growth Scenarios

Adding further validity to the model results, two hypothetical supply growth scenarios are assumed. The first scenario is a case where supply is shrinking at a faster rate than anticipated, -3%. The second scenario assumes supply is increasing but at a slower rate than demand, 2%. The results in Table [6-8] and [6-9] show that if supply ends up shrinking faster than anticipated in the model, the same conclusions are drawn. However, due to the faster rate of supply decline, the initial jump in the domestic production's market share, due to the hypothetical tariff rates would be smaller than under our original scenario. Also, the rate of decline will be faster.

Table 6-8: Model Results For Shrinking Supply- Inflation Adjusted Tariff, 21%

Year	Consumption (mil lb)	Production (mil lb)	Imports (mil lb)	Domestic Market Share (%)	
Base	409.1	131.6	278.0	32.2%	
1	369.1	131.8	237.3	35.7%	▲3.5%
2	382.7	127.8	254.9	33.4%	▼-2.3%
3	396.9	123.9	273.0	31.2%	▼-2.2%
4	411.6	119.9	291.6	29.1%	▼-2.1%

Source: Numerical simulation model results

Table 6-9: Model Results For Shrinking Supply- Trump's Tariff, 10%

Year	Consumption (mil lb)	Production (mil lb)	Imports (mil lb)	Domestic Market Share (%)	
Base	409.1	131.6	278.0	32.2%	
1	397.9	129.6	268.3	32.6%	▲0.4%
2	412.6	125.7	286.9	30.5%	▼-2.1%
3	427.9	121.7	306.2	28.4%	▼-2.0%
4	443.7	117.8	325.9	26.5%	▼-1.9%

Source: Numerical simulation model results

The results in Table [6-10] and [6-11] show that if supply is assumed to be increasing but at a slower rate than demand, the initial jump in the domestic production's market share due to the imposition of the hypothetical tariff rates will be much higher than the original scenario and the rate of decline is much slower, allowing more relative relief to the industry, even if the domestic share is not increasing. This could be a scenario where domestic initiatives are put in place to initially nudge production in the industry similar to what happened in 2011. Coupled with the hypothetical tariff rates, it would be more

effective than under a shrinking supply scenario. Figure [6-5] and [6-6], show the trend in the domestic market share under the different supply growth scenarios for the inflation adjusted tariff, 21%, and the 10% ad valorem tariff respectively.

Table 6-10: Model Results For Growing Supply- Inflation Adjusted Tariff, 21%

Year	Consumption (mil lb)	Production (mil lb)	Imports (mil lb)	Domestic Market Share (%)	
Base	409.1	131.6	278.0	32.2%	
1	369.1	138.4	230.7	37.5%	▲5.3%
2	382.7	141.0	241.7	36.8%	▼-0.6%
3	396.9	143.6	253.3	36.2%	▼-0.7%
4	411.6	146.3	265.3	35.5%	▼-0.7%

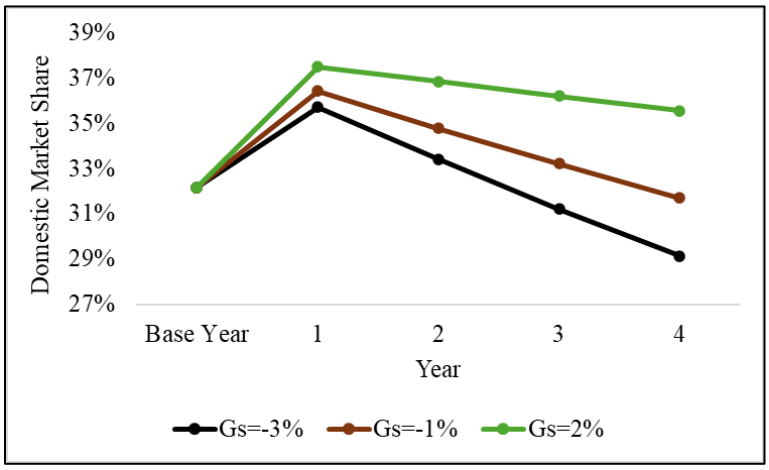
Source: Numerical simulation model results

Table 6-11: Model Results For Growing Supply- Trump's Tariff, 10%

Year	Consumption (mil lb)	Production (mil lb)	Imports (mil lb)	Domestic Market Share (%)	
Base	409.1	131.6	278.0	32.2%	
1	397.9	136.2	261.7	34.2%	▲2.1%
2	412.6	138.8	273.8	33.6%	▼-0.6%
3	427.9	141.5	286.4	33.1%	▼-0.6%
4	443.7	144.1	299.6	32.5%	▼-0.6%

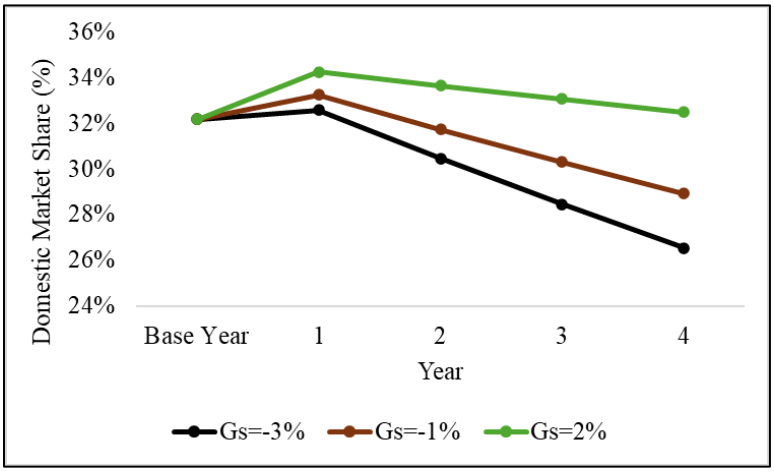
Source: Numerical simulation model results

Figure 6-5: Domestic Market Share under Three Supply Growth (G_s) Scenarios- Inflation Adjusted Tariff, 21%



Source: Numerical simulation model results

Figure 6-6: Domestic Market Share under Three Supply Growth (G_s) Scenarios- Trump's Tariff, 10%



Source: Numerical simulation model results

6.3.5 Sensitivity Analysis

To make sure the simulation model generated consistent results, two different demand elasticities are used for the two main simulated scenarios; the inflation adjusted tariff and Trump's 10% ad valorem tariff proposition under the actual anticipated shrinkage in supply. Tables [6-12]- [6-15] illustrate the results. The two elasticities used are the lowest and highest elasticities in the lamb meat demand literature; -0.437 by (Paarlberg & Lee, 2001) and -0.75 by Williams et al. (2010). The model generated similar results to what was illustrated in this chapter with respect to the initial jump in the first year's market share after the imposition of the hypothetical tariff rates. One main finding from the sensitivity analysis is that a higher elasticity of demand, meaning consumers are highly responsive to the price,

would cause demand to decline by a larger percentage. This consequently would lead to a higher initial jump in the domestic production's market share than under the lower elasticity. Figure [6-7] and [6-8] show the trend in the domestic market share under the different demand elasticity values for the inflation adjusted tariff and the 10% ad valorem tariff respectively.

Table 6-12:Sensitivity Analysis - Inflation Adjusted Tariff, 21% – Low Elasticity, -0.437

Year	Consumption (mil lb)	Production (mil lb)	Imports (mil lb)	Domestic Market Share (%)	
Base	409.1	131.6	278.0	32.2%	
1	385.3	134.4	250.9	34.9%	▲2.7%
2	399.6	133.1	266.5	33.3%	▼-1.6%
3	414.4	131.8	282.6	31.8%	▼-1.5%
4	429.7	130.5	299.2	30.4%	▼-1.4%

Source: Numerical simulation model results

Table 6-13:Sensitivity Analysis - Inflation Adjusted Tariff, 21% – High Elasticity, -0.75

Year	Consumption (mil lb)	Production (mil lb)	Imports (mil lb)	Domestic Market Share (%)	
Base	409.1	131.6	278.0	32.2%	
1	357.5	134.4	223.1	37.6%	▲5.4%
2	370.7	133.1	237.6	35.9%	▼-1.7%
3	384.5	131.8	252.7	34.3%	▼-1.6%
4	398.7	130.5	268.2	32.7%	▼-1.6%

Source: Numerical simulation model results

Table 6-14: Sensitivity Analysis - Trump's Tariff, 10% – Low Elasticity, -0.437

Year	Consumption (mil lb)	Production (mil lb)	Imports (mil lb)	Domestic Market Share (%)	
Base	409.1	131.6	278.0	32.2%	
1	405.7	132.3	273.4	32.6%	▲0.4%
2	420.7	130.9	289.7	31.1%	▼-1.5%
3	436.2	129.6	306.6	29.7%	▼-1.4%
4	452.4	128.3	324.1	28.4%	▼-1.4%

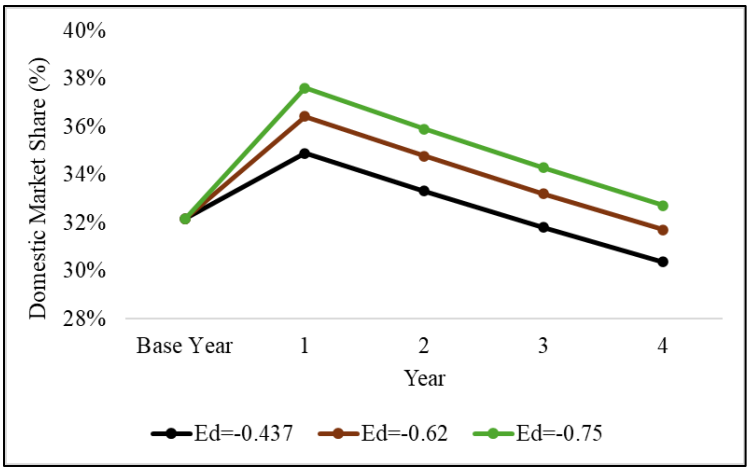
Source: Numerical simulation model results

Table 6-15: Sensitivity Analysis - Trump's Tariff, 10%– High Elasticity, -0.75

Year	Consumption (mil lb)	Production (mil lb)	Imports (mil lb)	Domestic Market Share (%)	
Base	409.1	131.6	278.0	32.2%	
1	392.4	132.3	260.1	33.7%	▲1.5%
2	406.9	130.9	276.0	32.2%	▼-1.5%
3	422.0	129.6	292.3	30.7%	▼-1.5%
4	437.6	128.3	309.3	29.3%	▼-1.4%

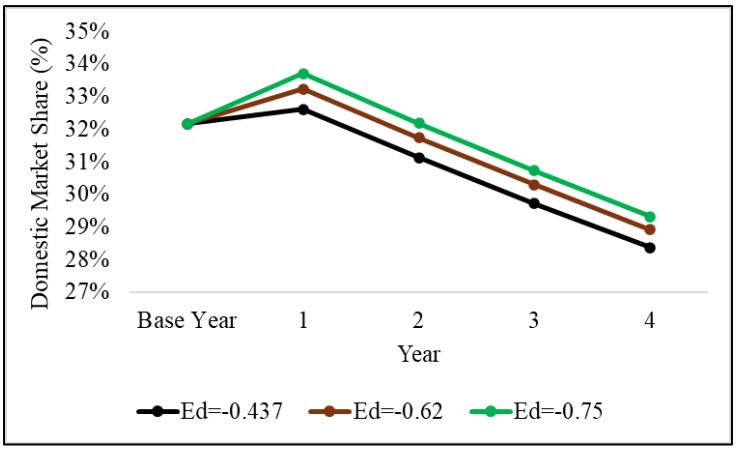
Source: Numerical simulation model results

Figure 6-7: Domestic Market Share under Inflation Adjusted Tariff, 21%– Three Elasticity Scenarios



Source: Numerical simulation model results

Figure 6-8: Domestic Market Share under Trump's Tariff, 10% Ad Valorem – Three Elasticity Scenarios



Source: Numerical simulation model results

Chapter 7: Conclusion

7.1 Discussion and Concluding Remarks

This thesis aimed to contribute to the lamb meat trade literature through determining the pure tariff rate or its equivalent pure quota volume that would increase the domestic production's market share from approximately 30% in 2022 to 50%. To the best of my knowledge, there has been no attempt in literature to do so. This 50% domestic market share is a stated target market share by R-CALF USA's petition letter (R-CALF USA, 2023a). The main finding is that the target pure tariff rate or its equivalent pure quota volume is extremely restrictive. It is expected to increase producer surplus, yet significantly decreases consumer surplus. Moreover, assessing the impact of the two hypothetical tariff rates also indicated net welfare loss, as a typical tariff would, yet compared to the highly restrictive target tariff, it was relatively lower. The welfare impacts of the tariff should be considered of high importance, especially the loss in consumer surplus, as not to offset industry efforts over the past few years to trigger consumption.

One of the main findings indicates that under shrinking supply and expanding demand, the industry is expected to continue shrinking, if no changes are introduced. Moreover, the thesis aimed to contribute to the lamb meat trade literature through assessing the potential impact of the two hypothetical tariff rates over a given time period, taking into consideration the growth rates of supply and demand, as well as their respective elasticities. The main finding from this analysis was that under a shrinking supply and expanding demand, the implementation of the hypothetical tariff rates will provide limited and temporary relief to for the industry. Under the two hypothetical tariff rates, the domestic market share is observed to increase with the initial implementation of the tariff but continues to decline in subsequent years. Furthermore, the higher the level of the tariff, the higher the initial jump in the domestic market share. The implementation of the hypothetical tariff rates slows down the decline in the domestic market share's decline, yet it does not support a continuous increase in its absolute value. The conclusions drawn under the numerical simulation model are tied to the model being static, with no change in the world price.

Under the hypothetical supply growth rate scenarios, two main findings are concluded. The first finding is that if the industry is assumed to shrink at a faster rate than anticipated, the initial jump in the domestic market share due to the imposition of the hypothetical tariff rates would be much smaller and the rate of decline after the first year is much faster compared to the anticipated growth rate scenario. The second finding is that if supply is assumed to be slightly improving and witnessing positive growth, which is still below that of demand, this could potentially have a greater impact on the industry. Even though the hypothetical tariff rates cause an initial jump in domestic market share, the jump is

significantly larger, providing more relief to the industry, compared to the anticipated growth scenarios. This slight improvement in supply could be through industry initiatives or programs that are put in place such as that implemented in 2011. This could also be through the provision of solutions to the inefficiencies and issues often facing the supply side of lamb production tackled in the literature review chapter. With the industry finally witnessing increasing consumption after it had been either stable or shrinking before 2011, the core problem in the industry, alongside the surge in imports, is the issues facing the supply side of the industry.

During the most recent ASI Convention in January 2024, multiple initiatives were introduced by various participants that would potentially support the industry. Some of those included means by which diseases and parasites could be controlled, possible genetic improvements to enhance the flock's quality and resilience to climate, and interestingly enough, means to enhance exports of lamb meat, especially to the Caribbean Market and Mexico (American Sheep Industry, 2024b). Moreover, there have been meetings with USDA officials and congressional leaders in Washington DC, in March 2023, where sheep producers convey their concerns regarding specific issues related to the industry (American Sheep Industry, 2024c). One of the meetings that was expressed to be of high priority was that regarding predator management, more specifically bird depredation (American Sheep Industry, 2024c). Accordingly, based on the industry's success in triggering production, this would also contribute to the effectiveness of a potential trade policy.

7.2 Research Limitations and Future Research

The first limitation of this research is that the derived value for the target trade policy, under the baseline scenario analysis, is guided by the price elasticity of supply and demand values. The conclusion that the industry would need a restrictive trade policy is still valid, as long as supply is significantly inelastic.

The second limitation of this research is that the numerical simulation model is a static and simplified representation of the lamb meat industry, which in reality is a complex industry. This was due to two main restrictions; the first was the shortage of theoretical studies linking the complex supply side of lamb meat production with demand of lamb meat to assess trade policy impact, such as Paarlberg and Lee's (2001) model. The other restriction was the information availability. There has been no response to the petition letter and therefore, there have been no suggested trade policies up until now. Accordingly, this thesis assumed two hypothetical tariff rates, from the context of the supplement to the petition letter and a possible change in the overall US trade policy. Since quotas and TRQs are usually set at levels based on comprehensive investigations by the USITC , it was impossible to assume a structure or a given time period for their implementation.

Moreover, the results of the numerical simulation model for the hypothetical tariff rates cannot be generalized to a TRQ. The impact of TRQs depends on the interaction between the import demand and the export supply function, which is guided by the TRQ's components. This is also guided by the extent of restrictiveness of the tariff rates and the specified quota under a TRQ.

Hence, future research in this field could potentially include building a comprehensive demand and supply linkage to assess the impacts of trade policies in this industry in the future. This requires extensive research, given the multiple levels of supply, as well as a comprehensive supporting data set. Assumptions could be relaxed and incorporated into the model. Even though concentration has been decreasing over the past few years, market power could also be introduced into the model to assess its potential impacts under the trade policy impacts. This model could also relax the 'small importing nation' assumption. Even though the United States has no significant impact on the world price, yet the extent of the interaction with Australia and New Zealand could be captured through integrating their export supply functions as well as the respective exchange rates.

In addition to the above, the assumption related to the perfect substitutability of domestic and imported lamb meat could be relaxed. This would require quantifying the elasticity of substitution between domestic and imported lamb meat, which has been neglected in the literature. An attempt was made to contribute to this portion of the literature for future research, using the trade cost approach outlined by Riker (2020). This methodology utilizes a fixed effects model, which supports industries that have a shortage in price and cost data, such as the lamb meat industry (Riker, 2020). The methodology depends on panel data of the landed duty paid value and the international trade cost factor which is the landed duty paid value as a ratio to the customs value (Riker, 2020). These values are extracted for every variety of the product, from every source country entering into every customs district for every given time period to build a panel dataset (Riker, 2020). Yet, his methodology fails to capture zero trade flows and as stated by Riker (2020) adjusting the methodology is a future research area. Looking at the required data for lamb meat imports from the USITC trade database, the flow was not consistent across the years and across the different districts, which made it impossible to disregard any outliers (United States International Trade Commission, 2023). One possible solution, according to the literature, was to add very small value to the zero trade flows, however, this solution was better to be avoided, since the small added values are arbitrary and could end up affecting the coefficient's interpretations (Schreiber, 2022). Another solution was to estimate it using a Psuedo-Poisson Maximum Likelihood (PPML) estimator, to take into consideration the zero trade flows (Schreiber, 2022). However, a comparison between OLS and PPML showed that PPML does not generate accurate estimates of the elasticity of substitution; they tend to generate larger values than OLS (Schrammel & Schreiber, 2023).

Accordingly, future research requires studies related to the extent of substitutability between domestic and imported lamb meat to integrate into trade studies. However, this depends largely on the availability of prices and costs data for both the importing and exporting countries.

On the other hand, since the potential trade policy might exclude imports under free trade agreements, the likely impact of the trade diversion could be estimated once the actual trade policy is clear.

With the high uncertainty regarding the potential trade policy change and the probability of no change being imposed, research could be conducted to discuss alternatives to trade policy through industry policies and initiatives and illustrate their expected impacts. Moreover, to gain deeper insights into consumer preferences between domestic and imported lamb meat, it is possible to conduct consumption choice experiments.

Literature Cited

Abbott, P. (2002). Tariff Rate Quotas: Failed Market Access Instruments? *European Review of Agricultural Economics*, *29*(1), 109–130. https://www.jstor.org/stable/1244310

Abbott, P., & Morse, B. A. (2000). Tariff Rate Quota Implementation and Administration by Developing Countries. *Agricultural and Resource Economics Review*, *29*(1), 115–124. https://doi.org/10.22004/ag.econ.31336

Abbott, P., & Paarlberg, P. (1998). Tariff Rate Quotas: Structural and Stability Impacts in Growing Markets. *Agricultural Economics*, *19*, 257–267. https://doi.org/10.1111/j.1574-0862.1998.tb00530.x

American Lamb Board. (n.d.). *American Lamb Checkoff Programs.* https://lambboard.com/checkoff

American Sheep Industry. (2018). Remembering The Wool Act 25 Years After Its Death. *Sheep Industry News*, 22 (10). https://cdn.coverstand.com/54583/527302/f878129033ea15e9164afe19d6326d6c37aaa8e0.1.pdf

American Sheep Industry. (2023a). ASI Investigating Trade Case. *Sheep Industry News*, *27*(6). https://digitaledition.pub/wc/asia/Sheep-Industry-News/June-2023/

American Sheep Industry. (2023b). ASI Closes Trade Case Investigation. *Sheep Industry News*, *27*(12). https://digitaledition.pub/wc/asia/Sheep-Industry-News/December-2023/

American Sheep Industry. (2024a). ASI Opposes OFF Act. *Sheep Industry News*, *28*(1). https://digitaledition.pub/wc/asia/Sheep-Industry-News/January-2024/

American Sheep Industry. (2024b). Information Abounds at Convention. *Sheep Industry News*, *28*(2). https://digitaledition.pub/wc/asia/Sheep-Industry-News/February-2024/

American Sheep Industry. (2024c). ASI Heads to Washington, D.C.. *Sheep Industry News*, 28(3). https://digitaledition.pub/wc/asia/Sheep-Industry-News/March-2024/

Appleyard, D., & Field, A. (2014). *International economics*. McGraw-Hill Companies.

Australian Government. (2024). *Australia-United States Free Trade Agreement (AUSFTA)*. Australian Government, Australian Trade and Investment Commission. https://www.austrade.gov.au/en/how-we-can-help-you/australian-exporters/free-trade-agreements/united-states

Babula, R. A. (1997). Economic Effects of a Countervailing Duty Order on the U.S. Lamb Meat Industry. *Agricultural and Resource Economics Review*, *26*(1), 82–93. https://doi.org/10.22004/ag.econ.31365

Bacchetta et al. (2012). *A Practical Guide to Trade Policy Analysis.* World Trade Organization and United Nations Conference on Trade and Development.

Barkley, A. (2023). *The Economics Of Food And Agricultural Markets*. LibreTexts, Kansas State University

Beckman, J., Gale, F., & Lee, T. (2021). *Agricultural Market Access Under Tariff-Rate Quotas* (Report No. 279). United States Department of Agriculture, Economic Research Service.

Bouet, A., Yvan, D., Lionel, F., Sébastien, J., & Laborde, D. (2005). *A Consistent, Ad-Valorem Equivalent Measure of Applied Protection across the world: The MAcMap-HS6 database* (CEPII Working Paper No. 2004–22).

Boughner, D. S., De Gorter, H., & Sheldon, I. M. (2000). The Economics of Two-Tier Tariff-Rate Import Quotas in Agriculture. *Agricultural and Resource Economics Review*, *29*(1), 58–69.

Brester, G., & Musick, D. (1995). The Effect of Market Concentration on Lamb Marketing Margins. *Journal of Agricultural and Applied Economics*, *27*(1), 172–183. https://doi.org/ 10.22004/ag.econ.15327

Byrne, P., Capps, O., Professor, J., & Williams, G. (1993). U.S. Demand for Lamb: The Other Red Meat. *Journal of Food Distribution Research*, 158–166. https:// 10.22004/ag.econ.26575

Carter, C., & Li, X. (2005, July 24-27). *Agricultural Tariff Rate Quotas: Impacts on Market Access* [Paper Presentation]. American Agricultural Economics Association Annual Meeting, Providence, Rhode Island.

Chang, H-H, & De Gorter, H. (2004). *Tariff Rate Import Quotas, Domestic Market Structure and Agricultural Support Program-The Case of Taiwanese Rice Import* [Paper Presentation]. The Western Agricultural Economics Association Annual Meeting, Honolulu, Hawaii.

Chavas, J-P. (1983). Structural Change in the Demand for Meat. *American Journal of Agricultural Economics*, *65*(1), 148–153.

Debertin, D., Meyer, A., Davis, J., & Jones. L. (1983). *A Monthly Econometric Model of The Sheep Industry* (Report No.37). University of Kentucky.

Federal Reserve Bank of St. Louis. (2022). *Population Growth for the United States* [Data set]. https://fred.stlouisfed.org/series/SPPOPGROWUSA

Federal Reserve Bank of St. Louis. (2024). *Real Disposable Personal Income: Per Capita* [Data set]. https://fred.stlouisfed.org/series/A229RX0A048NBEA

Feenstra, R. (1984). Voluntary Export Restraint in U.S Autos, 1980-91: Quality, Employment, and Welfare Effects. In R. Baldwin & A. Krueger (Eds.), *The Structure and Evolution of Recent U.S. Trade Policy* (pp. 35–66). University of Chicago Press.

Gee, C., Magleby, R., Bailey, W., Gum, R., & Arthur, L. (1977). *Sheep and Lamb Losses to Predators and Other Causes in The Western United States* (Report No. 369). United States Department of Agriculture, Economic Research Service.

George, P., & King, G. (1971). *Consumer Demand for Food Commodities in the United States with Projections for 1980 Giannini Foundation (Monograph No. 26*). Giannini Foundation of Agricultural Economics, University of California.

Ghosh, S., & Williams, G. (2016). Generic Advertising of U.S. Lamb. *Journal of International Food & Agribusiness Marketing*, *28*(4), 373–393. https://doi.org/10.1080/08974438.2016.1151398

Gohin, A. & Moschini, G. (2006). Evaluating the Market and Welfare Impacts of Agricultural Policies in Developed Countries: Comparison of Partial and General Equilibrium Measures. *Review of Agricultural Economics*, 28 (2), 195-211. https://doi.org/10.1111/j.1467-9353.2006.00281.x

Government of South Australia. (2024). *Baiting with 1080 Poison*. https://pir.sa.gov.au/biosecurity/introduced-pest-feral-animals/using_poison_baits_in_south_australia/baiting_with_1080_poison

Jafari, Y., Britz, W., Guimbard, H., & Beckman, J. (2021). Properly Capturing Tariff Rate Quotas for Trade Policy Analysis in Computable General Equilibrium Models. *Economic Modelling*, *104*. https://doi.org/ 10.1016/j.econmod.2021.105620

Jones, K. (2004). *Trends in U.S. Sheep Industry* (Bulletin No. 787). United States Department of Agriculture, Economic Research Service.

Jones, K., Hahn, W., & Davis, C. (2003, July 27-30). *Demand for U.S. Lamb and Mutton by Country of Origin: A Two-Stage Differential Approach* [Paper Presentation]. American Agricultural Economics Association Annual Meeting, Montreal, Canada.

Koontz, S., & Lawrence, J. (2010). Impacts of Alternative Marketing Agreement Cattle Procurement on Packer Costs, Gross Margins, and Profits: Evidence From Plant-Level Profit and Loss Data. *Agribusiness*, *26*(1), 1–24. https://doi.org/ 10.1002/agr.20234

Lim, S., & Babula, R. (2012). How Much Is It Worth To Protect Sensitive Products With Tariff-Rate Quotas- A Korean Case. *Journal of Rural Development*, *35*(5), 83–108. https://doi.org/ 10.22004/ag.econ.175743

Livestock Marketing Information Center. (2023). *Lamb Meat Production* [Data set]. https://lmic.info/

López, A., Figueroa, B., Figueroa-Rodríguez, K. A., & Ramírez-Valverde, B. (2020). Structure and Concentration of The Global Sheep Meat Market. *Revista Brasileira de Zootecnia*, *49*. https:// doi.org/ 10.37496/rbz4920190033

Lusk, J. L., & Tonsor, G. T. (2016). How Meat Demand Elasticities Vary with Price, Income, and Product Category. *Applied Economic Perspectives and Policy*, *38*(4), 673–711.

Meat & Livestock Australia. (2021). *Global Sheep Meat Industry and Trade Report*. https://www.mla.com.au/globalassets/mla-corporate/prices--markets/documents/os-markets/red-meat-market-snapshots/2021/global-sheep-industry-and-trade-report.pdf

Muhammad, A., Jones, K. G., & Hahn, W. F. (2007). The Impact of Domestic and Import Prices on U.S. Lamb Imports: A Production System Approach. *Agricultural and Resource Economics Review*, *36*(2), 293–303. https://doi.org/ 10.1017/S1068280500007103

National Research Council. (2008). *Changes in The Sheep Industry in the United States: Making The Transition From Tradition*. National Academies Press.

Orden, D. (2001, March 27). *Policy Options for Import Competing Commodities Consistent with Trade Liberalization* [Paper Presentation], 'Fixing the Farm Bill' Conference, National Press Club, Washington D.C.

Paarlberg, P., & Lee, J. (2001). U.S. Trade Policy on Lamb Meat: Who Gets Fleeced? *Source: American Journal of Agricultural Economics*, *83*(1), 196–208.

Paarlberg, P., Lee, J., & Eales, J. (2001, July). *Trade Policy Under Imperfect Competition: An Assessment of The TRQ on Lamb Meat* [Paper Presentation]. The Western Agricultural Economics Association Annual Meetings, Logan, Utah.

Purcell, W. D. (1989). *Analysis of Demand for Beef, Pork, Lamb and Broilers: Implications for The Future* (Bulletin No. 1-89). Research Institute on Livestock Pricing, Virginia Tech.

R-CALF USA. (2018). *R-CALF USA Applauds President Trump's Trade Policy Shift.* https://www.r-calfusa.com/r-calf-usa-applauds-president-trumps-trade-policy-shift/

R-CALF USA. (August 3, 2023a). [Letter from R-CALF USA to Katherine Tai]. https://www.r-calfusa.com/wp-content/uploads/2023/08/230803-Combined-Cover-Letter-and-Sheep-Petition.pdf

R-CALF USA. (December 5, 2023b). [Letter from R-CALF USA to Katherine Tai]. https://www.r-calfusa.com/wp-content/uploads/2023/12/231205-Letter-to-Ambassador-and-pages-1-34-combined-compressed.pdf

Reinert, K. & Roland-Hoist, D. (2012). Social Accounting Matrices. In J. F. Francois & K. A. Reinert (Eds.), *Applied Methods for Trade Policy Analysis: A Handbook* (pp. 94–121). Cambridge: Cambridge University Press.

Riker, D. (2020). *A Trade Cost Approach to Estimating the Elasticity of Substitution* (Working Paper No. 2020-07-D). United States International Trade Commission.

RTI International. (2007). *GIPSA Livestock and Meat Marketing Study-Volume 5: Lamb and Lamb Meat Industries* (Project No. 0209230).

Salvatore, D. (2013). *International Economics*. John Wiley & Sons.

Samuelson, P., & Nordhaus, W. (2010). *Economics*. McGraw Hill.

Schrammel, M. & Schreiber, S. (2023). *How Does Data Aggregation Impact Elasticity of Substitution Estimation?: Evidence from a New Elasticity Database* (Working Paper No.2023-10-B). United States International Trade Commission.

Schreiber, S. (2022). A Practical Approach to Estimating Sector-Level Substitution Elasticities with PPML (Working Paper No. 2022- 03-A). United States International Trade Commission.

Schroeder, T., Jerrick, R., Jones, R., & Spaeth, C. (2001). U.S. Lamb Demand. *Sheep and Goat Journal*, *17*(1), 14–19.

Shiflett, J., Purcell, W., Marsh, D., & Rodgers, P. (2007). *Analysis of Lamb Demand in the United States* (Report No. CM-02-11). AFCERC Commodity Market.

Shiflett, J., Williams, G., & Rodgers, P. (2010). *Nontraditional Lamb Market in the United States: Characteristics and Marketing Strategies. https://www.sheepusa.org/wp-content/uploads/2022/06/Nontraditional_Lamb_Market_Study_Feb__12_2010-1.pdf*

Skully, D. (1999). *U.S. Tariff-Rate Quotas for Peanuts*. United States Department of Agriculture, Economic Research Service.

Skully, D. (2001). *Economics of Tariff-Rate Quota Administration* (Technical Bulletin No.1893). United States Department of Agriculture, Economic Research Service.

Stein, J. (2023, August 22). *Trump Vows Massive New Tariffs If Elected, Risking Global Economic War*. The Washington Post. https://www.washingtonpost.com/business/2023/08/22/trump-trade-tariffs/

The President. (1999). Proclamation 7208- To Facilitate Positive Adjustment to Competition from Imports of Lamb Meat. *Federal Register*, *64*(131).

Thomsen, M. (2023). An Interactive Text for Food and Agricultural Marketing. LibreTexts, University of Arkansas.

Tonsor, G., Lusk, J., & Tonsor, S. (2021). Meat Demand Monitor During COVID-19. *Animals*, *11*(4). https://doi.org/10.3390/ani11041040

Tridge. (n.d.). *Lamb*. https://www.tridge.com/intelligences/lamb/import

United States Customs and Border Protection. (2023a). *Australia Free Trade Agreement (AUFTA)*. https://www.cbp.gov/trade/free-trade-agreements/australia

United States Customs and Border Protection. (2023b). *QB 21-505 Washers and Covered Parts*. https://www.cbp.gov/trade/quota/bulletins/qb-21-505-washers-and-covered-parts

United States Department of Agriculture. (2001). Livestock Mandatory Reporting Confidentiality Guide. *Federal Register*, *66* (152).

United States Department of Agriculture. (2002). Lamb Promotion, Research, and Information Order. *Federal Register*, *67*(70).

United States Department of Agriculture. (2007). Change in Disease Status of the Patagonia South Region of Argentina with Regard to Rinderpest and Foot- and-Mouth Disease. *Federal Register, 72*(3).

United States Department of Agriculture. (2011). *Livestock, Dairy, and Poultry Outlook* (December). United States Department of Agriculture, Economics, Statistics and Market Information System. https://www.ers.usda.gov/webdocs/outlooks/37429/ldpm-210.pdf?v=3735.7

United States Department of Agriculture. (2014). *2013 Annual Report: Packers and Stockyards Program*. United States Department of Agriculture, Grain Inspection, Packers, and Stockyards Administration. https://www.ams.usda.gov/sites/default/files/media/2013_psp_annual_report.pdf

United States Department of Agriculture. (2016). *Livestock, Dairy, and Poultry Outlook* (April). United States Department of Agriculture, Economics, Statistics and Market Information System. https://www.ers.usda.gov/webdocs/outlooks/37660/57187_ldpm-outlook-april-2016.pdf?v=2190.8

United States Department of Agriculture. (2017). *Livestock, Dairy, and Poultry Outlook* (February). United States Department of Agriculture, Economics, Statistics and Market Information System https://www.ers.usda.gov/webdocs/outlooks/82534/ldp-m-272.pdf?v=6546.5

United States Department of Agriculture. (2018a). *Livestock, Dairy, and Poultry Outlook* (May). United States Department of Agriculture, Economics, Statistics and Market Information System. https://www.ers.usda.gov/webdocs/outlooks/89008/ldp-m-287.pdf?v=4745.6

United States Department of Agriculture. (2018b). *Report to Congress: Livestock Mandatory Reporting*. United States Department of Agriculture, Agricultural Marketing Service.

United States Department of Agriculture. (2020). *Sector at a Glance U.S. Production*. United States Department of Agriculture, Economic Research Service. https://www.ams.usda.gov/sites/default/files/media/LMR2018ReporttoCongress.pdf

United States Department of Agriculture. (2021). *2020 Annual Report*. United States Department of Agriculture, Packers and Stockyards Division, Agricultural Marketing Service.

https://www.ams.usda.gov/sites/default/files/media/PackersandStockyardsAnnualReport2020.pdf

United States Department of Agriculture (2023a). *Sheep & Goats*. United States Department of Agriculture, National Agricultural Statistics Service. https://downloads.usda.library.cornell.edu/usda-esmis /files /000000018 /nc582026h/nv936d50f/shep0123.pdf

United States Department of Agriculture. (2023b). *Cotton & Wool Yearbook* [Data set]. United States Department of Agriculture, Economic Research Service. https://www.ers.usda.gov/data-products/cotton-wool-and-textile-data/cotton-and-wool-yearbook/

United States Department of Agriculture. (2024a). *Livestock and Meat Domestic Data* [Data set]. United States Department of Agriculture, Economic Research Service. https://www.ers.usda.gov/data-products/livestock-and-meat-domestic-data/

United States Department of Agriculture. (2024b). *Livestock and Meat International Trade Data* [Data set]. United States Department of Agriculture, Economic Research Service. https://www.ers.usda.gov/data-products/livestock-and-meat-international-trade-data/

United States Department of Agriculture. (2024c). *Sheep, Incl Lambs - Slaughtered, Measured In Head* [Data set]. United States Department of Agriculture, National Agricultural Statistics Service. https://quickstats.nass.usda.gov/results/982FC8EE-5036-3D31-9212-4C5E98A99420

United States Department of Agriculture. (2024d). *Weekly Retail Lamb and Veal Feature Activity (LSWLNVFEATURES)* [Data set]. https://mymarketnews.ams.usda.gov/viewReport/3229

United States International Trade Commission. (1990). *U.S. Imports of Lamb Meat: Interim Monitoring Report* (Investigation No. 332-264). https://www.usitc.gov/publications/332/pub2345.pdf

United States International Trade Commission. (1995). *Lamb Meat: Competitive Conditions Affecting the U.S. and Foreign Lamb Industries*. https://www.usitc.gov/publications/332/pub2915.pdf

United States International Trade Commission. (1999). *Lamb Meat: Determination and Views of The Commission* (Investigation No. TA-201-68). https://www.usitc.gov/publications/docs/pubs/201/pub3176.pdf

United States International Trade Commission. (2002). *Lamb Meat: Evaluation of the Effectiveness of Import Relief* (Investigation No. TA-204-s8). https://www.usitc.gov/publications/tariff_affairs/pub3512.pdf

United States International Trade Commission. (2023). *Trade Database*. https://dataweb.usitc.gov/

United States International Trade Commission. (2024). *Tariff Database*. https://dataweb.usitc.gov/

Williams, G., Capps, O., & Dang, T. (2010). Does Lamb Promotion Work. *Agribusiness*, *26*(4), 536–556.

Williams, G., Capps, O., Salin, V., Senarath, D., Higgins, L., Thompson, W. J., & Anderson, D. (2011). *Ethnic Lamb Buying and Preparation Behavior and Preferences* (Report No. CM-01-11). AFCERC Commodity Market.

World Trade Organization. (2000, April 19). *First Submission of Australia*.

World Trade Organization. (2001, May 1). *United States- Safeguard Measures on Imports of Fresh, Chilled or Frozen Lamb Meat from New Zealand and Australia – Report of the Panel.*

World Trade Organization. (2004, November 15). *Calculation of Ad Valorem Equivalent (AVEs): Data Requirements and Availability*. Committee on Agriculture, Special Session.