

DAIRY TRQ LIBERALIZATION: CONTRASTING BILATERAL AND MOST FAVORED NATION REFORM OPTIONS

Jason H. Grant^{a,b,*}, Thomas W. Hertel^{a,b}, Thomas F. Rutherford^c

^a *Dept. of Agricultural & Applied Economics, Virginia Tech, Blacksburg, VA, USA,*
jhgrant@purdue.edu

^b *Center for Global Trade Analysis, Purdue University, West Lafayette, IN,*
hertel@purdue.edu

^c *ETH Zürich, Centre for Energy Policy and Economy, Department of Management,
Technology and Economics Zürichbergstrasse 18, 8032 Zürich*
tom@mpsge.org

**Paper presented at the 11th Annual Conference on Global Economic Analysis,
Helsinki Finland, June 12-14, 2008**

* Corresponding author. Tel.: +1 540 231 7559; fax: +1 540 231 7147.
E-mail address: jhgrant@vt.edu (J.H. Grant)

Abstract

We develop a highly disaggregated, “tariff line”, source-differentiated partial equilibrium model of U.S. specialty cheese imports to investigate alternative reform options for tariff-rate quotas. A mixed-complementarity framework is used to represent bilateral and multilateral tariff-quota administration methods within the U.S. dairy industry. The impact of liberalizing U.S. specialty cheese imports via bilateral and multilateral tariff-rate quota expansions, out-of-quota tariff cuts, and simultaneous liberalization scenarios is evaluated. We find that the path of liberalization is quite different, depending on the reform approach undertaken. The results have important policy implications in the agricultural negotiations.

JEL Codes: F01, F17, Q17, Q18

Keywords: *agricultural trade, mixed-complementarity problem, partial equilibrium tariff-rate quotas, WTO*

More quantitative analysis of a possible agricultural trade agreement in the Doha Development Agenda (DDA) has been conducted than any previous negotiating round of the General Agreement on Tariffs and Trade (GATT) and the World Trade Organization (WTO). Analyses have ranged from smaller partial equilibrium (PE) assessments to large scale, comprehensive reforms using computable general equilibrium (CGE) models (Harrison, Rutherford and Tarr 1997; Anderson and Martin 2006; Anderson, Martin and van der Mensbrugghe 2006; Decreux and Fontangé 2006; Sébastien, Laborde and Martin 2005; Bouët, Mevel and Orden 2005; Bouët et al. 2005). In many cases, these models have enriched policy negotiations because: (i) they allow for an explicit evaluation of the welfare effects; (ii) they allow analysts to address the issue of “winners” and “losers”; and (iii) they can identify politically feasible packages of reforms.

However, views on the applicability of CGE and PE models of trade policy differ widely. Critics often point to the problem of policy aggregation. In the Uruguay Round (UR), Sumner (1993) argued that policy models were too aggregated and may have been harmful to the policy debate. Meilke and de Gorter (1996) argued that quantitative analyses were “woefully inadequate,” and these models became increasingly irrelevant as talks intensified into sensitive product lines. Gardner (1993) claims that CGE models have not necessarily been illuminating because key elements of the proposals dealt with non-standard policy instruments (i.e. tariff-rate quotas). Bureau and Salvatici (2003) note that differences in methods of aggregating protection is one of the main reasons why policy results are fundamentally different between models analyzing an almost identical set of liberalization scenarios.¹

In light of the fact that disaggregation of trade policy has been strongly advocated since at least 1985 by Anderson, it is puzzling that there has not been a more concerted quantitative effort in this respect.² In this article, we develop a highly disaggregated, tariff line policy model calibrated to 2001 protection levels to investigate bilateral and multilateral tariff-rate quota

reform options using the heavily protected U.S. specialty cheese market as our case study.³ U.S. dairy trade liberalization involving tariff-rate quotas (TRQs) is complex because there are two tariffs, a quota, three possible regimes, and a complex set of procedures to administer the quota. However, TRQs are one of the key vehicles for trade liberalization in the DDA. Thus, effective analysis requires manipulating them at the tariff line.

We make three important contributions. First, U.S. specialty cheese TRQ policy is specified as a mixed-complementarity problem (MCP) (Rutherford 1995) to account for regime changes in partial liberalization experiments. Previous studies have typically focused on complete liberalization because of the difficulty in handling regime changes (Larivière and Meilke 1999; Langley, Somwaru and Normile 2006; Cox et al. 1999). Indeed, it was Stillman (1999) who noted: “*It would be interesting to see an empirical application of dairy products limited by TRQs in the U.S. to identify what level of quotas and tariffs are necessary to cause an increase in global trade*” (p. 5, *italics added*). Elberhi et al. (2004) and van der Messenbrughe, Beghin and Mitchell (vdM-B-M 2005) use an MCP formulation but focus on sugar trade as this relatively homogeneous product is explicitly broken out in the GTAP data base.⁴ Both sets of authors carefully avoided dairy trade despite its much greater importance in world trade and protection and did not take into account TRQ administration methods.

Second, the tariff-quota framework is embedded in a tariff line, export-differentiated policy model of the U.S. specialty cheese sector. Beyond the MCP formulation, working at the tariff line enables us to account for TRQ administration methods which vary by exporter and commodity (Stillman 1999). For example, the U.S. allocates specialty cheese quota by country-specific (i.e. designated) and any country (i.e., Most Favored Nation (MFN)) licenses. To our

knowledge, this study is the first of its kind to highlight the interaction between country-specific and MFN TRQ administration methods in a quantitative framework.

Finally, our analysis contributes to the policy debate over TRQ liberalization strategies by tracing out the entire path of liberalization of key market variables including in- and out-of-quota imports, quota rents, composite imports, and import prices. This enables us to rank the effectiveness of four TRQ liberalization strategies in terms of market access: out-of-quota tariff reductions, country-specific quota expansions, simultaneous liberalizations as well as competition for and expansion of the MFN (i.e., any-country) quota.

US Dairy Trade and Protection

In 2001, US dairy imports amounted to \$1.5 billion dollars and accounted for the largest sectoral share of agricultural imports (Nicholson and Bishop 2004). U.S. import data, ranked by value share, for the 24 HS6-digit, and nine HS4-digit product lines comprising the dairy sector are reported in table 1. The largest class of US dairy imports in 2001 is cheese accounting for 59 percent of the total value of dairy imports at the HS4-digit level (column 3). Casein, a milk protein concentrate which, until recently has been exempt from tariff protection, accounted for 23.5% of US dairy import values in 2001.

At the HS6-digit level, a sharper picture emerges (table 1). Over 50 percent of U.S. dairy imports by value are “cheese except 040610-040640 including Cheddar and Colby” (HS6 digit 040690).⁵ The European Union (EU), New Zealand, Australia, Argentina and Canada are the world’s largest dairy exporters. Together, these countries supplied over 90 (95) percent of U.S. dairy (specialty cheese) imports in 2001 with EU countries accounting for the largest share.

Figure 1 summarizes the current levels of *ad valorem* tariff equivalents and tariff-rate quota protection in U.S. dairy. The length of the bar depicts the mean applied tariff rate, which is composed of an *ad valorem* tariff and the *ad valorem* equivalent (AVE) of specific tariffs.⁶ The

U.S. applies specific tariffs on 22 out of 24 tariff lines with an AVE impact ranging from zero percent to 33 percent. The U.S. applies an *ad valorem* tariff policy on 15 out of 24 dairy commodities ranging from zero to 17 percent. What is notable in figure 1 is that the US has established TRQs on 18 product lines. Clearly TRQs are an important instrument of protection.

Tariff-rate quotas combine quantitative restrictions (the quota) and tariffs (the in- or out-of-quota tariff). TRQs were introduced during the UR as a compromise for countries seeking additional policy flexibility after the conversion of non-tariff barriers into bound tariff equivalents (Boughner, de Gorter and Sheldon 2000).⁷ Exporters face a lower in-quota tariff when import demand is below the quota level (regime 1). When import demand is stronger but the out-of-quota tariff is prohibitive, the TRQ is similar to a *de facto* quota (regime 2). Quota rents can accrue to the importing or exporting firms or both depending on the method of TRQ administration.⁸ When import demand is sufficiently strong (regime 3), the out-of-quota tariff applies and quota rents are collected on the full difference between the in-quota and the out-of-quota tariff-inclusive price times the quota level. However, imports up to the quota level face a much lower tariff rate. Thus, the problem is who gets the right to supply under the quota? Exporters are willing to supply above the quota, but the in-quota tariff rate only applies on the in-quota portion of imports.

This supply rationing problem has led to a complex web of quota administration methods.⁹ In fact, one of the most complex facets of U.S. dairy TRQs is the allocation and administration of the quota level. Dairy imports under non-TRQ trade can enter in unlimited quantities at the prevailing tariff rate and, more importantly, do not require an import license. Similarly, out-of-quota imports can enter in unlimited quantities as long as the exporter or

importing firm pays the out-of-quota tariff rate. Imports under the quota enter in limited quantities and are subject to five types of licensing requirements (IATRC, 2001).¹⁰

Prior to the UR, dairy import quotas were allocated by designated (i.e. country-specific) licenses. Two major changes to U.S. dairy quotas occurred after the UR. First, pure quotas were converted into TRQs. Second, the U.S. introduced MFN, or “any country” quotas. While over 90 percent of specialty cheese quota continues to be administered by designated licenses, the newly created MFN quota helped the U.S. increase its minimum access commitment from three to five percent of domestic consumption as agreed to during the UR. In the case of specialty cheese, the U.S. opted for expanding bilateral quotas to meet its minimum access commitment while holding fixed the MFN quota. However, the current agricultural negotiations may change the structure of U.S. TRQ administration as talks have tentatively agreed on MFN quota expansions.

In summary, quantitative assessment of TRQ liberalization confronts a complex situation. TRQs involve regime changes that alter the distribution of quota rents, tariff revenues and ultimately, economic welfare. As TRQ liberalization occurs we expect out-of-quota exporters to change regimes which cannot be handled using an aggregate measure of protection. Moreover, modeling efforts need to be sufficiently disaggregated, and must be based on bilateral trade to account for TRQ administration procedures that vary by country and variety at the tariff line.

The Disaggregated Sub-Sector Model

The U.S. dairy trade model is formulated in an MCP framework (Rutherford 2005) where dairy products are differentiated by country of origin (Armington 1969) which permits us to handle country-specific TRQ allocations. In what follows, g denotes one of 24 HS6-digit dairy

products; d denotes final or intermediate demand segments; and r and s index source and destination regions respectively.¹¹

Sub-sector dairy products are produced using a constant elasticity of transformation (CET) function that permits dairy capacity to be shifted between HS6-digit products (i.e., cheese and milk):

$$(1) \quad Y_r = \left[\sum_g (\theta_{g,r}^Y P_{g,r}^Y)^{1+\gamma} \right]^{\frac{1}{1+\gamma}}$$

where, Y_r is the CET unit revenue function that determines the responsiveness of individual product supply to price, and γ is the elasticity of transformation.¹²

Market clearing ensures that sub-sector output is sufficient to cover domestic and export demand:

$$(2) \quad Y_r \left(\frac{P_{g,r}^Y}{P_r^Y} \right)^\gamma X_{g,r}^Y = \underbrace{\sum_d X_{g,d,r}^D \left(\frac{P_{g,d,r}^A}{P_{g,r}^Y} \frac{(1+\bar{t}_{d,r}^{AD})}{(1+t_{d,r}^{AD})} \right)^\sigma \left(\frac{P_{d,r}^A}{P_{g,d,r}^A} \right)^\sigma A_{d,r}}_{\text{DOMESTIC}} + \underbrace{\sum_s X_{g,r,s}^{EX} \left(\frac{P_{g,s}^M}{P_{g,r,s}^X} \right)^{\sigma_M} M_{g,s}}_{\text{EXPORT}}$$

This equation determines the supply price of sub-sector goods ($P_{g,r}^Y$). For example, if demand exceeds supply, then prices will rise to clear the market, and vice versa. The expression on the left-hand side of (2) denotes production activity where, $X_{g,r}^Y$ is the value of sub-sector output and P_r^Y is the CET unit revenue function at the industry (dairy sector) level. The first expression on the right-hand side of (2) is domestic demand activity where, $X_{g,r}^D$ is the level of sub-sector demand, t_r^D ($\bar{t}_r^D$) is the (benchmark) tax rate on domestic goods and σ is the elasticity of substitution between domestic (dairy) goods. The second term on the right-hand side of (2) is the activity level for export demand where, $X_{g,r,s}^{EX}$ is the activity level of sub-sector bilateral

trade, $M_{g,s}$ denotes sub-sector imports into region s and σ_M is the elasticity of substitution between imports from different sources.

Given the importance of specialty cheese in US imports we introduce several bilateral and one multilateral (global MFN) TRQ policy for this tariff line.¹³ Tariff-quota activities are based on the following market clearing condition:

$$(3) \quad X_{SC,r,s}^{IQ} + X_{SC,r,s}^{OQ} + X_{SC,r,s}^{MFN} = X_{SC,r,s}^{EX} \left(\frac{P_{SC,r}^M}{P_{SC,r,s}^X} \right)^{\sigma_M}$$

where exports of specialty cheese (SC) can be delivered as in-quota trade ($X_{SC,r,s}^{IQ}$) facing a tariff rate (t^{in}) and quota rent in the case of regime 2, as out-of-quota trade ($X_{SC,r,s}^{OQ}$) facing a much higher tariff rate (t^{out}), or by bidding for quota in the MFN market ($X_{SC,r,s}^{MFN}$) as described below. Equation (3) determines the equilibrium product price ($P_{SC,r,s}^X$) in the destination (U.S.) market, which is source (r) and destination (s) specific.

Equilibrium in tariff-quota trade implies zero profits on exports, after appropriate distribution of quota rents, so we augment the PE trade model with a zero-profit constraint for each tariff quota activity. Following the MCP convention (Rutherford 1995; vdM-B-M 2003), the zero-profit condition for in-quota trade (X^{IQ}) is:

$$(4) \quad X_{SC,r,s}^{IQ} \geq 0 \quad \perp \quad P_{SC,r,s}^X - P_{SC,r}^Y T_{g,r,s}^{in} - q_{g,r}^{rent} \leq 0$$

where, $T_{g,r,s}^{in}$ denotes the power of the in-quota trade cost, including taxes/subsidies and transport margins between r and s . In the zero-profit condition (4), $X_{SC,r,s}^{IQ} \geq 0$ holds with strict *inequality* if $P_{SC,r,s}^X \leq P_{SC,r}^Y T_{g,r,s}^{in} + q_{g,r}^{rent}$ holds with strict *equality*. For regime 2 (pure quota regime) to be operating, quota rents ($q_{g,r}^{rent}$) precisely exhaust the difference between the domestic supply price

of specialty cheese in the source region ($P_{SC,r}^Y$) and the tariff-inclusive import price ($P_{SC,r,s}^X$) if in-quota imports hit the quota level. In this framework, $q_{g,r}^{rent}$ is a slack variable that takes on value once $X_{SC,r,s}^{IQ}$ hits the quota level denoted $X_{SC,r,s}^{UP}$ which is country specific:

$$(5) \quad q_{g,r}^{rent} \geq 0 \quad \perp \quad X_{SC,r,s}^{IQ} \leq X_{SC,r,s}^{UP}$$

where, $q_{g,r}^{rent} > 0$ can only occur if $X_{SC,r,s}^{IQ} \leq X_{SC,r,s}^{UP}$ holds with strict equality and quota rents are assumed to accrue to the source region (r).

Analogously, the zero-profit condition for out-of-quota trade is:

$$(6) \quad X_{SC,r,s}^{OO} \geq 0 \quad \perp \quad P_{SC,r,s}^X - P_{SC,r}^Y T_{g,r,s}^{out} \leq 0$$

where, positive out-of-quota trade $X_{SC,r,s}^{OO} > 0$ implies that $P_{SC,r,s}^X \leq P_{SC,r}^Y T_{g,r,s}^{out}$ must hold with strict equality. Note there are no quota rents on out-of-quota imports.

The second method the U.S. uses to administer specialty cheese quota is through any-country or MFN licenses. The MFN quota is available to any country, including those countries with designated quotas (IATRC 2001). Thus, exporters with bilateral SC allocations will want to compete for newly expanded MFN quota. The MFN quota accounts for roughly five percent of total designated U.S. specialty cheese quotas as discussed in the next section.

MFN quota licenses are reviewed and allocated by the FAS-USDA based on license applications that specify the product type and certain quality standards. To operationalize the MFN-based licenses in the model, we assume MFN quota is auctioned off to the highest bidder. In equilibrium, the highest bids will come from those exporters supplying the highest valued cheeses, and are currently out-of-quota.¹⁴ These countries can bid an amount slightly lower than their bilateral out-of-quota tariff and still garner additional revenue, since they do not have to pay the out-of-quota premium on the newly expanded MFN quota.

Since products in the model are differentiated by origin, we need to convert bilateral flows into a common unit in order to compute the MFN quota fill. We do so by using the bilateral unit value of products. Specifically, we sum the value of all bilateral quota flows under the MFN quota, each one divided by the appropriate exporter unit value:

$$(7) \quad X_{SC,r,s}^{MFN} = \sum_r \frac{X_{SC,r,s}^Q}{UV_{SC,r}}$$

where, $X_{SC,r,s}^{MFN}$ denotes the activity level of bilateral trade between r and s that occurs in the MFN quota market; $X_{SC,r,s}^Q$ is the value of country-specific quota level that is allocated to country r by country s (the U.S.); and $UV_{SC,r}$ is the unit-value price of specialty cheese in the source region (r). In calibrating the benchmark (2001) data, we assume that $X_{SC,r,s}^{MFN} = 0$ and then introduce MFN quota in increments of five percent.

The following zero profit condition determines the equilibrium level of MFN quota:

$$(8) \quad X_{SC,r,s}^{MFN} \geq 0 \quad \perp \quad UV_{g,r} (P_{SC,r,s}^X - P_{SC,r}^Y T_{g,r,s}^{in}) \leq qrent_{g,s}^{MFN}$$

where, $qrent_{g,s}^{MFN}$ denotes the value of MFN quota rents. All other variables are defined previously. Notice, MFN quota rents ($qrent_{g,s}^{MFN}$) are only indexed over s (i.e. the US). The existence of a common MFN quota implies the existence of a single quota price. For $X_{SC,r,s}^{MFN} \geq 0$ to hold with strict inequality, profitability of MFN quota trade must be zero. That is, the difference between the destination price ($P_{SC,r,s}^X$) and marginal costs inclusive of the in-quota tariff ($P_{SC,r}^Y T_{g,r,s}^{in}$) scaled by the unit values ($UV_{g,r}$) must equal the MFN quota rent available (which is assumed to be collected by the U.S. government).

The quantity of sub-sector imports must be sufficient to cover demand in different markets ($d = \text{either final or intermediate demand}$). The market clearing condition is:

$$(9) \quad M_{g,i,r} X_{g,i,r}^{AM} = \sum_d X_{g,d,r}^{IM} \left(\frac{P_{g,d,r}^A (1 + \bar{t}_{d,r}^{AM})}{P_{g,r}^M (1 + t_{d,r}^{AM})} \right)^{\sigma_M} \left(\frac{P_{d,r}^A}{P_{g,d,r}^A} \right)^{\sigma} A_{d,r}$$

where $X_{g,r}^{AM}$ denotes aggregate expenditure on sub-sector imports, $X_{g,d,r}^{IM}$ denotes the activity level for import demand, and $t_{d,r}^{AM}$ is the tax rate on imports (with benchmark level $\bar{t}_{d,r}^{AM}$). The unit cost of sub-sector imports ($P_{g,r}^M$) is a share-weighted ($\theta_{g,s,r}^M$) CES function of the destination price ($P_{g,r,s}^X$):

$$(10) \quad P_{g,r}^M = \left[\sum_g \left(\theta_{g,s,r}^M P_{g,s,r}^{Xss} \right)^{1-\sigma_M} \right]^{\frac{1}{1-\sigma_M}},$$

where, σ_M is the elasticity of substitution between import sources (r). This composite price, in turn, enters a higher level CES function that determines the price of aggregate domestic consumption for specialty cheese:

$$(11) \quad P_{g,d,r}^A = \left\{ \underbrace{\theta_{g,d,r}^D \left(\frac{P_{g,r}^Y (1 + t_{d,r}^{AD})}{(1 + \bar{t}_{d,r}^{AD})} \right)^{1-\sigma}}_{\text{DOMESTIC}} + \underbrace{(1 - \theta_{g,d,r}^D) \left(\frac{P_{g,r}^M (1 + t_{d,r}^{AI})}{(1 + \bar{t}_{d,r}^{AI})} \right)^{1-\sigma_{DM}}}_{\text{IMPORTED}} \right\}^{\frac{1}{1-\sigma_{DM}}}$$

where, $P_{g,d,r}^A$ is the sub-sector Armington price index as a share weighted composite price of domestic (θ^D) and imported (θ^M) varieties governed by the import-domestic elasticity of substitution (σ_{DM}) between sub-sector products.¹⁵

Finally, HS6-digit level dairy products substitute for one another in a constant elasticity of substitution (CES) function which forms aggregate domestic dairy consumption:

$$(12) \quad A_{d,r} = \left[\sum_g \left(\theta_{g,d,r}^D P_{g,d,r}^A \right)^{1+\sigma} \right]^{\frac{1}{1-\sigma}}$$

where, σ is the elasticity of substitution between sub-sector dairy products in consumption.

Higher prices for specialty cheese, for example, will encourage more production (via the transformation function) and less consumption (via the substitution function).

This completes the partial equilibrium model of specialty cheese production, consumption and trade. We now turn to the estimation of key parameters in the model, and the sources and methods for our data set.

Data and Model Parameters

In this section we discuss briefly the estimation of the Armington parameters and the TRQ filling ratios for bilateral and MFN TRQs. This is followed by a discussion of the trade flow and protection data sources and the imputation of domestic demands. A more detailed discussion of the bilateral and MFN TRQ database, country and commodity aggregation, and the imputation of domestic demands at the tariff line can be found in Appendices I though IV.

Model Parameters

There are four parameters in the sub-sector dairy model developed in the previous section: (i) import-import elasticity of substitution (σ_M); (ii) the domestic-import elasticity of substitution (σ_{DM}); (iii) the elasticity of substitution in consumption (σ); and (iv) the transformation elasticity governing the supply of HS6-digit products (γ).

In our model, a key parameter is the substitutability between imported and domestic dairy products, σ_{DM} . When tariffs are reduced, σ_{DM} will govern the extent to which imports displace domestic goods. Moreover, when relative prices of different import varieties change in the wake of TRQ liberalization, we expect consumers to substitute between imported cheese (e.g., between

French Brie and Swiss Emmentaler cheese). The importance of these Armington elasticities is highlighted in McDaniel and Balistreri (2001), who show that Armington parameters in applied trade models drive the quantitative and even the qualitative results of trade reform. Therefore, these deserve special attention.

As discussed below, the trade flow and tariff rate data are from the *Centre d'Etudes Prospectives et d'Informations Internationales* (CEPII) Market Access Maps (MAcMap) dataset.¹⁶ MAcMap data offer a snapshot of 2001 protection including applied *ad valorem* and the *ad valorem* equivalent of specific tariffs at the HS6-digit level. We follow Hertel *et al.* (2007) and Hummels (1999) and treat expenditure on composite import and domestic goods as exogenous and focus on variation in applied protection to identify the elasticity of substitution between import sources:

$$(13) \quad \ln V_{irs} = \alpha_0 + \alpha_r + \alpha_s + \alpha_i + (1 - \sigma_M) \ln(1 + t_{irs}^{ADV} + t_{irs}^{SPE}) + \varepsilon_{irs}$$

where, V_{irs} is the value of bilateral trade between countries r and s ; α_r , α_s , and α_i are source, destination and commodity fixed effects to control for all time-invariant effects specific to each country and HS6-digit commodity; t_{irs}^{ADV} and t_{irs}^{SPE} are the *ad valorem* and *ad valorem* equivalent of specific tariff rates, respectively; σ_M is the import-import elasticity of substitution; and ε_{irs} is a log-normal error term. We estimate two versions of equation (13), once for all 24 HS6-digit dairy products and once for the four HS6-digit commodity lines corresponding to specialty cheeses.

In the interest of space we briefly summarize the estimation results.¹⁷ First, the elasticity of substitution between all dairy products from different sources are moderately substitutable with $\sigma_M = 4.94$ and highly significant. Second, the ease of substitution between import sources is almost twice as large when we restrict our attention to the four HS6-digit specialty cheese

product lines. In this case, $\sigma_M = 8.11$ and is highly significant. This is the value we adopt in the model.

It is harder estimate σ_{DM} since this requires combining trade data with data on domestic utilization. Yet it is precisely this product line competition that is central to our tariff line analysis of trade policy. Of the studies that have estimated σ_{DM} , most are conducted at a more aggregated (sector) level (see for example Stern, Francis and Schmacher 1976; Shiells, Stern and Deardorff 1986; Reinert and Roland-Holst 1992; Shiells and Reinert 1993; and Gallaway *et al.* 2001). However, if we restrict our attention to domestic and imported specialty cheeses in the U.S., the National Agricultural Statistics Service of the USDA (NASS-USDA) provide domestic shipment and price data for some varieties.¹⁸ Following Gallaway *et al.* (2001) we can derive an estimation strategy from the CES functional form that regresses the first-difference of the ratio of imports to domestic quantities on the relative price ratio:

$$(14) \quad \ln(\Delta A_{it}) = \alpha_0 + \alpha_1 \ln(\Delta B_{it}) + \varepsilon_{it}$$

In equation (14) Δ denotes the first-differenced operator; A_{it} denotes the ratio of composite imports (M_{it}) to domestic goods (D_{it}) for specialty cheese variety i in year t , where M_{it} is the aggregate quantity of imports and D_{it} is the domestic quantity; B_{it} denotes the domestic (P_{it}^D) to import price (P_{it}^M) ratio of good i in year t , where P_{it}^M is the composite price index over imported varieties and P_{it}^D is the equivalent domestic price;.

Results from the estimation of (14) (discussed in greater detail in Grant 2007) reveal that imported and domestic specialty cheese varieties in the U.S. are quite substitutable. The implied elasticity of substitution between imported and domestic varieties of specialty cheese are: 5.92 for American Cheese; 1.63 for cheddar cheese; and 2.96 for Swiss Cheese. The simple average import-domestic elasticity of substitution is 3.38. This is the value we adopt in the model.

The final two parameters govern the aggregate responsiveness of supply and demand in the dairy industry. We find that our results are much less sensitive to their values.¹⁹ The elasticity of transformation (γ) governs the ease with which dairy output can be transformed amongst 24 HS6-digit products. Because dairy products share the same input – fluid milk - we believe this transformation elasticity should be quite large, in absolute value, and set it equal to four. Thus, a permanent rise in the price of cheese, relative to butter, for example, would be accompanied by a significant shift in cheese supplies from the industry. The other parameter required in the PE model is the elasticity of substitution in consumption (σ) across HS6-digit products. How responsive are consumers to price when choosing between cheese, fresh milk and yogurt products? While this substitutability is surely larger than that between dairy products as a group and other food items, we are inclined to believe this is not nearly as large, in absolute value, as the transformation elasticity, so we set it equal to 1.0.

US Bilateral Tariff-Quota Data and Unit Values

Appendix II provides the details on our methodology for computing bilateral TRQ fill ratios. These ratios are as follows for the key exporters in our data base: Other South America: SAM=2.10, Australia: AUS=2.07, New Zealand: NZL=1.49, Canada: CAN=1.32, the EU-15: EU=1.21, Argentina: ARG=1.16, and Rest of Europe: ROE=0.88. Six exporting regions in our model are out-of-quota in 2001 with two of them (AUS and SAM) exporting more than twice their quota allocations. Clearly these exporters have a lot at stake when it comes to liberalizing US specialty cheese TRQs. Moreover, TRQ fill ratios are a critical piece of information since these ratios determine the TRQ regime that is binding in the benchmark equilibrium and the effectiveness of TRQ liberalization strategies.

Bilateral unit values are a critical component of the bid prices an exporter can offer for MFN quota. Exporters with the highest unit values will be the first to switch to MFN quotas for their exports to the US market. We draw on the U.S. International trade Commission's (USITC) Interactive Tariff and Trade database (dataweb.usitc.gov) to estimate unit values by exporter. The EU15 supplies the highest valued specialty cheese. Normalizing on the EU15 unit values so that all export unit values fall on the $(0,1]$ interval, we have the following ranking: EU (1.0), CAN and ROE (0.9), NZL (0.8), AUS (0.7), ARG (0.6) and SAM (0.4).

Trade, Protection and Domestic Data

Trade flows and tariff rates for the 2001 benchmark at the HS6-digit level are taken from CEPII's MAcMap dataset (Bouët et al. 2004). Domestic data at the HS6-digit level of detail are not readily available. However, in Appendix IV we develop an ordinary least squares approach to imputing domestic demands based on target import intensity shares. While this is surely an imperfect characterization of the dairy sector at the HS6-digit tariff line, it is essential to our approach of permitting tariff line competition amongst dairy products. Until domestic data become available at this level of detail, our approach to imputing domestic demands provides a reasonable starting point.

Results

Four liberalization experiments are performed. Scenario 1 progressively liberalizes U.S. specialty cheese TRQs by expanding bilateral quota levels. Scenario 2 liberalizes U.S. TRQ policy by progressively cutting out-of-quota tariffs. In scenario 3, we simultaneously expand the quota and cut the out-of-quota tariff. Finally, in scenario 4 we expand the MFN quota. All experiments progressively liberalize TRQs until complete liberalization is achieved. We focus on

bilateral and MFN quota expansions. However, we conclude by ranking all four TRQ liberalization options and discussing the policy implications.

Bilateral Quota Expansion

Figure 2 reports the evolution of out-of-quota imports for New Zealand (NZL), Canada (CAN), Australia (AUS), and the EU15 members (other exporters are suppressed for ease of exposition). What is notable in figure 2 is that quota expansions of less than 30 percent may not result in a significant improvement in market access. This is because major exporters of specialty cheese are substantially out-of-quota (regime 3). Looking at out-of-quota imports, for the EU15 and CAN (AUS and NZL) to move out of regime 3, a 30 (40) percent quota expansion is required. Until exporters move out of regime 3 and into regime 2, there is no price decline and hence no increase in imports.

Figure 3 tracks the level of bilateral tariff-quota rents which are assumed to accrue to the exporting country. Modest quota expansions (<30%) actually increase quota rents for all out-of-quota exporters as the volume of in-quota export earning quota rents increases. In effect, the U.S. is swapping out-of-quota, tariff-laden imports for in-quota tariff-laden imports. This results in a shift of tariff revenues (by the difference between the in- and out-of-quota tariffs) from the U.S. to the exporting countries in the form of increased quota rents. Quota expansions greater than 30 percent move the EU15 and CAN into regime two where designated quota rents dissipate quickly. AUS and NZL quota rents increase as long they remain in regime 3 (until a 40 percent expansion is reached). Note that a 70 percent US specialty cheese bilateral quota expansion is necessary for all four bilateral quotas to become non-binding.

Being able to track the path of TRQ rents has important policy implications. Our analysis suggests dairy exporting countries may support modest expansions in the U.S. specialty cheese

quota because quota rents increase initially. However, exporters may not be enthusiastic supporters of bilateral quota expansions greater than 40 percent because of the sharp decline in quota rents when all countries enter regime 2.

We can evaluate the effectiveness of bilateral quota expansions as a market access strategy by comparing out-of-quota tariff cuts and a simultaneous liberalization experiment and looking at the change in specialty cheese composite imports and import prices along the path of liberalization. Figure 4 illustrates the percentage change in each of these key market variables. Consistent with the findings above, a simultaneous liberalization experiment does not perform any better than cutting out-of-quota tariffs for modest expansions. This is because cutting out-of-quota tariffs is the binding instrument of liberalization when exporters remain in regime 3 (for quota expansions of 40 percent or less). Thus, out-of-quota tariff cuts force an immediate reduction in import prices which contribute to increased trade. However, when the quota expansion is enough to move all four exporters out of regime 3 (after a 40 percent expansion), the simultaneous liberalization experiment subsequently outperforms out-of-quota tariff cuts as bilateral quota expansions subsequently become binding and exporters move through regime 2. For example, a 60 percent out-of-quota tariff cut generates a 147 percent increase in specialty cheese imports, whereas a 60 percent simultaneous liberalization generates a 219 percent increase in specialty cheese imports.

This has import policy implications. For modest TRQ liberalization commitments, negotiators could achieve the same increase in market access by cutting out-of-quota tariffs alone. However, under a more aggressive scenario - in the neighborhood of a 50 to 60 percent cut/expansion - negotiators could achieve further market access by simultaneously liberalizing country-specific quotas and cutting bilateral out-of-quota tariff rates.

MFN Quota Expansion

In the final scenario we progressively expand the MFN quota. Current MFN quota represents approximately five percent of total bilateral quotas in the specialty cheese market and our liberalization experiment introduces MFN quota in increments of five percent of total bilateral quotas.

As noted in the previous section, the highest unit values for specialty cheese exports belong to the EU15 and CAN, which are therefore the highest bidders for the MFN quota at the outset. We can gain substantial insight into the workings of the MFN scenario by simply tracing out-of-quota exports in the bilateral quota market along the path of MFN TRQ liberalization. Figure 5 plots bilateral over-quota exports under an MFN quota expansion scenario for four countries. For illustrative purposes, Australia (AUS) has been dropped from this figure and replaced with the South American Group (SAM) of countries whose unit value prices are much lower than that of Australia's. What is interesting about this scenario is that the EU15 and CAN begin by simply diverting (bilateral) out-of-quota exports to the MFN quota market. That is, out-of-quota exporters exhibit a horizontal supply function as long as there are still out-of-quota bilateral exports to be diverted to the MFN market. The reason is that, at the margin, they are not earning any rents on these exports, so they can costlessly divert this trade from the bilateral to the MFN quota market until they eliminate their over quota bilateral exports. This is a key insight offered by our paper.

Moreover, the MFN scenario may be an attractive TRQ liberalization option. In the bilateral quota expansion discussed above, the EU15 moved into regime 2 after a 30 percent bilateral quota expansion (figures 2 and 3). In the MFN scenario, the EU15 bilateral out-of-quota exports are simply redirected to the MFN market, and absorb all of the MFN quota

expansion. Therefore, the EU15 moves out of regime 3 in the bilateral market much earlier, after only a 15 percent expansion of MFN quota, or *half* the amount of quota expansion it took to get the EU15 into regime 2 in the bilateral quota expansion scenario.

Once the EU15 has exhausted the transfer of its bilateral over-quota exports to the MFN market, the price falls and NZL and CAN begin successfully bidding for MFN quota. Both countries enter the MFN market after a 15 percent MFN quota expansion. MFN quota liberalization moves NZL out of regime 3 in its bilateral quota market after just a 30 percent MFN expansion, whereas it took a 40 percent bilateral quota expansion in the previous bilateral quota expansion scenario. Once CAN, NZL and AUS (not shown) exhaust the transfer of bilateral over-quota exports to the MFN market, SAM enters into the MFN quota market.

Comparing TRQ Liberalization Strategies

In table 2 the four liberalization scenarios are judged with respect to one another by comparing aggregate import volumes and delivered (after tariff) import price changes. This is facilitated by measuring each scenario's percentage change in imports and import prices with respect to increments of liberalization versus absolute quota or tariff cuts as depicted in the forgoing figures. For example, it took a 190 percent bilateral quota expansion to move all model countries into regime 1 (100% liberalization). Thus, 100 percent liberalization is equivalent to a 190 percent bilateral quota expansion.²⁰

Consistent with the findings above, expanding bilateral quotas (scenario one) does not generate substantial market access until out-of-quota exporting countries move out of regime 3. A 76 percent bilateral quota expansion (40% liberalization) decreased the composite import price by 7.19 percent and increased aggregate imports by 30 percent. However, just a 20 percent out-of-quota tariff cut could generate an increase in market access equivalent to a 76 percent bilateral

quota expansion! This result is driven by the fact that tariff cuts are immediately binding and contribute to lower prices even as exporters remain in regime 3. Expanding quotas on an MFN basis by 10 and 20 percent produces modest liberalization results. Thereafter, liberalization accelerates quickly. A 40 percent MFN quota expansion actually generates a larger increase (decrease) in imports (price) than comparable out-of-quota tariff cuts. Remarkably, complete liberalization (equal to a 273 percent increase in imports or a 190% bilateral quota expansion) occurs after MFN quota is expanded by only 50 percent of the amount required for full liberalization under the bilateral expansion scenario.

Conclusion

Agricultural market access continues to be a contentious issue in the WTO negotiations. WTO Members (particularly developing countries) have made it clear they are unwilling to negotiate on other topics until a suitable agreement on agriculture exists. In this article we develop a pragmatic approach to the problem of trade policy aggregation, particularly tariff-rate quotas, by developing a highly disaggregated, HS6-digit tariff line model. We disaggregated the dairy sector into 24, HS6-digit product lines, focusing special attention on US specialty cheese imports and border policies. Working at the tariff line level permitted us to evaluate alternative TRQ liberalization strategies with different tariff-quota administration methods: designated (country-specific) licenses; and MFN (any country) licenses. This article highlighted for the first time the interaction between MFN quota expansions (the proposed negotiating modality) and existing bilateral quotas which dominate US dairy imports at present.

The results contribute to the policy debate by comparing TRQ liberalization options and the extent of TRQ liberalization required to achieve significant market access improvements in the US specialty cheese market. Expanding bilateral quota levels on the order of 20-30 percent

(on an absolute basis) will benefit some exporting countries through higher quota rents but will not generate much in the way of increased trade in this market.

For small liberalization commitments (<40%), cutting out-of-quota tariffs is the most efficient method of improving market access. This result is consistent with de Gorter and Boughner (1999) and Elberhi et al. (2004) who similarly argued for out-of-quota tariff cuts. However, expanding quotas on an MFN basis is the option currently receiving attention in the agricultural negotiations. Under an MFN expansion scenario where quota is allocated via a competitive auction, liberalization occurs in a cascading fashion, with those countries with the highest bids dropping into the MFN market first, followed by those countries with lower unit value of products. Since the EU15 exports the highest valued specialty cheeses in 2001, they are first in this cascade of liberalization.

The MFN scenario produced some interesting interactions with bilateral quotas currently in place. MFN quota expansions initially have little impact because exporters simply redirect bilateral out-of-quota exports to the MFN market. However, once this transfer is complete for the highest unit value exporter (the EU in this case), further MFN expansion increases trade rapidly towards the free trade equilibrium (more than simply expanding existing bilateral quotas.) Of course eliminating the bilateral quotas and replacing them with MFN quotas would offer a more immediate impact on trade, but it would likely encounter significant resistance from current quota-holders who would see their quota rents evaporate immediately upon implementation of such a policy.

In summary, the framework developed in this paper offers an excellent vehicle for conducting highly disaggregated trade policy analysis. Researchers can target a sector for special attention – in this case we focus on the U.S. dairy industry. And, if they wish to examine a whole

range of reforms together, the framework here can be embedded in a general equilibrium model, as in Grant (2007). Data bases are now available to support HS6-digit analysis of trade policy including TRQ policies and differing quota administration methods. By adopting the framework proposed in this paper, economists can finally address the perennial criticism that their analysis is “too aggregated.” With this framework in hand they can effectively taking trade policy analysis to the “tariff line”.

Endnotes

¹ The authors concluded that “...almost all modeling efforts of agricultural trade liberalization and market access run into major difficulties (*due to aggregation*) that limit the scope and accuracy of their results” (pg 5, *italics added*).

² Anderson and Neary (1996) showed how a complex vector of trade policy (tariffs and quotas) can be summarized in a single index, called the Trade Restrictiveness Index (TRI). In practice however, the TRI assumes that the quotas are strictly binding and ignores different administration methods. As we will see however, these assumptions are not innocuous in the case of tariff-rate quotas (TRQs). TRQs involve regime changes and the quota portion of this policy instrument is allocated according to a complex and diverse set of administration methods.

³ HS refers to the Harmonized Commodity Description and Coding System. In total there are over 5,000 products at the HS6 digit level covering 98 chapters. Dairy falls under chapter 04 and contains 24 HS6-digit product lines.

⁴ GTAP is short for the Global Trade Analysis Project (www.gtap.org)

⁵ Specialty cheese varieties that fall under HS 040690 are Bryndza, Cheddar, Colby, Edam, Gouda, Goya, Romano, Parmesan, Provolone, Sbrinz, Swiss, and cheese substitutes.

⁶ The mean applied tariff rates in figure 1 are calculated using a simple average across all partners for a particular HS6 product line.

⁷ Forty-three WTO members have designated TRQs in their tariff schedules for a total of 1,427 individual quotas (Abbott and Morse 2000). While developing countries have not used TRQs extensively, most developed countries opted to convert their non-tariff barriers into systems of TRQs, especially in international dairy trade.

⁸ Quota rents are equal to the difference between the domestic and tariff inclusive world price multiplied by imports.

⁹ For an exhaustive list of the possible TRQ administration methods, see Skully (1999).

¹⁰ Licensing of tariff-quotas is administered annually by the Foreign Agricultural Service (FAS) of the United States Department of Agriculture (FAS-USDA). U.S. tariff-quota licenses are: designated quota licenses, historical quota licenses, non-historical (lottery-based) licenses, first-com-first-served licenses or any country (MFN) licenses.

¹¹ Following the GTAPinGAMS model (Rutherford 2005), equilibrium conditions in the dairy sub-sector model are based on a “dual” approach (Dixit and Norman 1992) where zero profits and market clearance determine an equilibrium under perfect competition and constant returns to scale (Mathiesen 1985). The variables that define an equilibrium are activity levels and prices. The “dual” approach is different from standard equilibrium modeling

because quantity variables are implicit in the model and calculated after a counterfactual scenario is run, but need not appear as explicit variables.

¹² Dairy is a multi-product industry that potentially produces all 24 HS6-digit products. However, our intent is not to build a forecasting model to predict output changes or the growth of dairy output over time. Rather, we treat aggregate dairy output capacity at 2001 levels as fixed and focus on the mix of products being traded and consumed.

¹³ The data requirements to introduce TRQs are described in the next section.

¹⁴ In-quota exporters have no incentive to increase supply to a market where marginal cost is already equal to price, less the in-quota tariff.

¹⁵ This is a critical feature of our approach because it implies that imports substitute for domestic products at the HS6-digit level. In Gohin and Laborde (2006) for example, the authors aggregate imports across HS6 categories before permitting them to substitute for domestic goods. This blunts the impact of heterogeneous tariffs at the HS6 level – effectively eliminating the variation observed in figure 1.

¹⁶ MACMap has been developed jointly by the International Trade Center in Geneva (ITC) and Paris-based CEPII and includes an exhaustive list of applied and bound *ad valorem* and specific tariffs, indicators of TRQs and TRQ rents, as well as taking into account an extensive list of tariff preferences (www.cepii.com).

¹⁷ A complete set of results and further econometric testing is contained in Grant (2007).

¹⁸ Domestic quantity and price data of four specialty cheese varieties are available with consistent time coverage to permit estimation: aggregate cheese shipments and American, Cheddar and Swiss cheese domestic shipments.

¹⁹ We have conducted considerable sensitivity analysis with respect to these values. The impacts of US trade policy are robust to variation in these parameters (i.e., cutting by half and doubling their values).

²⁰ Or, each 10 percent *liberalization* increment in table 2 is equivalent to a 19 percent bilateral quota *expansion* (see footnote to table 2 for further clarification).

References

- Abbott, P.C. and B.A. Morse. 2000. "Tariff Rate Quota Implementation and Administration by Developing Countries," *Agricultural and Resource Economics Review*, 29(1): 115-124.
- Anderson, J.E. 1985. "The Relative Inefficiency of Quotas: The Cheese Case," *American Economic Review*, 75(1): 178-190.
- Anderson, J.E. and J.P. Neary 1996. "A New Approach to Evaluating Trade Policy," *Review of Economic Studies*, 63: 107-125.
- Anderson, K. and W. Martin. 2006. "Agricultural Trade Reform and the Doha Development Agenda." *World Economy* 28(9): 1301-27.
- Anderson, K., W. Martin and D. van der Mensbrugghe. 2006. "Market and Welfare Implications of the Doha Reform Scenarios." In *Agricultural Trade Reform and the Doha Development Agenda*, ed. K. Anderson and W. Martin (chapter 12). New York: Palgrave Macmillan.
- Armington, P.S. 1969. "A Theory of Demand for Products Distinguished by Place of Production," *IMF Staff Papers*, International Monetary Fund, 16: pp159-178.
- Bouët A., S. Mevel and D. Orden, 2005. "More or Less Ambition? Modeling the Development Impact of US-EU Agricultural Proposals in the Doha Round," Policy Brief, International Food Policy Research Institute, Washington DC, December.
- , J.C. Bureau, Y. Decreux, J. Sebastien, 2005. "Multilateral Agricultural Trade Liberalization: the Contrasting Fortunes of Developing Countries," *The World Economy* 28(9): 1329-1354.

- , Y. Decreux, L. Fontagne, S. Jean and D. Laborde. 2004. "A Consistent, Ad-Valorem Equivalent Measure of Applied Protection Across the World: The MAcMap-HS6 Database," CEPII, Working Paper No. 2004-22, December.
- Boughner, D.S., H. de Gorter, and I.M. Sheldon. 2000. "The Economics of Two-Tier Tariff Rate Imports," *Agricultural and Resource Economics Review*, 29(1): 58-69.
- Bureau, J.C. and L. Salvatici. 2003. "WTO Negotiations on market Access: What We Know, What We Don't and What We Should," International Conference on Agricultural Policy Reform and the WTO: Where are we Heading? Capri, Italy, June 23-26.
- Cox, T.L., J.R. Coleman, J.P. Chavas, and Y. Zhu. 1999. "An Economic Analysis of the Effects on the World Dairy Sector of Extending Uruguay Round Agreement to 2005," *Canadian Journal of Agricultural Economics* 47(5): 169-183
- de Gorter, H. and D.S. Boughner. 1999. "US Dairy Policy and the Agreement on Agriculture in the WTO," *Canadian Journal of Agricultural Economics*, 47(5): 31-42.
- Decreux, Y. and L. Fontangé, 2006. "A Quantitative Assessment of the Outcome of the Doha Development Agenda," CEPII Working Paper No. 2006-10, May.
- Dixit, A. and V. Norman, eds. *International Trade Theory*. Cambridge University Press, 1992.
- Elbehri, A., M. Ingco, T.W. Hertel, and K. Pearson. 2004. "Liberalizing Tariff Rate Quotas: Quantifying the Effects of Enhancing Market Access," In *Agriculture and the New Trade Agenda: Creating a Global Trading Environment for Development*, (eds.) M. Ingco and A. Winters, Cambridge University Press.

- Gallaway, M.P., C. A. McDaniel and S.A. Rivera. 2003. "Short-run and Long-run Industry-level Estimates of U.S. Armington Elasticities", *North American Journal of Economics and Finance*, 14(1):49-68.
- Gardner, B.L., 1993. "Reforming Agricultural Economists and What They Do," *Canadian Journal of Agricultural Economics*, 4(1): 383–386.
- Gohin, A. and D. Laborde. 2006. "Simulating Trade Policy Reforms at the Detailed Level: Some Practical Solutions," Presented at the Ninth Annual Conference on Global Economic Analysis, Addis Ababa, Ethiopia, June 15-17.
- Grant, J.H. 2003. "Tariff Line Analysis of U.S. Dairy Protection" Ph.D Thesis, Purdue University, West Lafayette, IN.
- Grant, J.H., T.W. Hertel, and T.F. Rutherford. 2008. "AJAE Appendix: Model Aggregation, TRQ Fill Data, and Domestic Demand Imputation," Unpublished manuscript. Available at: <http://agecon.lib.umn.edu>
- Harrison, G., T.F. Rutherford and D. Tarr. 1997. "Quantifying the Uruguay Round," *The Economic Journal*, 107(444): 1405-30.
- Hertel, T.W., D. Hummels, M. Ivanic and R. Keeney, 2007. "How Confident Can We Be in CGE-based Analysis of Free Trade Agreements?" *Economic Modelling*: 24(4): 611-635.
- Hummels, D. 1999. "Towards a Geography of Trade Costs," GTAP Working Paper No. 17, Center for Global Trade Analysis, Purdue University, West Lafayette, IN.
- IATRC. 2001. "Issues in Reforming Tariff-Rate Import Quotas in the Agreement on Agriculture in the WTO," Commissioned Paper No. 13, International Agricultural Trade Research Consortium, May.

- Langley, S. A. Samwaru and M.A. Normile. 2006. "Trade Liberalization in International Dairy Markets: Estimated Impacts," Economic Research Report No. 16, US Dept. of Agr. February.
- Larivière, S. and K.D. Meilke. 1999. "An Assessment of Partial Dairy Trade Liberalization on the U.S., EU-15 and Canada," *Canadian Journal of Agricultural Economics*, 47(5): 59-73.
- Mathiesen, L. 1985. "Computation of Economic Equilibrium by a Sequence of Linear Complementarity Problems," *Mathematical Programming Study*, 23(1): 144-162.
- McDaniel, C. A. and E. J. Balistreri. 2002. "A Discussion on Armington Trade Substitution Elasticities," Office of Economics Working Paper, US International Trade Commission, No. 2002-01-A.
- Meilke, K.D. and H. de Gorter. 1996. "Challenges in Quantitative Economic Analysis in Support of Multilateral Trade Negotiations," *Agricultural Economics*, 14(3): 185-200.
- Nicholson, C.F. and P.M. Bishop. "US Dairy Product Trade: Modeling Approaches and the Impact of New Product Formulations," Final Report for NRI Grant 2001-35400-10249, March 2004.
- Reinert, K and D. Roland-Holst. 1992. "Armington Elasticities for United States Manufacturing Sectors," *Journal of Policy Modeling*, 14(5): 631-39.
- Rutherford, Thomas F. 2005. "GTAP6 in GAMS: The Dataset and Static Model," Prepared for Workshop on Applied General Equilibrium Modeling for Trade Policy Analysis in Russia and the CIS, Moscow, December 1-9.

- Rutherford, T. F., 1995. "Extensions of GAMS for Complementarity Problems Arising in Applied Economics," *Journal of Economic Dynamics and Control*, 19(1995):1299-1324.
- Sébastien J., D. Laborde and W. Martin. 2005. "Consequences of Alternative Formulas for Agricultural Tariff Cuts," CEPII Working Paper No. 2005-15, September.
- Shiells, C., R. Stern and A. Deardorff. 1986. "Estimates of the Elasticities of Substitution between Imports and Home Goods for the United States," *Weltwirtschaftliches-Archiv*, 122: 497-519.
- Shiells, C. and K. Reinert. 1993. "Armington Models and Terms of Trade Effects: Some Econometric Evidence for North America," *Canadian Journal of Economics*, 26(2): 299-316.
- Skully, D. 1999. "The Economics of TRQ Administration", IATRC Working Paper #99-6, St Paul: University of Minnesota, May.
- Stern, R. M., J. Francis, and B. Schumacher. 1976. *Price Elasticities in International Trade: An Annotated Bibliography*. London: Macmillan Press Ltd.
- Stillman, R. 1999. "US Dairy Policy and the Agreement on Agriculture in the WTO: Discussion," *Canadian Journal of Agricultural Economics*, 47(5): 43-44.
- Sumner, D.A., 1993. "Economic Analysis for Better Agricultural Trade Policy," In: The 1993 James N. Snyder Memorial Lecture, Purdue University 31 March.
- van der Mensbrugghe, D., J.C. Beghin and D. Mitchell. 2003. "Modeling Tariff Rate Quotas in a Global Context: The Case of Sugar Markets in OECD Countries," Working Paper 03-WP 343, Center for Agricultural and Rural Development (CARD), Ames Iowa.

Table 1. The Composition of U.S. Dairy Imports, 2001

HS6	HS4 Description	HS4 Import Share (%) ^a	HS6 Description	HS6 Import Share (%) ^a
040690			Cheese except 040610-040640 including Cheddar and Colby	52.3
040630			Cheese processed, not grated or powdered	2.2
040640	Cheeses	58.6	Cheese, blue-veined	1.8
040620			Cheese, grated or powdered, of all kinds	1.3
040610			Fresh cheese, unfermented whey cheese, curd	0.9
350110	Casein and milk protein concentrates	23.5	Casein and other caseinates	23.5
040590			Other milk fats and oils	2.4
040510	Butter and dairy spreads	6.1	Butter	2.0
040520			Dairy spreads	1.7
040490			Natural milk products nes	3.4
040410	Whey and modified whey	4.5	Whey and modified whey	1.1
040210			Milk powder < 1.5% fat	1.1
040299			Milk and cream nes sweetened or concentrated	1.1
040221	Milk and cream powders	3.5	Milk and cream powder unsweetened < 1.5% fat	1.0
040291			Milk and cream unsweetened, concentrated	0.2
040229			Milk and cream powder sweetened < 1.5% fat	0.1
210500	Ice Cream	1.6	Ice cream and other edible ice	1.6
040130			Milk/cream not concentrated nor sweetened < 6% fat	0.7
040120	Milk not concentrated nor sweetened	1.1	Milk not concentrated nor sweetened 1-6% fat	0.3
040110			Milk not concentrated nor sweetened < 1% fat	0.1
040310			Yogurt	0.5
040390	Yogurt and buttermilk	0.9	Buttermilk, curdled milk, cream, kephir, etc.	0.4
170211			Lactose & syrup, containing by weight 99 % or more lactose	0.2
170219	Lactose and Lactose Syrup	0.3	Other Lactose and lactose syrup	0.1

^a Numbers indicate value shares

Source: CEPII (2001) and author's calculations

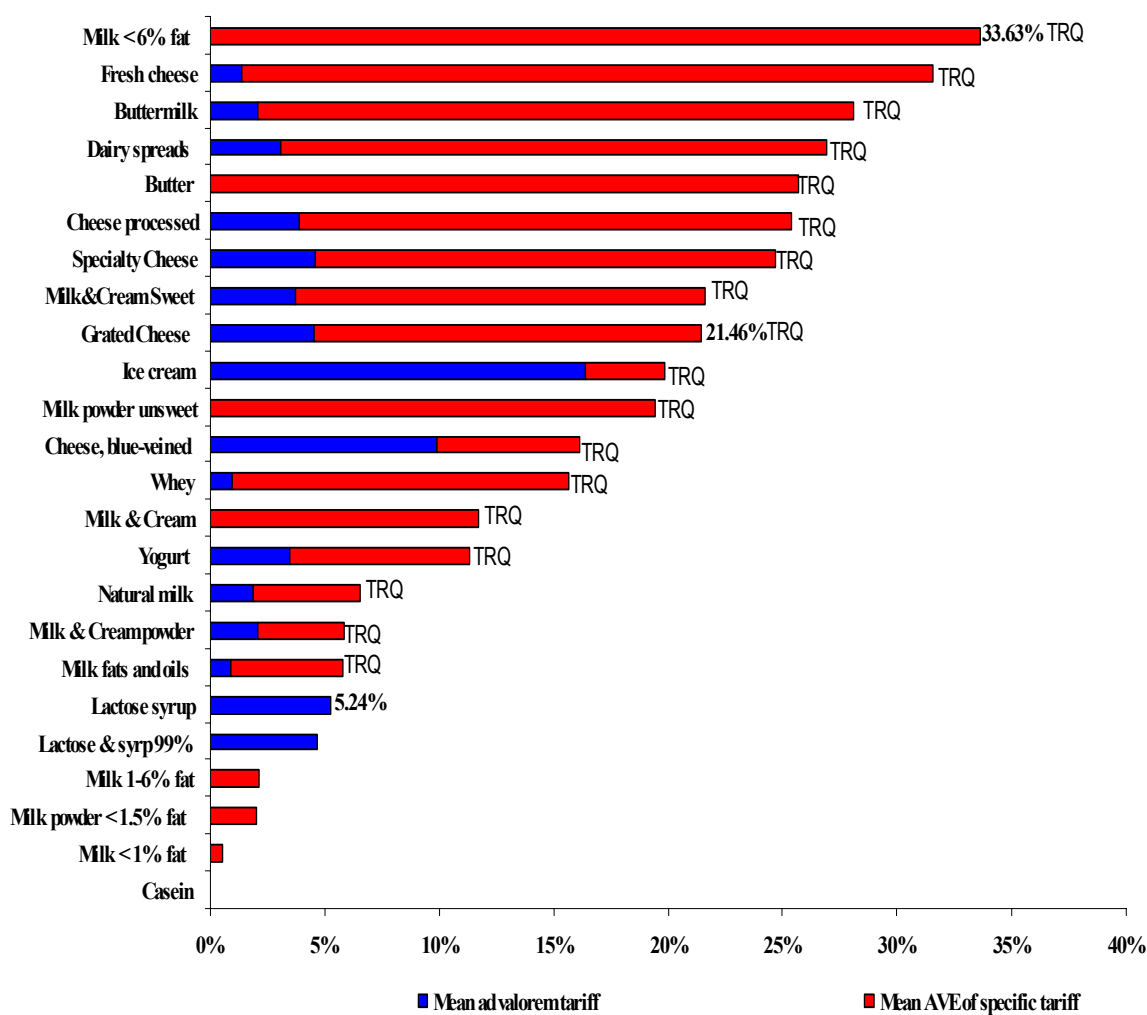


Figure 1. Import protection in the U.S. dairy market, 2001

Source: CEPII's MAcMap database for 2001 (Bouët et al. 2004) and author's calculations

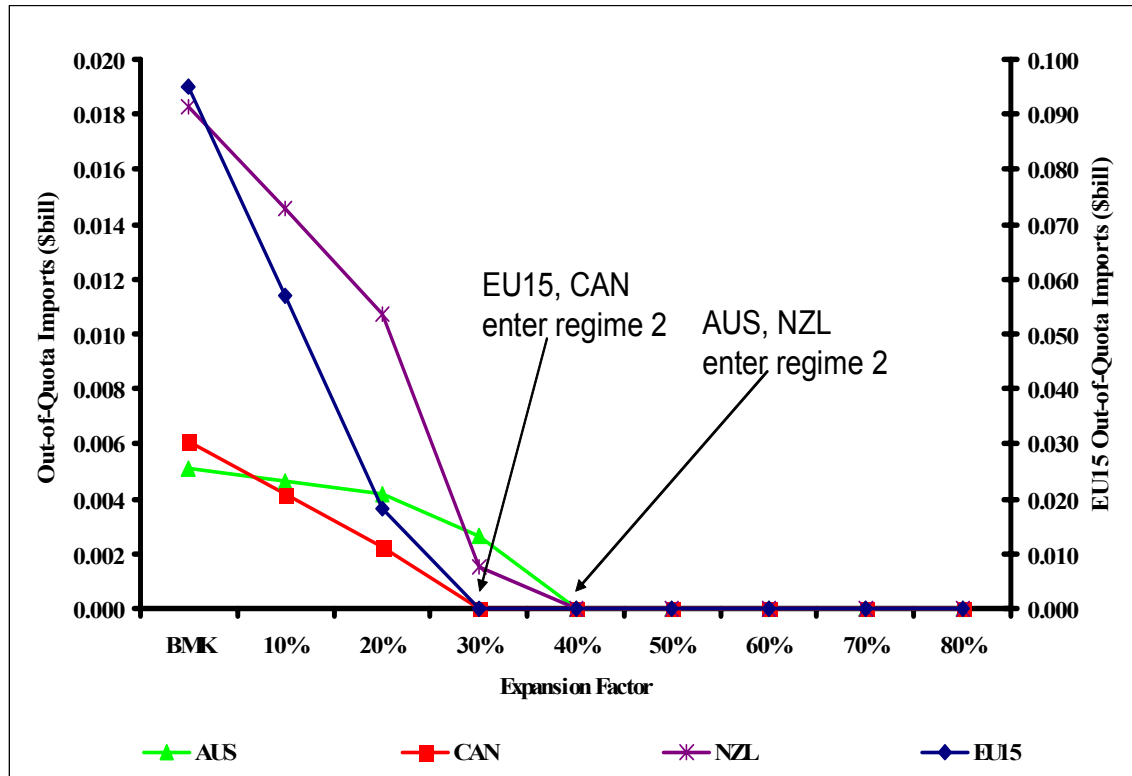


Figure 2. Out-of-Quota Specialty Cheese Imports after Bilateral Quota Expansion

Note: For scaling reasons, the EU15 imports are illustrated on the secondary vertical axis

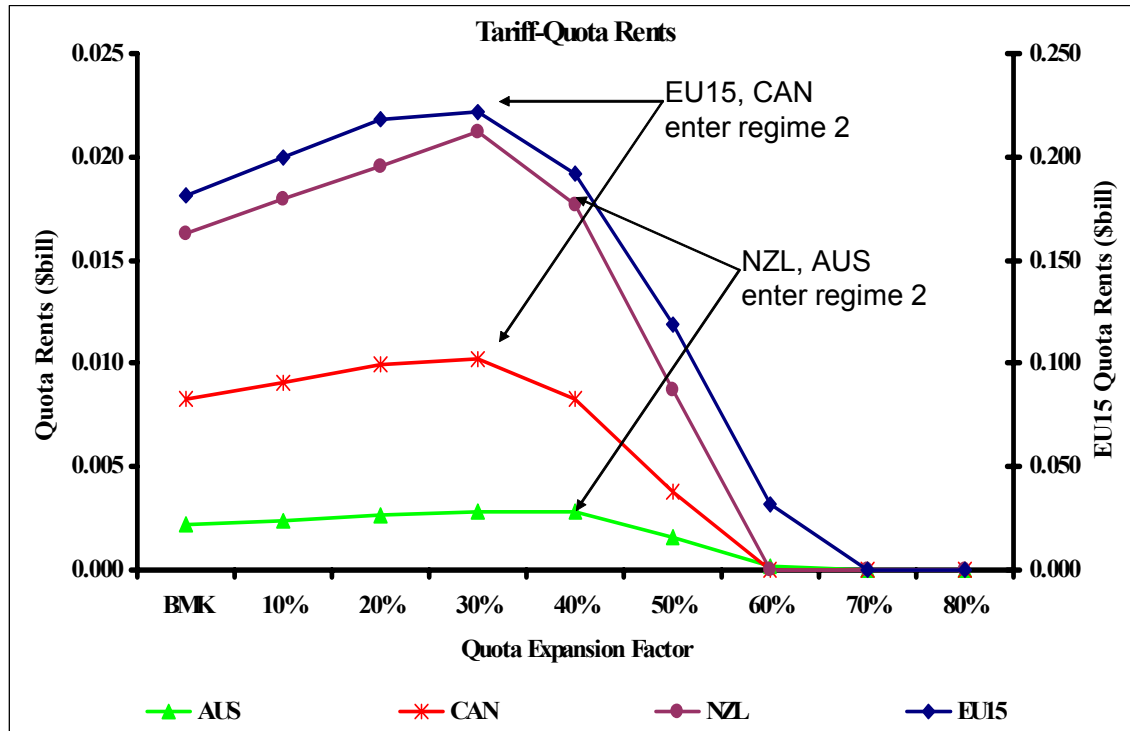


Figure 3. Value of Specialty Cheese Tariff-Quota Rents after Bilateral Quota Expansions

Note: For scaling reasons, the EU15 quota rents are illustrated on the secondary vertical axis

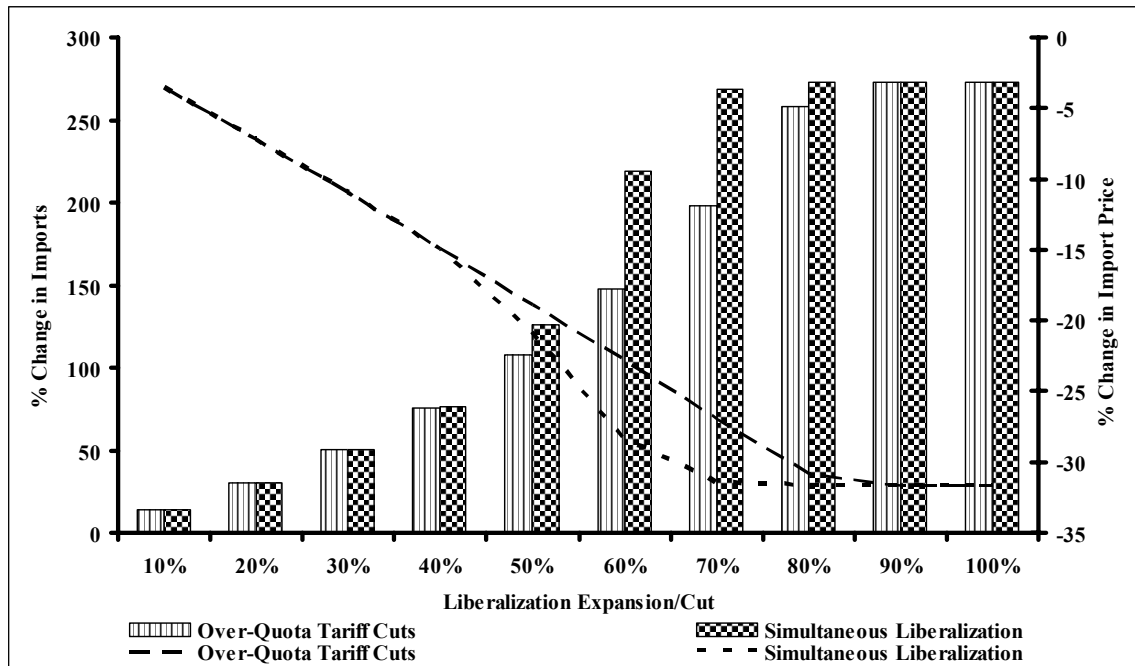


Figure 4. Percent Change in Specialty Cheese Composite Imports and Import Price

Note: Simultaneous liberalization refers to cutting over-quota tariffs and expanding bilateral quotas.

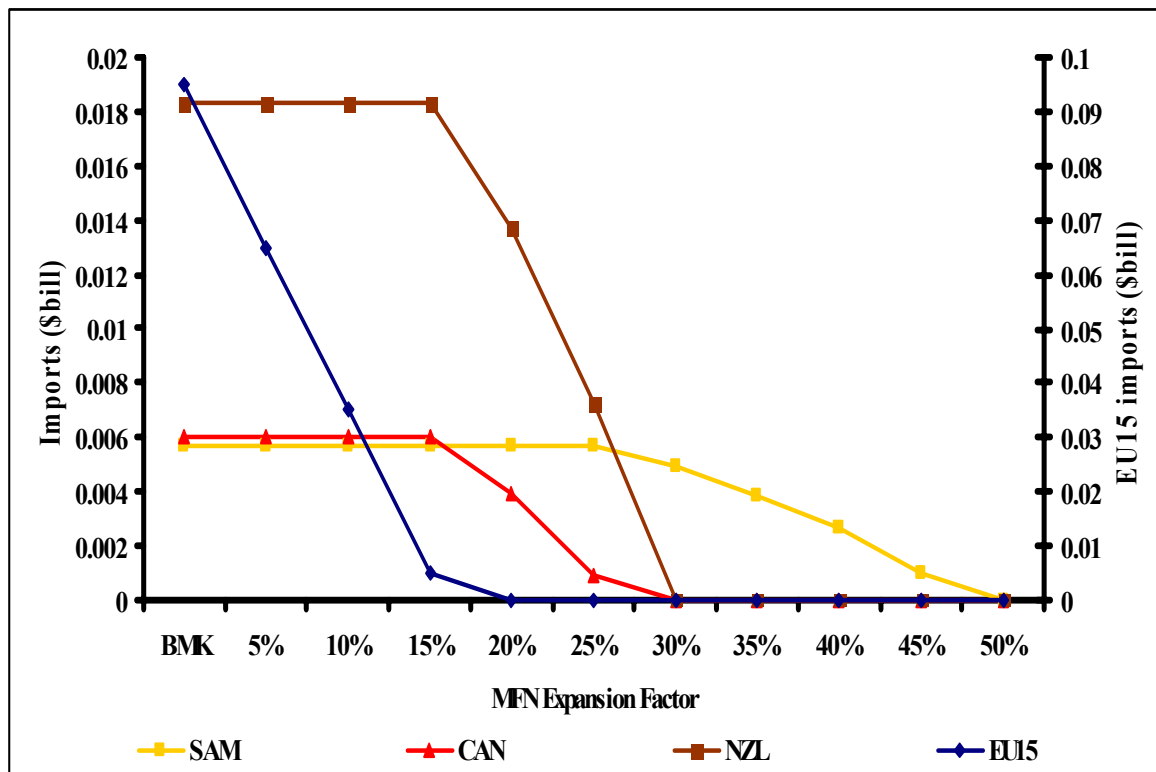


Figure 5. Bilateral Out-of-Quota Specialty Cheese Exports under an MFN Quota Expansion

Table 2. Specialty Cheese TRQ Liberalization Results Compared

Scenario									
(1)				(2)			(3)		
Quota Expansion ^a				Out-of-quota Tariff Cut			Simultaneous Liberalization		
Liberalization	Composite Imports (%)	Composite Import Price (%)	Composite Import Price	Composite Imports (%)	Composite Import Price (%)	Composite Import Price	Composite Imports (%)	Composite Import Price (%)	Composite Import Price
10%	0.85	-0.25		13.51	-3.53		13.51	-3.53	0.00
20%	0.92	-0.27		30.09	-7.19		30.09	-7.19	-1.22
30%	6.38	-1.75		50.55	-10.98		50.56	-10.98	-5.33
40%	30.01	-7.19		75.92	-14.87		76.30	-14.92	-15.04
50%	96.20	-17.51		107.60	-18.84		125.70	-20.78	-31.62
60%	215.41	-28.16		147.42	-22.87		219.52	-28.43	-31.62
70%	270.31	-31.49		197.89	-26.94		268.68	-31.40	-31.62
80%	271.08	-31.54		258.60	-30.84		272.61	-31.62	-31.62
90%	271.85	-31.58		272.61	-31.62		272.61	-31.62	-31.62
100%	272.61	-31.62		272.61	-31.62		272.61	-31.62	-31.62

Note: All values are percent changes from benchmark equilibrium.

^a Quota Expansion values reported (scenario 1) have been scaled to reflect a percentage of full liberalization (100%) versus an absolute quota expansion. In figure 3, bilateral quotas were expanded in 10% increments and we saw that after a 70 percent expansion, EU15, CAN, NZL and AUS entered regime 1. However, to get all model countries into regime 1 required a 190% quota expansion. For example, 40% liberalization of bilateral quotas is equivalent to a 76% (190/100*40).

Appendix I. Country and Sector Information

Commodity Aggregation (19)		Country Aggregation (14)	
PDR	Paddy Rice	ARG	Argentina
WHT	Wheat	AUS	Australia
GRO	Other Cereals	CAN	Canada
V_F	Vegetables and Fruit	EU15	European Union
OSD	Oilseeds	JPN	Japan
C_B	Sugar Cane and Beet	LAM	Latin America and Caribbean
PFB	Plant Based Fibers	MEX	Mexico
OCR	Other Crops	MNA	Middle East and North Africa
CTL	Bovine Cattle	NZL	New Zealand
OAP	Other Animal Products	ROA	Rest of Asia
RMK	Raw Milk	ROE	Rest of Europe
WOL	Wool	SAM	South America
VOL	Vegetable Oils and Fats	SAO	South Asia and Oceania
MIL	Dairy	USA	United States
PCR	Processed Rice		
SGR	Sugar		
OFD	Other Food Products		
B_T	Beverages and Tobacco		
OTH	All Other Goods		

Appendix II: Bilateral TRQ Filling Ratios

The U.S. has *nine* different specialty cheese quotas (called TRQIDs) totaling over 136,000 metric tons (mt) (IATRC, 2001): Cheese Substitutes (TRQID11); Blue Veined (TRQID12); Cheddar (TRQID13); American (TRQID14); Edam/Gouda (TRQID15); Italian (TRQID16); Swiss (no eye) (TRQID17); Other cheese substitutes (TRQID18); and Swiss (with eye) (TRQID19). Within each TRQID, the quota allocated varies by country and variety across product lines at the *HS8-digit* level. However, each TRQID covers only a subset of HS8-digit cheese lines that do not map directly to the model's HS6-digit tariff lines (i.e. HS 040690).

We also had to confront the issue of bilateral quota allocations. The AMAD notifications report the quota level allocated to specific partners for each TRQID. However, not all countries export to the U.S. in all TRQID categories (table 2). Furthermore, for some TRQIDs (but not all) Finland, Sweden and Austria received separate quota allocations from the EU15 as a group. To minimize the amount of information lost in aggregating TRQs to the model's HS6 digit commodity level and 14 country aggregation (table 1), we calculated a filling ratio for each of the nine specialty cheese quotas at the most detailed level available (HS8-digit):

$$(1) \quad {}^{ID}FR_{r,k} = \frac{{}^{ID}Quant_{r,US,k}}{{}^{ID}Quota_{r,k}}$$

where, ID indexes a particular TRQID ($ID = 11 \dots 19$), r indexes the source region, k indexes the HS8-digit specialty cheese line, FR denotes the filling ratio, equal to the quantity exported from r to the U.S. ($Quant$) divided by the $Quota$ allocated to r in commodity (k). At this point we have filling ratios at the HS8 digit level that vary by r and TRQID (ID).

TRQ Allocations and MFN Unit Values in the US Specialty Cheese Market, 2001

		-----TRQID-----										<i>MFN Unit Values</i>
Country	TRQ Variable	<i>11</i>	<i>12</i>	<i>13</i>	<i>14</i>	<i>15</i>	<i>16</i>	<i>17</i>	<i>18</i>	<i>19</i>	<i>Model Aggregation</i>	
ARG	Quota	100				143	4,808				4,782	0.6
	Trade	24				48	5,633				5,578	
	Fill	0.24				0.33	1.17				1.16	
AUS	Quota	1,133		1,617	1,000						1,249	0.7
	Trade	3,153		2,470	1,136						2,585	
	Fill	2.78		1.53	1.14						2.07	
CAN	Quota	1,141		833						70	828	0.9
	Trade	1,222		1,083						206	1085	
	Fill	1.07		1.30						2.95	1.32	
EU15^b	Quota	20,756	2,529	430	271	5,348	3,499	3,675	4,000	6,117	10,000	1.0
	Trade	22,800	2,692	724	159	6,326	4,625	5,625	1,977	11,000	12,100	
	Fill	1.10	1.06	1.68	0.59	1.18	1.32	1.53	0.49	1.80	1.21	
NZL	Quota	11,322		3,950	2,000						4,040	0.8
	Trade	13,600		8,226	1,985						10,700	
	Fill	1.20		2.08	0.99						1.49	
ROE^a	Quota	1,579				167	1,323	1,850	175	5,487	4,783	0.9
	Trade	1,728				45	1,302	857	20	4,780	3,555	
	Fill	1.09				0.27	0.98	0.46	0.11	0.87	0.88	
SAM	Quota	250					511			42	471	0.4
	Trade	255					1,178			110	987	
	Fill	1.02					2.30			2.64	2.10	
MFN Quota^c % of Bilateral Quota		502	N/A	240	170	26	14	80	N/A	86		
		1.4	N/A	3.5	5.2	0.5	0.2	1.5	N/A	0.7		

Note: Quota and Trade values are in metric tons (mt). Fill = Trade/Quota.

^a ROE countries exporting specialty cheese to the US with bilateral quota allocations are Switzerland, Czech Republic, Hungary, Norway, Poland and Romania.

^b EU15 TRQ information accounts for quota that was allocated separately to Sweden, Finland and Austria for TRQID11, TRQID15, TRQID17, TRQID18 and TRQID19.

^c The amount of MFN quota allocated in the benchmark equilibrium of the tariff line model is zero

Next we aggregated the filling ratios under each TRQID to the sub-sector model regions (14 countries) using a trade-value weighted aggregation as:

$$(2) \quad {}^{ID}FR1_m = \sum_m \left[\frac{{}^{ID}V_{r \in m, US, k \in g}}{\sum_m {}^{ID}V_{m, US, k \in g}} {}^{ID}FR_{r,k} \right]$$

where, m indexes one of the 14 model countries in a particular TRQID (ID). The numerator in (2), ${}^{ID}V_{r \in m, US, k \in ID}$, is the value of trade from r (as an element of m) to the U.S. in commodity k (as an element of TRQID (ID)) and the denominator is the total value of trade from m to the US in a particular TRQID. This yields a value share from which to weight the filling ratios ($FR_{r,k}$) derived in (1).

The share weighted filling ratios (${}^{ID}FR_m$) in (2) vary by (ID) and exporter (m). As a final step we aggregated ${}^{ID}FR1_m$ across TRQIDs using the value of trade in the total value of trade across all TRQIDs as weights to arrive at the model aggregated filling ratios which vary only by exporter (m):

$$(3) \quad FR2_m = \sum_m \left[\frac{V_{m, US, g}}{\sum_g V_{m, US, g}} FR1_{m,g} \right]$$

The resulting filling ratios are reported in table 2. The EU15 is the only country to trade in all nine TRQIDs. TRQID 11 (Cheese Substitutes) is the largest traded category with the EU15 and NZL getting the largest quota allocation in this category. The second-to-last column in table 2 reports the PE/GE model filling ratios. Interestingly, six countries were out-of-quota in 2001 with Australia (AUS) exporting more than twice its quota allocation. Clearly these seven countries have a lot at stake when it comes to liberalizing US specialty cheese TRQs.

Appendix III: Multilateral (MFN) TRQs

To complicate matters, the MFN quota, which is available for any country, is at the forefront of the agricultural trade negotiations. The MFN quota accounts for less than five percent of total bilateral TRQs in most cases (table 2). We allocate the MFN quota as an auction where the quota goes to the highest bidder and assume that exporters can shift specialty cheese costlessly from the bilateral out-of-quota market to the MFN market. This is an important point because substantial improvements in market access may not occur immediately if exporters simply redirect bilateral (out-of-quota) exports to the MFN regime in order to take advantage of the additional quota available.

Which exporter will pick up the MFN quota is a critical issue in the set up of this scenario. We incorporate detailed unit values of specialty cheese supplied by different exporters to re-establish the units of comparison. The EU15 supplies the highest valued specialty cheese (table 2) so we normalize all unit values on the (0,1) interval ($EU15 = 1.0$).

Appendix IV: Imputation of Commodity Demands

Given data on international trade flows, we then need to attribute commodity imports to v intermediate and final demand segments (d) for each region (r). Dropping region (r) subscripts, we impute demands using a least squares procedure which minimizes deviations from target import shares ($\hat{\theta}_{g,d}$) in demand segment (d):

$$\min_{M_{g,d}^*, D_{g,d}^*} \Omega = \sum_d \left[(1 + t_d^M) M_{g,d}^* - \hat{\theta}_{g,d} \left((1 + t_d^M) M_{g,d}^* + (1 + t_d^D) D_{g,d}^* \right) \right]^2$$

subject to:

$$\sum_d M_{g,d}^* = \overline{M}_g$$

$$\sum_g D_{g,d}^* = \overline{D}$$

$$\sum_g \left((1 + t_d^M) M_{g,d}^* + (1 + t_d^D) D_{g,d}^* \right) = \overline{A}_d$$

where, $\overline{M}_g$ is aggregate imports of commodity g from the trade flow data; $\overline{D}$ is aggregate sectoral output taken from the GTAP database; $\overline{A}_d$ is aggregate sectoral demand from the GTAP database; and t_d^M (t_d^D) is the tax rate on imported (domestic) goods purchased in use d . We assume that target import shares ($\hat{\theta}_{g,d}$) are equivalent to the sector shares in the GTAP database. If we had external data on import demand intensity at the commodity level, this could be incorporated into the procedure. The imputed benchmark data are $M_{g,d}^*$, which is the demand for imported commodity g in demand segment d ; and $D_{g,d}^*$, which is the demand for the domestic commodity g in demand segment d . Finally, once demand has been obtained, production is calculated by summing domestic commodity demands and exports of sub-sector good (g) in region (r).