# Effects of Proposed Trade Barriers for Milk Protein Concentrate and Casein Imports on the U.S. Dairy Industry

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## Introduction

Tight import barriers cover many milk products, but import quotas or prohibitive tariffs have not covered imports of a variety of high-protein specialty products. These products without tariff rate quotas include various casein and milk protein concentrate products. In recent years, imports of milk protein products into the United States have received increasing attention from U.S. dairy interests.

A recent United States General Accounting Office (USGAO) study presented data on these imports and discussed the uses of imported milk protein concentrate products. Further, proposed legislation has been introduced in Congress that would restrict imports of casein and other protein products for the first time (S847 and HR1786). This legislation proposes to revise the U.S. HTS to include a tariff-rate-quota system

This paper models effects of imports on U.S. prices and production of milk protein, on government purchases of dairy products, and on the production, prices and incomes of U.S. milk producers. We conduct the analysis using a simulation model that investigates implications of trade barriers on a number of aggregate measures.

## 1. Imports of Milk Protein and the Domestic Dairy Situation

Dairy protein products are imported into the United States with low or no tariffs under four eight-digit HTS codes. Table 1 lists these categories, along with their current tariff rates. MPC4 (HTS 0404.90.10) includes processed milk products containing between 40 percent and 90 percent protein by weight. Dry ultra-filtered milk (UFM) with protein levels within this range is classified as MPC4. Products other than UFM, such as blends of NFDM with casein, may also be classified as MPC4 if they meet the protein concentration criteria. Although dairy blends classified as MPC4 also meet the protein criteria for this category, potential applications may be different than for UFM. However, the U.S. Customs Service does not report the composition of MPC4 imports.

Dry UFM is the product of a process that extracts most of the lactose, minerals and water from milk, retaining a concentrated milk protein in its native state. UFM contains both casein and whey protein. Dry UFM may or may not contain any milk fat.

The three HTS Chapter 35 categories (3501.xx.xx) comprise various forms of casein. Casein is the main protein in milk and is obtained from skim milk by precipitation, or curdling with acids or rennet. Various types of caseins differ by the method of curdling (acid casein, rennet casein, caseiogen). MPC35 (HTS 3501.10.10) includes concentrated milk proteins with greater than 90 percent protein by weight. Casein other than MPC (HTS 3501.10.50) includes acid casein, rennet casein, and co-precipitates. These products are 89-95 percent protein. Caseinates (HTS 3501.90.60) include the sodium and ammonium salts used to prepare concentrated foods and pharmaceutical products. Other products included in this category are chlorinated casein, brominated casein, iodised casein and casein tannate (HTS Chapter 35 Chapter notes).

An important dairy protein product is NFDM. NFDM is made by removing fat and water from milk, leaving lactose, protein and minerals in the same proportions as they existed in the milk. NFDM typically contains approximately 27 percent casein, 8 percent whey protein, 50 percent lactose, 1 percent fat, 8 percent minerals, and 5 percent moisture. It is one of the major commodities of the U.S. dairy complex. The study released by the USGAO reported that some MPCs can be used to replace NFDM in some applications.

Most NFDM, 60 to 75 percent over each of the last several years, is used within the U.S. dairy industry. Major uses include the production of hard cheeses, frozen desserts, fluid milk and drink mixes, cultured dairy products and other dairy uses. Uses outside the dairy industry include packaged retail sales, use in prepared dry mixes, and applications in the confectionery industry, the baking industry, and the nutrition and pharmaceutical industries.

Significant quantities of whey in various forms are also produced in the United States. Whey can be dried and concentrated to alter the level of protein. Whey products include dry whey and whey protein concentrate. Whey and whey protein concentrate contain no casein, which is the main protein source in NFDM, MPC and casein. Due to this difference in protein structure, the applications of dry whey and whey protein concentrate are quite different than those of NFDM, MPC and casein.

Table 2 indicates the magnitude of dairy production in the United States. Production has been rising gradually. About 76 million metric tons of raw milk was produced in 2000. This milk is about 12.3 percent dry matter and about 87.7 percent fluid. About 3.6 percent of the weight is milk fat. About 8.7 percent of the weight is comprised of non-fat solids and about 3.3 percent is solid protein. In 2000, the United States produced about 6.6 million metric tons of nonfat dry milk. The government has purchased from zero to almost 40 percent of that NFDM depending on the strength of the market price relative to the support price. In year 2000, the share was unusually high. Dry whey, which is a by-product from cheese production, constituted another 2.5 million metric tons of non-fat product in the U.S. market.

Table 3 provides recent annual quantities of domestic milk protein production and use in the United States, as well as imports of milk protein products. A total of about 2.5 million metric tons of milk protein was produced in the United States in year 2000. About one third of that total was used in fluid milk products mainly for beverage milk ranging from whole milk through non-fat milk. This share has been relatively stable in recent years. NFDM accounted for about two-thirds on the non-fluid use of milk protein. This percentage has moved up and down from a low of 52 percent in 1993 to a high of 68 percent in 2000. In between, the share of NFDM ranged from 56 percent to 65 percent. The rest of the milk protein is used in cheese and other products. Some protein remains in the cheese and other products and some is returned as dry whey and may be then used in further processing. Further, we should note that some NFDM is used in the cheese making process and in Table 3 this quantity is counted only in the NFDM column and does not appear in the column for dry whey nor in the column labeled other, which includes cheese.

The import figures shown in Table 3 are the approximate protein content of the imports. These data make clear that the MPC imports remained a quite small share of U.S. milk protein consumption and production even in 2000 which was a peak import year. The traditional imports of casein and caseinates are significantly larger but they still comprise a small share of the milk protein supply in the U.S. market.

**2. Milk protein, milk producers, and U.S. dairy policy**

Obviously, substitution toward domestic sources of milk protein caused by limits on imports may have an effect on milk producers. Increased demand for domestic NFDM or whey, given tight import barriers for these products, would likely put upward pressure on the price of these products, and increase the demand for raw milk. Imports also affect the demand for raw milk on farms when imported MPC4, MPC35, casein, and caseinates substitute for protein used in the fluid beverage milk products. However, heavy regulation of the farm price of raw milk necessitates an understanding of U.S. dairy policy in order to analyze the effects of a potential increase in the demand for domestic milk on the prices and quantities of raw milk sold in the United States.

USDA's price support purchase program is an element of U.S. dairy policy that is important to determining the effect of MPC and casein imports. USDA purchases of NFDM vary from month to month, and from year to year.

## 3. A model of the effects of milk protein imports on the U.S. dairy sector

We define the relevant market as the market for milk protein used in the United States. We simplify further by adding the products in protein units into two aggregate products, domestic and imported milk protein. We then analyze the effects of imported milk protein on price and quantity of domestic milk protein as an aggregate. An alternative would be to note that each of the seven milk protein products (four imported and three domestic) actually has unique attributes and, in some cases, unique applications that differentiate it from the other six. Thus one may define markets for each of the seven products. Defining the relevant markets as such, we could analyze the effects of individual imported milk protein products on price and quantities of various domestic milk protein products. We chose not to pursue this disaggregated approach because of a lack of detailed information on individual parameters.

The USDA purchases NFDM, butter, and cheese whenever the market price of any of these commodities is below the administrative purchase price. NFDM is the only one of which the USDA has purchased significant quantities in recent years.

We quantify the price, quantity, and welfare effects of imported milk protein in the market for milk at the farm level. The regulated minimum price received by producers of milk in the United States is stated explicitly in pricing formulas, and is based directly on the wholesale price of NFDM and other publicly traded dairy products. Any changes in the prices of these products influences the final average pool price paid to producers of milk. Therefore, based on the results of the model, changes in the price of milk protein may lead to changes in the price (and quantity and revenue) in the market for milk at the farm level.

Our model of the market for milk and milk protein in the United States uses a locally log-linear differential specification of supply and demand. This specification is straightforward and has the advantage of allowing key parameters to be specified as elasticities. In what follows we consider the import restrictions as percentage shifts from a pre-policy equilibrium.

This model is also specified at a relatively high level of aggregation. Our model does not specify separate equations for the uses of milk protein in producing the various intermediate or final consumer goods. In our model, the demand for these goods that contain milk protein is implicit and we focus on the demand for milk proteins, which are derived from the final goods demands. We do not differentiate between the various types of imported MPC and casein. We treat these items as an aggregate because available information does not allow us to specify separate substitution parameters and trace through the separate uses of each type of import. In a parallel fashion, we also do not differentiate in the model among the various sources of domestic milk protein. We use the symbol E to represent a percentage change (i.e., EX = dlnX). We begin by specifying the percentage change of the supply of raw milk from farms as a function of the price faced by farmers:

(1) $EQ_{milk} = \varepsilon_{milk} EP_{milk}$ ,

where $Q_{milk}$ is the quantity supplied of raw milk from farms in the United States, $P_{milk}$ is the price of milk faced by farmers, and $\varepsilon_{milk}$ is the price elasticity of raw milk supply.

We specify farm price of raw milk as the weighted average of the prices of the two key milk components, fat and non-fat solids (or protein). We capture these factors in a "reduced form" relationship as follows:

(2) $EP_{milk} = \delta_{fat} EP_{fat} + (1- \delta_{fat}) EP_{nonfat}$ ,

where $\delta_{fat}$ is the value share of fat in raw milk. This value share depends on the quantity shares (about 3.5 percent for fat and about 8.7 percent for nonfat solids) and the relative prices of the components in the base period. We note that the nonfat solid component of milk is itself about 40 percent protein. The parameter $\delta_{fat}$ can be further decomposed as follows:

(2a) $\delta_{fat} = (Q_{fat}/Q_{milk})*(P_{fat}/P_{milk})$.

The percentage changes in the two prices, $EP_{fat}$ and $EP_{nonfat}$ , reflect the changes in prices of products comprised of these components.

We complete the raw milk side of the model by noting that production of fat and nonfat solids is not a function of relative prices over the length of run and with the magnitudes of price changes contemplated. That means the changes in fat and nonfat solids are proportional to changes in milk output. Thus, in percentage change terms, equations (3) and (4) apply:

(3) $EQ^{s}_{fat} = EQ_{milk}$, and

(4) $EQ^{s}_{nonfat} = EQ_{milk}$.

We can complete the supply side by modeling the policy shifts that affects the potential percentage change in supply of imported milk protein (MPC and casein). The supply restriction policy considered is a tariff rate quota with a prohibitive second tier tariff. This supply policy may be approximated simply as:

(5) $EQ^{s}_{import} = \theta$,

where $\theta$ is the percentage change in the amount of imported MPC and casein allowed. For example, a policy that lowered allowed imports by 25 percent would be shown as a $\theta$ of –0.25. The tariff rate on excess imports is itself not relevant for our analysis so long as it is taken to be prohibitive.

We denote the aggregate derived demand for fat as:

(6) $EQ^{d}_{fat} = \eta_{fat} EP_{fat}$,

where the parameter $\eta_{fat}$, which is negative, refers to the own price elasticity of demand for fat. This equation shows how much the quantity demanded of fat responds, in percentage terms to a percentage change in the price of fat.

Now we specify the demand for imported protein and domestic nonfat milk. It is central to our analysis that these two demands are related and so we allow the quantity demanded of each to depend on its own price and on the price of the other:

(7) $EQ^{d}_{nonfat} = \eta_{nn} EP_{nonfat} + \eta_{ni} (EP_{import})$,

where $\eta_{nn}$ is the own price elasticity of demand of domestic nonfat milk, $EP_{import}$ is the price of imported protein, and $\eta_{ni}$ is the cross-price elasticity of demand for nonfat. The cross-price elasticity shows how the quantity of domestic nonfat milk components responds, in percentage terms, to a percentage change in the price of imported protein. In this specification $\eta_{nn}$ will be negative and $\eta_{ni}$ will be positive because domestic nonfat milk and imports are substitutes in demand.

The demand for imported protein may be specified in a similar fashion:

(8) $EQ^{d}_{import} = \eta_{in} EP_{nonfat} + \eta_{ii} (EP_{import})$,

where $\eta_{in}$ is the cross elasticity of demand for imports as a function of the percentage change in the price of domestic nonfat milk (which is expected to be positive) and $\eta_{ii}$ is the own price elasticity of demand for imports (which is negative).

We may denote the overall own price elasticity of demand for this aggregate milk protein as, $\eta_{protein}$. This demand effect reflects how the use of aggregate milk protein would respond to a change in the price of the aggregate. We denote the substitution elasticity between the two sources of protein as $\sigma$. This parameter reflects how the relative use of protein from the imported and domestic sources would respond to a change in the relative prices, holding constant the total use of the protein aggregate. The demand elasticities that appear in equations (7) and (8) may now be decomposed as:

(7a) $\eta_{nn} = (1 - s_i)\eta_{protein} - s_i\sigma$

(8a) $\eta_{ii} = s_i\eta_{protein} - (1 - s_i)\sigma$

(7b) $\eta_{ni} = s_i [\eta_{protein} + \sigma]$

(8b) $\eta_{in} = (1 - s_i)[\eta_{protein} + \sigma]$,

where $s_i$ is the import share of the U.S. milk protein market.

These eight behavioral equations characterize the supply and demand for the three milk components we are considering and the relationship back to raw milk production and pricing in the United States. However, to complete the model we must specify the market clearing relationships. The following three equalities are conditions that re-establish an equilibrium after a policy shock such as the imposition of an import tariff or an import limiting quota:

(9) $EQ^{s}_{fat} = EQ^{d}_{fat}$,

(10) $EQ^{s}_{nonfat} = EQ^{d}_{nonfat}$, and

(11) $EQ^{s}_{import} = EQ^{d}_{import}$.

These equations simply say that after a policy change a supply and demand balance is reestablished in the system by adjustments induced in the various prices.

In percentage change terms, this may be written as the sum of the percentage change in price and the percentage change in quantity,

(12) $ERev_{milk} = EP_{milk} + EQ_{milk}$.

When the USDA purchase price is binding, reduced imports raise demand for domestic milk protein (as shown above). The quantity reduction in the protein sold in the U.S. resulting from a given reduction in the quantity of imported milk protein, depends on domestic demand parameters, and on the degree of substitutability between imported and domestic milk protein.

Building on the above model for the case where the USDA purchase price is binding, the supply and demand equations for milk protein imports (in elasticity form) are the same as equations (5) and (8). The demand for domestic milk protein is the same as equation (7).

Note that milk protein accounts for a fixed proportion of the nonfat component of milk, so, because our model focuses on percentage changes, we use protein and nonfat interchangeably here. When the USDA purchase price is binding, the equilibrium price of domestic protein is irrelevant: $EP_{nonfat} = 0$. Using this fact, we can solve equations (5), (8) and (7) for the effect of decreased imports ($\theta$) on the demand for domestic protein. With some algebra, we get an expression for the shift, in percentage terms, in the demand for domestic milk protein.

(13) $$EQ^{d}_{nonfat} = \eta_{ni}\theta/\eta_{ii}.$$

When the USDA support price is *not* binding, a shift in demand for milk protein interacts with the domestic supply function (equation (4)), resulting in the change in equilibrium price and quantity of domestic protein. However, when the USDA support price is binding, the shift in demand for domestic milk protein does not affect the equilibrium price or quantity of domestic protein, both of which are determined by the support price. Instead, the shift in demand for domestic milk protein, equation (13), affects only the portion of total domestic milk protein that is sold to private consumers versus USDA purchases in the form of NFDM. In fact, equation (13), when translated into a quantity of protein, is equivalent to the reduction in USDA purchases of milk protein (in the form of NFDM). The percentage change in USDA purchases of NFDM is:

(14) $$EQ_{USDA} = -\,(100 - S_{USDA})EQ^{d}_{nonfat}/S_{USDA}$$

$$= -\,(100 - S_{USDA})(\eta_{ni}\theta/\eta_{ii})/S_{USDA},$$

where $EQ_{USDA}$ is the percentage change in USDA purchases, and $S_{USDA}$ is the initial USDA purchases as a share of all milk protein.

Recall from equations (8a) and (7b) that the cross- and own-price elasticities of demand for the two sources of milk protein are functions of the import share in the domestic market for milk protein, the elasticity of substitution between domestic and imported milk protein, and the overall demand elasticity for milk protein. These parameters, together with the size of the reduction in imports ($\theta$), the share of NFDM in all milk protein, and the share of USDA purchases in all NFDM, determine the effect of reduced imports on USDA purchases.

Simulation results follow from specifying the parameters and solving the model.

**Table 1. Imports of milk protein products to the United States from all countries, 1991 through 2001[1]**

| Year | MPC4 0404.90.10 | MPC35 3501.10.10 | Casein 3501.10.50 | Caseinates 3501.90.60 |
|---|---|---|---|---|
| | | M. tons | | |
| 1991 | 1,122 | 3,702 | 68,797 | 16,779 |
| (Jan-Oct) | (874) | (3,043) | (57,828) | (13,809) |
| 1992 | 3,933 | 3,508 | 74,622 | 16,718 |
| (Jan-Oct) | (3,697) | (3,074) | (60,415) | (14,795) |
| 1993 | 5,820 | 3,395 | 60,466 | 16,946 |
| (Jan-Oct) | (4,507) | (2,593) | (49,239) | (13,648) |
| 1994 | 12,009 | 6,787 | 68,339 | 20,846 |
| (Jan-Oct) | (9,557) | (5,468) | (56,775) | (17,152) |
| 1995 | 7,287 | 3,010 | 65,806 | 24,585 |
| (Jan-Oct) | (6,015) | (2,740) | (55,477) | (19,981) |
| 1996 | 14,256 | 3,867 | 69,166 | 25,481 |
| (Jan-Oct) | (10,663) | (2,660) | (55,485) | (20,891) |
| 1997 | 16,998 | 11,394 | 65,025 | 25,961 |
| (Jan-Oct) | (13,308) | (9,057) | (54,608) | (22,319) |
| 1998 | 28,929 | 10,919 | 70,394 | 29,929 |
| (Jan-Oct) | (23,451) | (9,887) | (56,924) | (24,014) |
| 1999 | 44,877 | 9,849 | 65,960 | 32,460 |
| (Jan-Oct) | (34,362) | (8,090) | (53,614) | (27,120) |
| 2000 | 52,677 | 11,921 | 74,230 | 34,200 |
| (Jan-Oct) | (46,167) | (10,450) | (59,937) | (28,972) |
| 2001 (Jan-Oct) | (23,439) | (6,035) | (52,071) | (30,756) |

Source: USITC. 1/ Numbers in parentheses represent total imports through October, included for comparison with the most recent data available for year 2001.

**Table 2. Annual U.S. production of select dairy products**
(all units in 1000 metric tons, except where noted by %)

| Year | Raw Milk | Nonfat Dry Milk | CCC purchases Of NFDM | | Dry Whey | Concentrated Whey |
|---|---|---|---|---|---|---|
| | | | | (%[1]) | | |
| 1993 | 63,328 | 433 | 8 | 2 | 543 | 23 |
| 1994 | 69,673 | 558 | 26 | 5 | 550 | 39 |
| 1995 | 70,440 | 559 | 8 | 1 | 520 | 69 |
| 1996 | 69,857 | 482 | 0 | 0 | 506 | 78 |
| 1997 | 70,802 | 561 | 18 | 3 | 516 | 75 |
| 1998 | 71,373 | 515 | 52 | 10 | 534 | 55 |
| 1999 | 73,805 | 617 | 107 | 17 | 520 | 56 |
| 2000 | 76,049 | 658 | 253 | 38 | 539 | 52 |
| 2001 (Jan-July) | 44,414 | 404 | 127 | 31 | 308 | 0 |

Source: USDA, AMS. 1/ CCC purchases of NFDM as a percent of NFDM production.

**Table 3. Annual U.S. production and imports of milk protein**

| | Domestic | | | | | | Imported[5] | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Total[1] | Fluid | Non-fluid | NFDM[2] | Dry Whey[3] | Other[4] | MPC4 | MPC35 | Casein | Caseinates |
| | | | | | 1000 metric tons | | | | | |
| 1993 | 2,255 | 828 | 1,427 | 152 | 60 | 1,216 | 0.9 | 2.2 | 64.1 | 16.1 |
| 1994 | 2,299 | 821 | 1,478 | 195 | 60 | 1,222 | 0.5 | 2.6 | 67.6 | 15.8 |
| 1995 | 2,325 | 829 | 1,495 | 196 | 57 | 1,242 | 0.7 | 3.3 | 67.4 | 16.4 |
| 1996 | 2,305 | 851 | 1,454 | 169 | 56 | 1,230 | 2.4 | 3.2 | 73.1 | 16.4 |
| 1997 | 2,336 | 848 | 1,488 | 196 | 57 | 1,235 | 3.5 | 3.1 | 59.3 | 16.6 |
| 1998 | 2,355 | 827 | 1,528 | 180 | 59 | 1,289 | 7.2 | 6.1 | 67.0 | 20.4 |
| 1999 | 2,436 | 833 | 1,602 | 216 | 57 | 1,329 | 4.4 | 2.7 | 64.5 | 24.1 |
| 2000 | 2,510 | 853 | 1,656 | 230 | 59 | 1,367 | 8.6 | 3.5 | 67.8 | 25.0 |

1/ Assuming raw milk contains 3.3 percent milk protein.
2/ Assuming NFDM contains 35 percent milk protein.
3/ Assuming dry whey contains 11 percent milk protein.
4/ Other calculated as a residual; includes cheese (less whey protein that is reported in the previous column), "Class II" soft products and ice cream, and other.
5/ The protein contents of MPC and casein imports vary across and within HTS categories. Based on product definitions and industry sources, we use the following average protein percentages to convert tons of product to tons of protein: MPC4, 60 percent; MPC35, 90 percent; Casein, 98 percent; and Caseinate, 98 percent.

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