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A DESCRIPTIVE ANALYSIS OF RECENT TRENDS IN THE INTERNATIONAL MARKET FOR DRY MILK PRODUCTS

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Brian W. Gould and Hector J. Villarreal*

Introduction

Historically, non-fat dry milk (NFDM) has been the U.S.'s major dairy export. The domestic price of NFDM has typically been well above international FOB port prices. In order to reduce the effective export price, the Dairy Export Incentive Program (DEIP) has been used to enable U.S. NFDM exporters to compete in the world market. The assistance is provided through targeted export subsidies for various export regions to the point that the U.S. products are competitive in international markets, especially against subsidized EU dairy exports.[1] In contrast to historical trends, during the last quarter of 2000, foreign FOB prices for NFDM increased dramatically relative to the U.S. domestic price. In April 2001, the NFDM DEIP program was suspended.

These dramatic price increases along with the growth in the market for other dry milk products provides the impetus for undertaking the following descriptive analysis of the international market for such products. We envision this report as a first step in the analysis as we provide an overview of:

- International prices for dry milk products;
- World production patterns;
- World exports and the distribution of imports across countries.

The importance of export markets for manufacturers of the dairy products reviewed in this report can be obtained from the fact that in 2000, 17% of U.S. NFDM, 35% of dry whey, 47% of lactose, and 11% of whey protein concentrate (WPC) production were exported.[2] It is highly likely that the international demand and associated trade for these products will become more significant and the composition of this trade in terms of the types of products involved may change as well—especially with ongoing trade discussions such as those centered around the deliberations of the Codex Alimentarius Commission (CODEX) and the continued increase in technological development of food and non-food uses of dry milk products.

An example of a possible source of change in the international market for dry products can be found in the proposed revisions to CODEX cheese standards. CODEX standards serve as the basis within the World Trade Organization (WTO) for resolving trade disputes by member nations where one nation's standards are at variance with widely accepted international standards. There are ongoing discussions concerning changes to the CODEX cheese standards—the CODEX cheese standards are umbrella standards that cover any product in international trade called "cheese." Sections of these cheese standards identify general cheese properties, standards of identity for specific cheeses, raw materials allowed in the cheese-making process, allowable levels of contaminants, hygiene standards, labeling standards, and methods of sampling and analysis. One of the major differences between proposed changes in the CODEX cheese standards and current U.S. cheese standards are the types of ingredients allowed for use in cheese manufacturing. Under

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[1] For a detailed review of the European Union's Dairy Export Restitution Program and the U.S. Dairy Export Incentive Program see: W.D. Dobson, *Canada's Class 5 Pricing System, the EU's Dairy Export Restitution Program and the U.S.'s DEIP: An Update on Impacts of Dairy Export Subsidy Programs*, Babcock Institute Discussion Paper 99-1, The Babcock Institute for International Dairy Research and Development, University of Wisconsin-Madison.

[2] Derived from export data obtained from the U.S. Dairy Export Council and production data obtained from National Agricultural Statistical Service of USDA. This data can be downloaded from the University of Wisconsin Dairy Marketing web site: http://www.aae.wisc.edu/future.

CODEX, *milk and/or products obtained from milk* may be used, while under current U.S. standards of identity, only *milk, nonfat milk and cream* are allowed. These changes have important implications for the U.S. dairy industry if the U.S. standards continue to be in compliance with the CODEX standards in that it would allow casein, milk protein concentrates (MPC), and other forms of whey-based proteins to be used in cheese manufacture. Not only could this impact the domestic dairy industry via the substitution of imported protein sources for domestically produced milk for use in cheese making but such changes could alter the demand for dry products in foreign markets away from the relatively expensive NFDM based protein.

As will be seen below, there have been dramatic increases in world exports of several types of dry milk products over the last two decades. These products vary in their total solids, protein, lactose, and other nonfat solids composition. This increase is due to recent technological innovations in ultrafiltration, spray-drying, and other separation technologies that allow for the custom design of dried products that match the functional, sensory, and nutritional requirements of specific final products. For example, dry whole milk can be used in the reconstitution of fluid milk, milk protein concentrates can be used in the standardization of milk used in the manufacture of cheese with no standards of identity, and dried whey has been increasingly popular as a source of protein supplementation in beverages and infant formulas.

This report provides basic background information regarding trends in prices, production, and trade of a variety of dry dairy products. This information may be useful to dairy manufacturers and traders for improving their understanding of historical and current market conditions. The structure of this report follows. First, we provide brief descriptions of a variety of dairy products emphasizing their functionality and unique component compositions. Next, an overview of recent export price patterns for those products is provided, where such historical information is available. This discussion is followed by an overview of trends in production levels. Finally, we present an overview of recent trade patterns for these products.

I. A Brief Description of Dry Milk Product Characteristics

Understanding the behavior of dry milk product prices and trade flows can be extremely complex for a variety of reasons including:

- Dry products may be stored for considerable lengths of time;
- Production often comes from residual milk not used in the production of other primary dairy products; and
- Some dry products (e.g. dried whey, milk protein concentrates, lactose) are byproducts obtained from the production of other primary dairy products.

To illustrate the variety of dried/evaporated/condensed dairy products that are available using today's processing technologies, Table 1 shows common profiles of wet and dry milk products. Besides substantial differences in moisture contents, the composition of the solids portion varies considerably across product. For example, whole milk powder (WMP) contains substantially less lactose than nonfat dry milk (NFDM), although they both have the same relative solids content. Alternatively, some types of milk protein concentrates (MPC) have relatively high protein and low lactose compositions within a similar solids composition.

Until recently, NFDM was the commodity with the greatest share (in terms of tonnage) of U.S. exports. Over the last 20 years there has been a steady increase in the relative share of other commodities with very different composition profiles. To better appreciate these differences we provide some brief descriptions of these products.[3] In addition, Appendix A contains a diagram showing the processes typically used to produce the milk protein products discussed below.

[3] Much of the following review is obtained from: Wisconsin Center for Dairy Research, *Dairy Proteins,* October 2001, and can be downloaded from the publications section of the University of Wisconsin Dairy Marketing web site: http://www.aae.wisc.edu/future. Additional material is obtained from Dairy Management, Inc.'s web site: http://www.doitwithdairy.com.

Table 1. Typical Composition (%) of Various Milk Products

Product	Moisture	Fat	Protein	Lactose	Ash
Whole Milk	87.5	3.7	3.1	4.8	0.7
Dry Matter	—	29.6	24.8	38.4	5.6
Whole Ultra Filtered Milk (3X)	72.2	11.5	9.9	4.3	1.5
Dry Matter	—	41.4	35.6	15.5	5.4
Skim Ultra Filtered Milk	82.8	0.3	11.2	4.7	1.0
Dry Matter	—	1.7	65.1	27.3	5.8
Whole Milk Powder (WMP)	3.5	27.3	25.8	37.3	6.0
Dry Matter	—	28.3	26.7	38.7	6.2
Non-Fat Dry Milk	3.0	1.0	34.5	51.0	9.0
Dry Matter	—	1.0	35.6	52.6	9.3
Dried Sweet Whey	4.5	1.0	12.0	73.0	8.0
Dry Matter	—	1.0	12.6	76.4	8.4
Whey Protein Concentrate					
WPC-34	4.0	3.0	32.6	51.0	6.0
Dry Matter	—	3.1	34.0	53.1	6.3
WPC-50	4.0	4.0	48.0	35.0	7.0
Dry Matter	—	4.2	50.0	36.5	7.3
WPC-80	4.0	5.0	76.8	4.0	4.0
Dry Matter	—	5.2	80.0	4.2	4.2
Milk Protein Concentrate					
MPC-42	3.5	1.0	40.5	46.0	7.5
Dry Matter	—	1.0	42.0	47.7	7.8
MPC-80	3.8	2.5	77.2	5.5	8.5
Dry Matter	—	2.6	80.0	5.7	8.8
Casein					
Rennet Casein	12 (max)	1.0 (max)	75.5	—	7.5
Dry Matter	—	1.1	90.9	—	8.5
Acid Casein	10 (max)	1.5 (max)	85.5	0.2 (max)	2.2 (max)
Dry Matter	—	1.7	95	0.2	0.0
Lactose Powder (Food)	5.0	0.0	0.4	94.1	0.2
Dry Matter	—	0.0	0.4	99.0	0.2

Whole Milk Powder

Whole Milk Powder (WMP) is produced by removing water from pasteurized and homogenized whole milk or from reconstituted milk that conforms to U.S. federal standards of identity. Typically, WMP has 2-5% water content, with the solids portion having the same relative composition as the solids portion of the underlying fluid product. As shown in Table 1, WMP may have as much as 25% protein. WMP can be produced using roller dried or spray drying technologies, with the latter method being the most common. Removal of water inhibits microbiological growth and allows for a shelf life of six to nine months.

Nonfat Dry Milk

Nonfat dry milk (NFDM) is white to light cream in color with a clean dairy flavor. It is manufactured by removing water from pasteurized skim milk and contains 5% or less moisture (by weight) and 1.5% or less milkfat (by weight). By removing moisture to the greatest extent possible, microbial growth is prevented. Typically, more than half of the weight is associated with lactose. The presence of such large relative amounts of lactose places an upper limit on the degree to which

NFDM can be used to standardize milk in the manufacture of some cheeses without impacting cheese functionality or flavor.

Dried Whey

Whey is a collective term referring to the watery part of milk that remains after cheese manufacturing. It takes approximately 100 lbs. of fluid milk to produce 10 lbs. of cheese, with the remaining 90 lbs. being whey. Whey can be transformed into a dry product by a number of techniques where the quality of the product varies with the technology applied. Dry whey is manufactured by removing a substantial portion of water from fresh sweet or acid whey. The whey is pasteurized and no preservatives are added. Except for moisture, the remaining components of fluid whey are retained in the same relative proportion in dry whey. Whey proteins typically account for ten to 12% of whey total solids. As noted above, the demand for whey has been increasing as researchers continue to discover the nutritional benefits of whey proteins. Whey is increasingly being used as a source of protein in beverages and snack bars, infant formulas and sports nutrition products. It is also being used as a means of fortifying the calcium content of dairy products and snack foods.[4]

The development of new filtration technologies has dramatically increased the availability of "designer" whey-based products. Some types of filtration systems separate components by particle size, others remove water or separate out lactose, leaving a product relatively high in protein content referred to as whey protein concentrate (WPC). The non-protein constituents are removed by physical separation techniques such as precipitation, filtration, or dialysis. There are several industrial methods suitable for selectively concentrating whey. The most commonly used method is ultrafiltration, where low-molecular weight compounds such as lactose, minerals, non-protein nitrogen and vitamins are filtered from the whey to the permeate, and the proteins are concentrated in the retentate. The permeate is used for producing lactose, alcohol, single-cell protein, yeast, galactose, glucose, cattle feed, and various pharmaceuticals. WPC is a white to light cream-colored product with a bland, clean flavor and typically composed of 25% or more protein. The composition of WPC-34 (e.g., 34% protein in the dry matter) is similar to that of NFDM and may be used as a less costly partial replacement for NFDM. Table 1 shows the dramatic decrease in lactose composition as protein levels in WPC increase.

Milk Protein Concentrate

As shown in Appendix A, milk protein concentrate (MPC) is produced from skim milk by a series of processes that include ultrafiltration (UF), evaporation, and drying.[5] Ultrafiltration determines the composition of the MPC, while evaporation and drying are used to remove only water. The product is pasteurized to eliminate potential pathogens in raw milk. Typically, the first step in the manufacture of MPC is ultrafiltration of skim milk. UF is a process that separates milk components according to their size. There are two size-groups of milk components: minerals and lactose that are smaller in size, and proteins (including casein and whey proteins) that are much larger. It is this large size difference that allows milk to be separated efficiently by UF. During UF, milk passes across a membrane that resembles a piece of thin plastic. Some of the lactose, minerals and water will cross through the membrane and become the permeate stream. Because of their large size, casein and whey proteins will not be able to pass through the membrane. The proteins, along with the lactose and minerals that did not go into the permeate stream, will become the retentate stream. Protein concentration in the retentate stream will increase as more lactose and minerals are removed to the permeate stream. A diafiltration (DF) or washing step is required to get protein concentration greater than 65% in the final dried product. DF involves adding water to the retentate as it is being ultrafiltered to reduce product viscosity and further remove lactose and

[4] For a review of the current technology concerning the utilization of whey and whey products refer to: P. Frank, Finding the Whey, *Dairy Field*, October 2001. Pp. 63-68. For an overview of the current U.S. whey market refer to: National Milk Producers Federation, *Whey: Ready for Takeoff?* U.S. Dairy Market Outlook, August 2001, Vol 7(3).

[5] Wisconsin Center for Dairy Research, *op.cit.*

minerals. UF can be done over a range of temperatures; however, for microbiological reasons, UF is typically done when the milk is either cold (41° F) or hot (115° F). The temperature of the process affects the economics of producing MPC, but usually does not affect final product composition. Following UF, the retentate may be evaporated to increase total solids in the processing stream, which improves dryer performance. The retentate is then spray dried.

MPC is used in a manner similar to NFDM, as an ingredient in prepared food applications such as desserts, baked goods, toppings, lowfat spreads, dairy-based dry mixes, dairy-based beverages, sports-nutrition beverages and foods, and weight-loss beverages and foods. Like NFDM, MPC is used as a source of dairy protein in prepared foods because its bland flavor allows other flavors to develop fully. It adds opacity to reduced-fat food formulations. Other functional properties include improved viscosity, mouthfeel, emulsification, water binding, and a favorable nutritional profile.

For the most part, MPC's are not produced in the U.S. but are imported. There has been considerable debate as to the role imported MPC's have had in the displacement of domestically produced milk in cheese manufacture.[6] For regulatory purposes, cheese products fall into two broad categories—standardized and nonstandardized cheese.[7] The Food and Drug Administration (FDA) regulates certain cheeses such as cheddar or mozzarella through its standards-of-identity regulations to ensure that they meet specifications for ingredients and characteristics. The use of ultra-filtered milk is an acceptable in-plant procedure during the manufacture of cheese. However, the use of ultra-filtered milk as a starting ingredient to make cheese is not allowed by FDA's standards-of-identity regulations. In contrast, FDA does not specify the ingredients and characteristics of nonstandardized cheese products, such as pizza cheese. Producers of nonstandardized cheese products may use wet or dry ultra-filtered milk as either a direct replacement for raw milk, as a standardizing agent, or as a starting culture.[8]

Casein

Casein is a well-defined group of proteins found in milk, constituting about 80% of the proteins in cow's milk, but only 40% in human milk. Casein is an efficient nutrient, supplying not only essential amino acids, but also some carbohydrates and the inorganic elements calcium and phosphorus. It can be manufactured into a range of extremely versatile protein products with many food ingredient and industrial uses. Commercial casein is made from skim milk by one of two methods—precipitation by acid or coagulation by rennet. Fat, whey proteins, lactose, and minerals must be removed from the casein by washing it with water to improve the quality of the final casein product (Table 1). The product is dried to improve its quality during storage. Addition of acid or rennet to milk will cause casein to join together and separate from the other components. This

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6 For a discussion of these displacement issues refer to the following reports: U.S. General Accounting Office, *Imports, Domestic Production, and Regulation of Ultra-Filtered Milk*, Washington D.C., March 2001. This is available from the University of Wisconsin-Madison Dairy Marketing web site at http://www.aae.wisc.edu/future. K.W. Bailey, *Imports of Milk Protein Concentrates: Assessing the Consequences*, Penn. State University, Department of Agricultural Economics and Rural Sociology, Staff Paper #343, Nov. 2001. This is available from the web site at http://dairyoutlook.aers.psu.edu/reports/Pub2001/StaffReport343.pdf. National Milk Producers Federation, *Milk Protein Imports: Impact on U.S. Dairy Producers*, April 2001.

7 Standards of identity have been established for most natural cheeses, processed cheeses, cheese foods, and cheese spreads (21 CFR, Part 133). Where a standard has been adopted for a particular cheese variety, all cheeses belonging to the variety must comply with the standard and be labeled with the name prescribed in the standard. Most of the standards prescribe maximum allowable moisture content and minimum milk fat contents. A few natural cheeses are required to be made from pasteurized milk. Most, however, may be made from either raw milk or pasteurized milk. When made from raw milk, they are required to be aged for 60 days or longer at a temperature of at least 35 degrees F. The 60-day aging requirement is necessary to ensure the safety of the cheese.

8 In 2001, the U.S. Food and Drug Administration implemented a temporary rule that allows for the use of wet UF milk products such as those shown in Table 1 for use in cheesemaking. There is current debate as to whether this temporary rule will be made permanent and whether dried forms of UF milk should be allowed in cheesemaking (Cheese Reporter, Vol 126(11), Sept. 21, 2001).

separation is exactly what happens during the cheese manufacturing process, where the casein portion is referred to as curds and the remaining milk components are known as whey. The casein is separated from the whey, then washed and dried (Appendix A).

Acid casein is a granular milk protein produced by the controlled acidification using mineral acid of pure pasteurized skim milk. It is high in nutritional value, flavorful and low in fat and cholesterol. Acid casein is insoluble in water, completely soluble in alkali, and heat stable. There are two varieties; edible acid casein and technical acid casein. Edible acid casein has a good flavor profile and excellent nutritional properties making it ideal for medical and nutritional applications. It is used in coffee whiteners, infant formulas, processed cheese, and in pharmaceutical industries. Technical acid caseins have good binding properties and are used for the manufacture of paper coatings, adhesives, paints, concrete, textile fabrics and cosmetics. Lactic casein is used in pharmaceutical products, food ingredients, and as a binding agent in industrial products such as paint, glue and paper. It is made by adding microbial cultures to milk to convert lactose to lactic acid, lowering the pH, and precipitating the casein by heating. When the enzyme rennet is used to precipitate the casein instead of acid, a protein with high levels of calcium results. Technical rennet casein has a good dye-binding ability and excellent extrusion properties, making it ideal for use in plastics.

The product caseinate is produced by neutralizing acid or rennet casein with alkali and then drying the resulting product. The alkali treatments result in caseinates being more soluble in water than casein.

Lactose

Lactose is the primary carbohydrate found in cow's milk. It is often referred to as milk sugar, and represents a major portion of milk's dry matter content. Lactose is obtained from dairy products such as whey and whey permeate after the production of cheese and/or caseinates. Lactose is obtained when water is removed from whey through evaporation, thereby increasing lactose concentration.

II. An Overview of U.S. and International Dry Milk Product Prices

In this section we provide an overview of export prices for a variety of dairy products. It should be remembered that for many of these products there is considerable variability in composition of key product (e.g., protein) components that could impact unit values. A good example is the protein concentration of the various Milk Protein Contents (MPC's) shown in Table 1. In the data available for this report, an annual aggregate MPC unit value is reported for a number of exporting nations. If a particular region emphasizes one type of MPC versus other regions, then unit values should be expected to differ, all other things being equal.

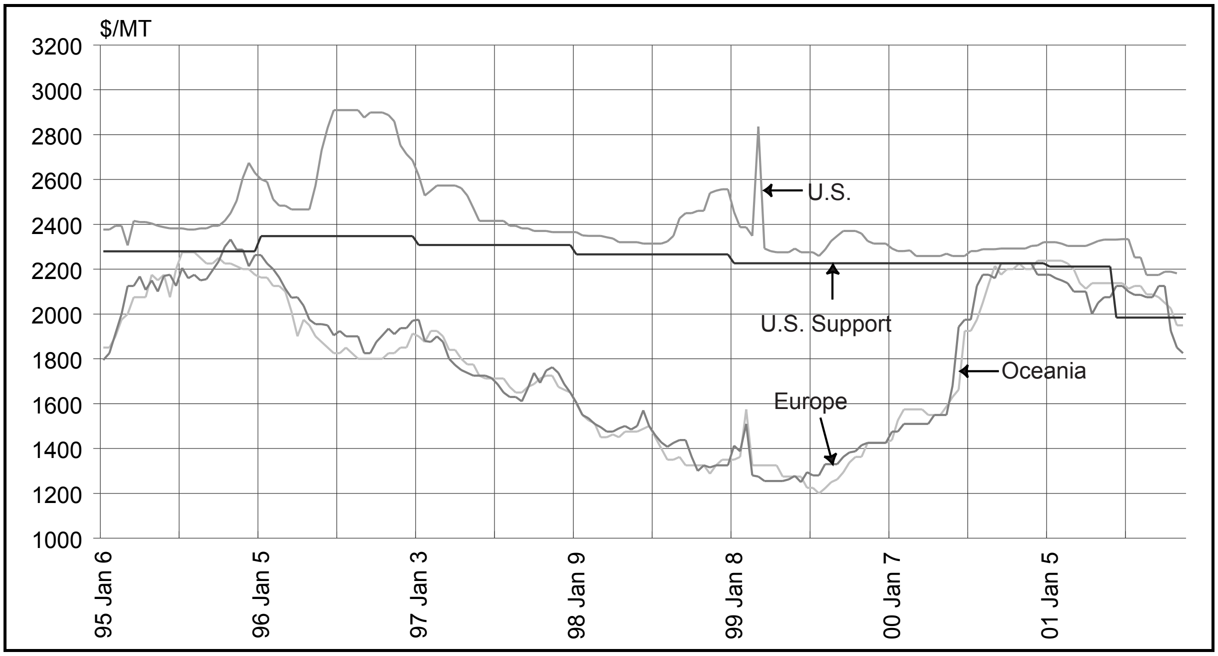
Nonfat Dry Milk Prices

Using biweekly price data obtained from USDA, Figure 1 shows domestic and international (FOB) prices for NFDM over the January 1995 through October 2001 period.[9] Domestic price levels are obviously faced with a lower bound set by NFDM price support levels. Figure 1 shows that, starting in early 2000, there was a general upward movement in international prices for NFDM approaching prices in U.S. Central States. In 2001, the closeness of U.S. and international NFDM prices resulted in the DEIP program being suspended in April. In late 2001, international NFDM

[9] Domestic NFDM prices are obtained from the average of the upper and lower range of reported NFDM Central FOB Prices taken for the most part from various issues of the Dairy Market News Monthly dairy product prices report (http://www.ams.usda.gov/dairy/mncs/average.htm). The European and Oceania prices are the average of the range of FOB port prices for 1.25% Butterfat NFDM reported in various issues of the Dairy Market News (http://www.ams.usda.gov/dairy/mncs/weekly.htm).

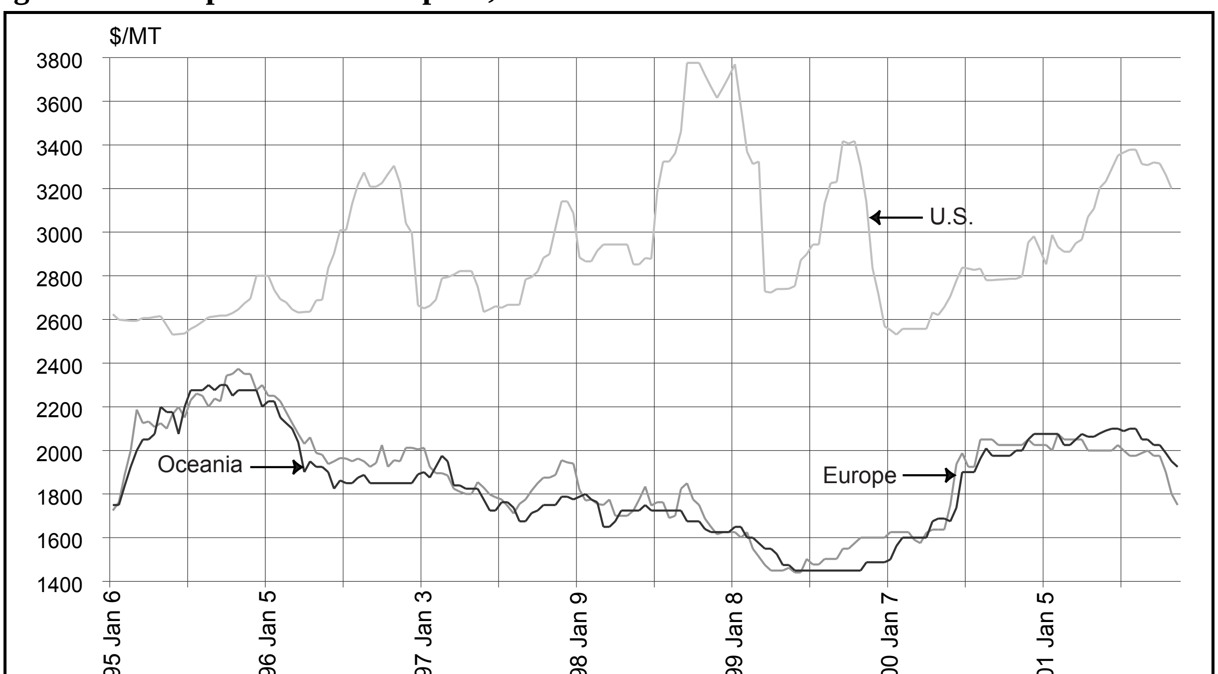
prices moderated to the point that the DEIP program was reinstituted on November 9th with an allocation of 68,201 metric tons for the July-June 2001/2002 year.[10]

Figure 1. Comparison of European, Oceania and U.S. NFDM Prices: 1995-2001



The degree to which the domestic and international dry milk prices move together can be obtained by calculating the correlation coefficients between related price series. As shown in Figure 1, European and Oceania FOB NFDM prices essentially move together over the 1995-2001 period, as evidenced by a correlation coefficient of the mean values of the biweekly price ranges of 0.98. In contrast, the correlation coefficients between NFDM prices in the US versus Europe/Oceania are relatively low, 0.13 and 0.07, respectively.

Figure 2. Comparison of European, Oceania and U.S. WMP Prices: 1995-2001



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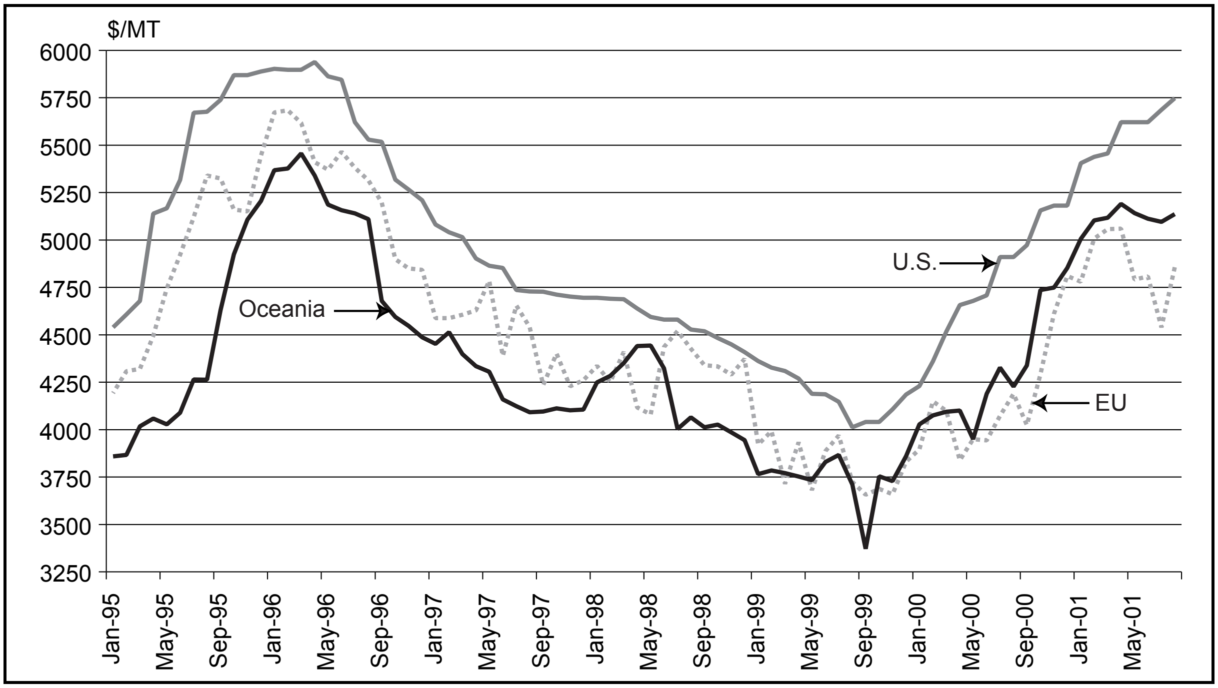
10 Dairy Market News, Vol 68(44), Nov 9, 2001, p.10.

Whole Milk Powder Prices

Figure 2 shows time series of domestic and international whole milk powder (WMP) prices.[11] The close relationship between the FOB prices in Europe and Oceania is again obvious. The correlation coefficient between the two price series over the 1995-2001 period is 0.948. With respect to European and Oceania WMP prices, the general trend observed over the above seven-year period is similar to the international NFDM price movements. The correlation coefficients between the WMP and NFDM FOB price series are relatively high with values of 0.93 for both Europe and Oceania. The one obvious difference between the relationship between domestic and international WMP prices is the extremely high relative domestic WMP prices. In fact, the correlation between domestic and international WMP prices were found to be approximately -0.25. There does not appear to be any correlation with domestic and international WMP prices. As will be shown below, the U.S. is a very minor participant in international WMP trade.

Figure 3. Comparison of Domestic and Imported Casein Prices: 1995-2001



Casein Unit Values

Figure 3 shows both domestic and imported monthly casein prices over the 1995-2001 period.[12] Given that there is virtually no casein production in the U.S., it is not surprising that the domestic whole price series shown in this figure is above imported prices. The obvious connection

[11] Domestic WMP prices are obtained from the average of the upper and lower range of reported national WMP FOB producing plant prices, obtained from various issues of the Dairy Market News Monthly dairy product prices report (http://www.ams.usda.gov/dairy/mncs/average.htm). The European and Oceania prices are the average of the range of FOB port prices for 26% butterfat WMP reported in various issues of the Dairy Market News (http://www.ams.usda.gov/dairy/mncs/weekly.htm).

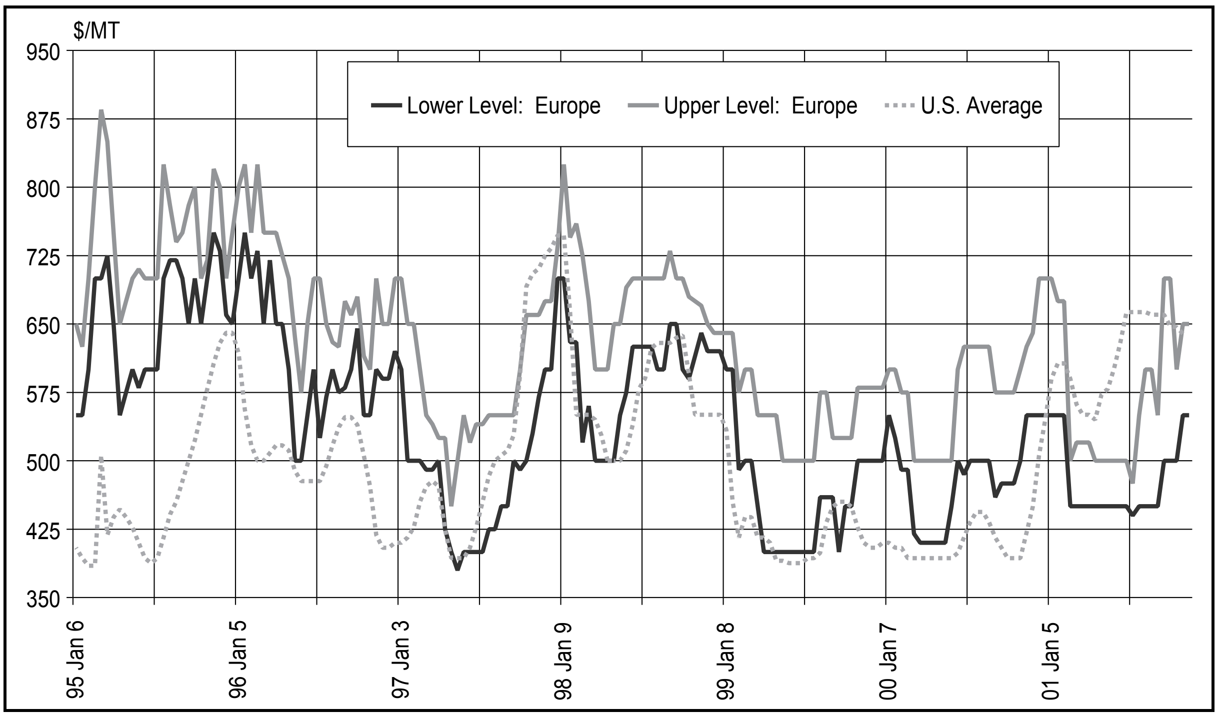
[12] In contrast to Figures 1 and 2, the international casein unit values are not FOB prices but are derived from reported U.S. imported quantity and values. The international price series did not differentiate between edible and nonedible casein. The data was obtained using spreadsheets from the FATUS web site, http://www.ers.usda.gov/FATUS. Average casein import prices are calculated using the commodity, casein and mixtures. Domestic casein price is calculated as the average of acid and rennet casein national wholesale prices for the U.S. reported in various issues of the Dairy Market News. The biweekly data can be downloaded from the University of Wisconsin Dairy Marketing web site at http://www.aae.wisc.edu/future.

between domestic and international prices is shown by the relatively high correlation coefficients of 0.92 and 0.90 between European and Oceania prices and domestic casein prices, respectively. Surprisingly, we find a positive but relatively weak correlation between European and Oceania imported casein prices, with a correlation coefficient of 0.84. This lower correlation coefficient value may be due to differences in the types of casein that are imported from the various countries, although over the 1995-2001 period the average difference in price between acid and rennet casein was only $0.033/lb when the average rennet versus acid casein prices were $2.1915 and $2.1585 respectively.

Dry Whey Prices

In contrast to the consistent movements of international prices for WMP and NFDM, the dried whey market appears to be more chaotic (Figure 4).[13] The correlation coefficients between European whey prices and WMP and NFDM prices are relative low with both values less than 0.40. The correlation between domestic and international (EU) whey FOB prices was also a surprisingly low 0.32.

Figure 4. Comparison of FOB Europe and Domestic Dry Whey Prices: 1995-2001



Milk Protein Concentrate Unit Values

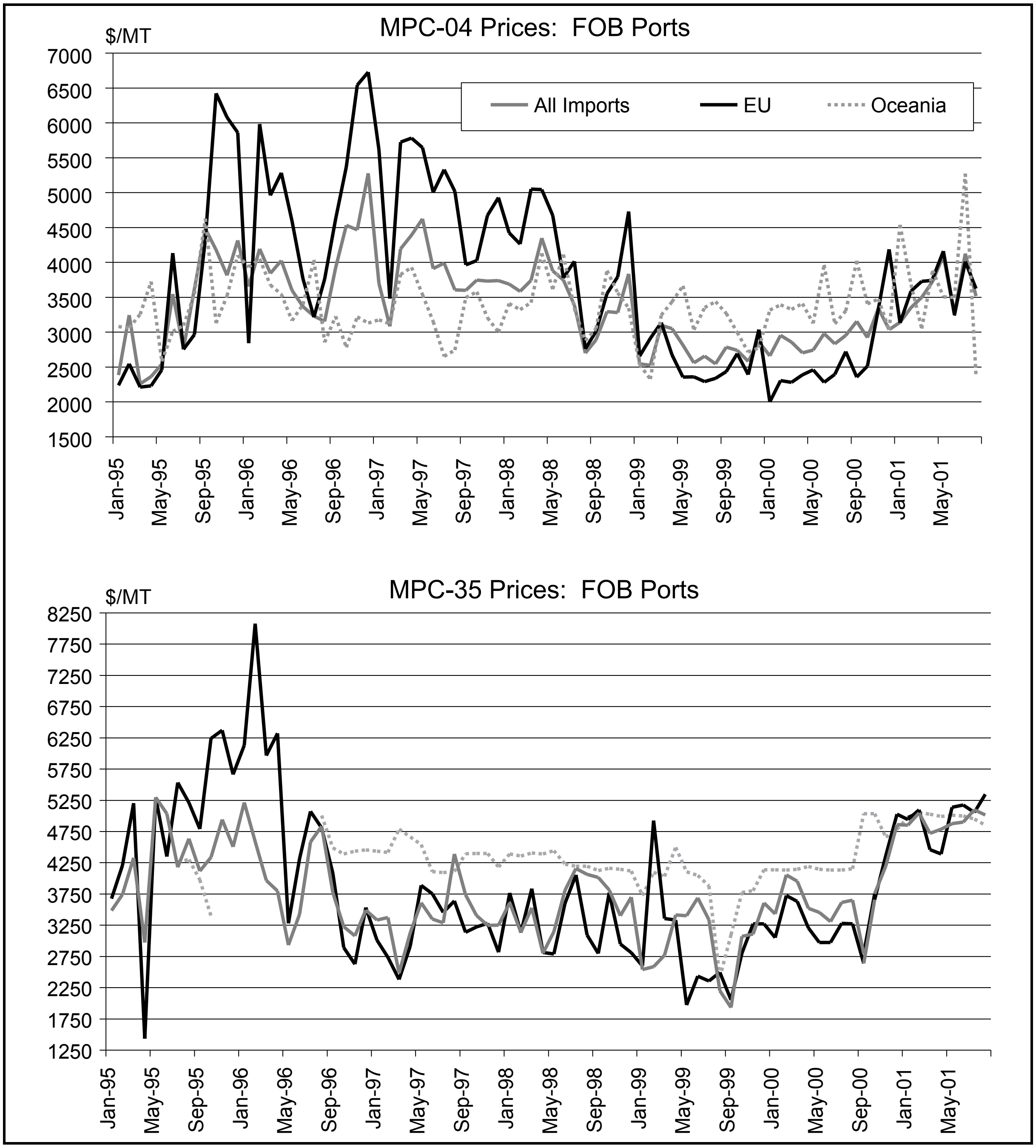
Average price data FOB port for Milk Protein Concentrates (MPC) are not available. We were able to obtain average U.S. import unit values using data from the Foreign Agriculture Service of USDA and a web site maintained by the U.S. International Trade Commission.[14] Contained in this web site are two categories of MPC imports using Harmonized Tariff Schedule (HTS) codes 0404.90.10 (MPC-04) and 3501.10.10 (MPC-35). MPC-04 is a broad classification of MPC and

[13] The domestic whey prices are obtained from the average of the upper and lower range of reported whey powder (nonhygroscopic) Central-Mostly FOB, obtained from various issues of the Dairy Market News Monthly dairy product prices reports (http://www.ams.usda.gov/dairy/mncs/average.htm). The European prices are the range average of the FOB port prices for sweet whey powder reported in various issues of the Dairy Market News (http://www.ams.usda.gov/dairy/mncs/weekly.htm).

[14] The International Trade Commission and USDA's Foreign Agricultural Service web site used to obtain this data. The URL for the ITC web site is http://dataweb.usitc.gov and the FAS web site is http://www.fas.usda.gov/ustrade.

includes any complete milk protein concentrate that is more than 40% milk protein by weight, where the 40% refers to the combination of casein plus whey protein. MPC-35 is defined more narrowly than MPC-04 where the milk protein content of the MPC is at least 90% casein. In other words, a commodity is classified as being MPC-35 due to its casein content, not its milk protein content.[15]

Figure 5. Comparison of Monthly U.S. MPC Import Unit Values by Type and Source: 1995-2001



Using the above import value and quantity data, Figure 5 shows monthly MPC values for all U.S. imports, and imports from the EU and Oceania over the 1995-2001 period. It should be

[15] For more information see: K.W. Bailey, *Imports of Milk Protein Concentrates: Assessing the Consequences*, Penn State University, Department of Agricultural Economics and Rural Sociology, Staff Paper #343, Nov 2001. This is available at http://dairyoutlook.aers.psu.edu/reports/Pub2001/StaffReport343.pdf.

remembered when viewing this figure that the definition of MPC-04 is fairly broad in terms of protein content. With the value of MPC based on this content, it is not surprising that there may be significant variability across months, especially in the early years when MPC imports were relatively small.

Table 2. U.S. Import Unit Values of MPC by Type and Country of Origin ($/MT)

	MPC-04*					
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
New Zealand	3301	3505	3439	3461	3086	3439
Australia	4720	2491	2734	3593	2800	3197
Ireland	5819	7011	6085	4387	3263	3108
Germany	2133	2646	2690	2778	1940	2072
Netherlands	7498	NA	3439	1984	1742	2006
Canada	1972	2557	2579	2513	2271	2271
Hungary	5580	7121	6526	6746	4123	3660
Switzerland	NA	NA	NA	NA	1720	2116
France	2468	5798	3616	NA	2646	2579
Denmark	3355	4519	3064	2976	1698	1962
Average	3192	3990	3880	3417	2734	2910
	MPC-35					
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
New Zealand	4065	4560	4293	4261	3946	4246
Australia	4606	NA	NA	4101	1163	4893
Ireland	5295	3371	2368	2245	1995	2719
Germany	4814	5487	4559	3633	2222	2278
Netherlands	5969	4223	3399	2556	4182	4151
Canada	2651	2652	2491	NA	NA	NA
Hungary	6281	NA	6736	4336	4068	5208
Switzerland	NA	NA	NA	NA	NA	3160
France	4710	4484	4407	4179	2556	3361
Denmark	3403	NA	4346	3777	4372	3072
Average	4192	3715	3421	3843	2939	3675

* MPC-04 pertains to imports of WPC under the HTS code #0404.90.10 and Casein-25 pertains to imports of casein under the HTS code #3501.10.50.

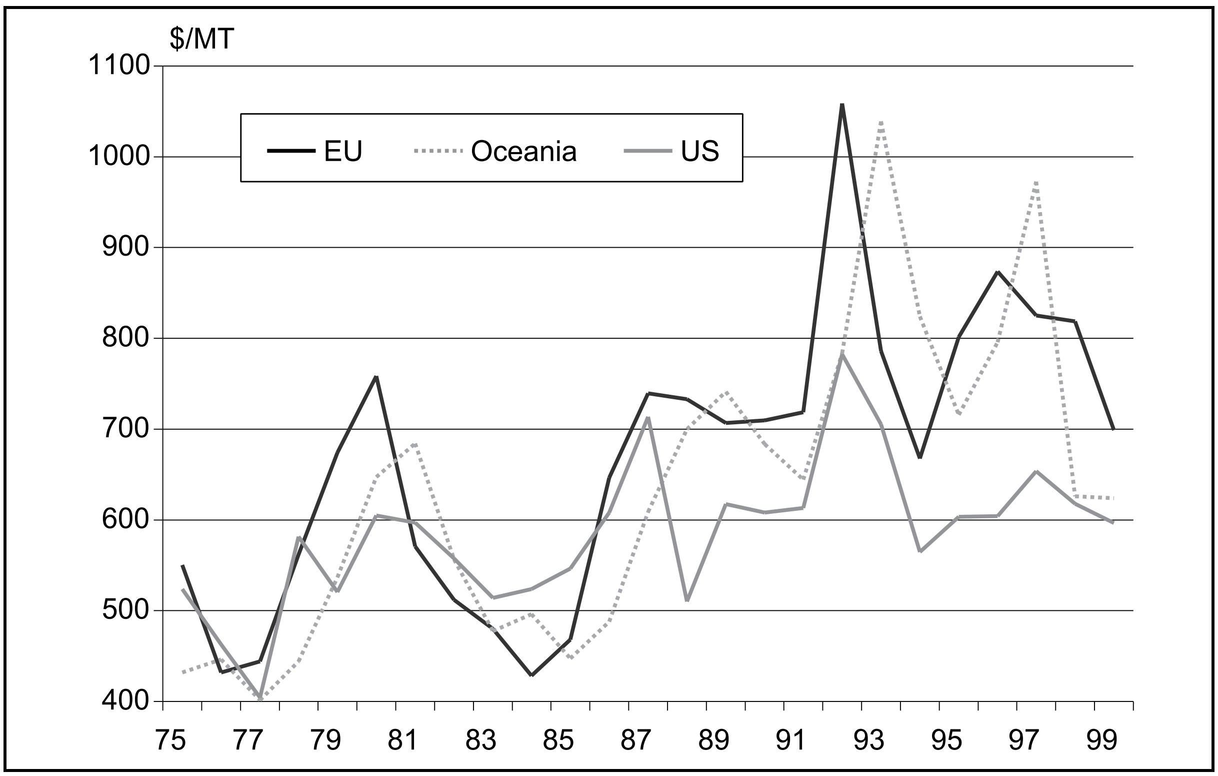
This variability in MPC values can be obtained when looking at specific countries that export to the U.S. Given the thinness of the import market, we are able to present only annual values by country. Table 2 shows annual MPC import unit values across country by country of origin and type of MPC. Even with the more narrowly defined MPC-35, there is significant variability in unit values within a given year. For example, in 1999, France exported 2992 metric tons of MPC-35 to the U.S. and New Zealand exported 2,971 metric tons. The average unit value of New Zealand's imports was $3,946/MT compared to the average French MPC-35 import unit value of $2556/MT. In contrast, in 1999 the three largest exporters of MPC-04 to the U.S. were New Zealand, Ireland, and Germany with 14601, 9755 and 5261 MT's, respectively. The average unit values for these imports ranged from $3263/MT for Ireland's imports to $1940/MT for Germany's.

Lactose Unit Values

The international market for lactose is relatively small. As will be shown in the section that discusses export levels, less than 325,000 MT were exported in 1999. This compares with the 1,640,000 MT of world NFDM exports. Using data from the Food and Agriculture Organization

(FAO) of the United Nations, we obtained estimates of lactose export quantities and values by country over the 1975-1999 period.[16] We then used this data to estimate lactose export unit values. Figure 6 shows annual average export unit values for the EU, Oceania, and the U.S. over this 25-year period. When viewing this table, and similar to the market for MPC and casein, it should be remembered that the solids composition can vary tremendously across specific products within the aggregate commodity group. If one country (region) tends to specialize in a specific type of product that has a unique composition (e.g., extremely high lactose composition), then different price patterns are to be expected. A trend seen in this figure is the relatively large variability in prices, regardless of region. A measure of the relative variation from 1975 through 1999 can be obtained by calculating the *coefficient of variation*, which is defined as the ratio of the standard deviation of a particular series to its mean. The coefficient of variation value obtained for the three regions was 0.236, 0.265, and 0.136 for the EU, Oceania, and the U.S. respectively. The EU and Oceania values are similar to calculated NFDM values of 0.174 and 0.184. The coefficient of variation for U.S. domestic lactose is approximately twice the calculated NFDM value of 0.72 obtained over the same period. A second trend that may be observed is the relatively low export values for the U.S. relative to the other two regions. After 1988, U.S. lactose export values are consistently lower than EU and Oceania unit values.

Figure 6. Annual Lactose Export Unit Values: 1975-99



III. An Overview of the Production of Dry Milk Products

Overall Production Trends

Table 3 provides an overview of world NFDM, WMP and dried whey production over the last 20 years.[17] Again it should be remembered that virtually no casein is produced in the U.S. Of the

[16] The lactose price data was obtained from a database maintained by the FAO on its web site located at http://apps.fao.org.

[17] No production information was available with respect to MPC's. Production data for lactose could only be obtained from the U.S. Only casein production data for the EU, Australia, and New Zealand was consistently available.

Table 3. Characteristics of World NFDM, WMP and Dry Whey Production

Product	Time Period	Annual Mean (000 MT)	Coef. Of Variation	Min.	Max.	Avg. U.S. % of World	Max. U.S. % of World
NFDM	1980-2000	3,938	0.138	3,306	4,998	14.2	18.6
	1980-1989	4,390	0.086	3,844	4,998	13.1	14.6
	1990-2000	3,455	0.077	3,306	4,249	15.2	18.6
WMP	1980-2000	2,191	0.133	1,726	2,649	2.8	3.8
	1980-1989	1,947	0.092	1,726	2,227	2.9	3.6
	1990-2000	2,412	0.070	2,085	2,649	2.7	3.8
Dry Whey	1980-2000	1,549	0.170	1,090	1,906	31.1	34.0
	1980-1989	1,317	0.125	1,573	1,546	32.0	34.0
	1990-2000	1,760	0.061	1,090	1,906	30.3	33.3

three products shown in Table 3, the relative importance of the U.S. as a major producer varies from being insignificant for whole milk powders (where the U.S. averages less than 3% of world production) to being quite significant for dry whey (where the U.S. typically accounts for close to one-third of world production).

Figure 7. Total Annual World Production of Selected Dry Products: 1980-2000

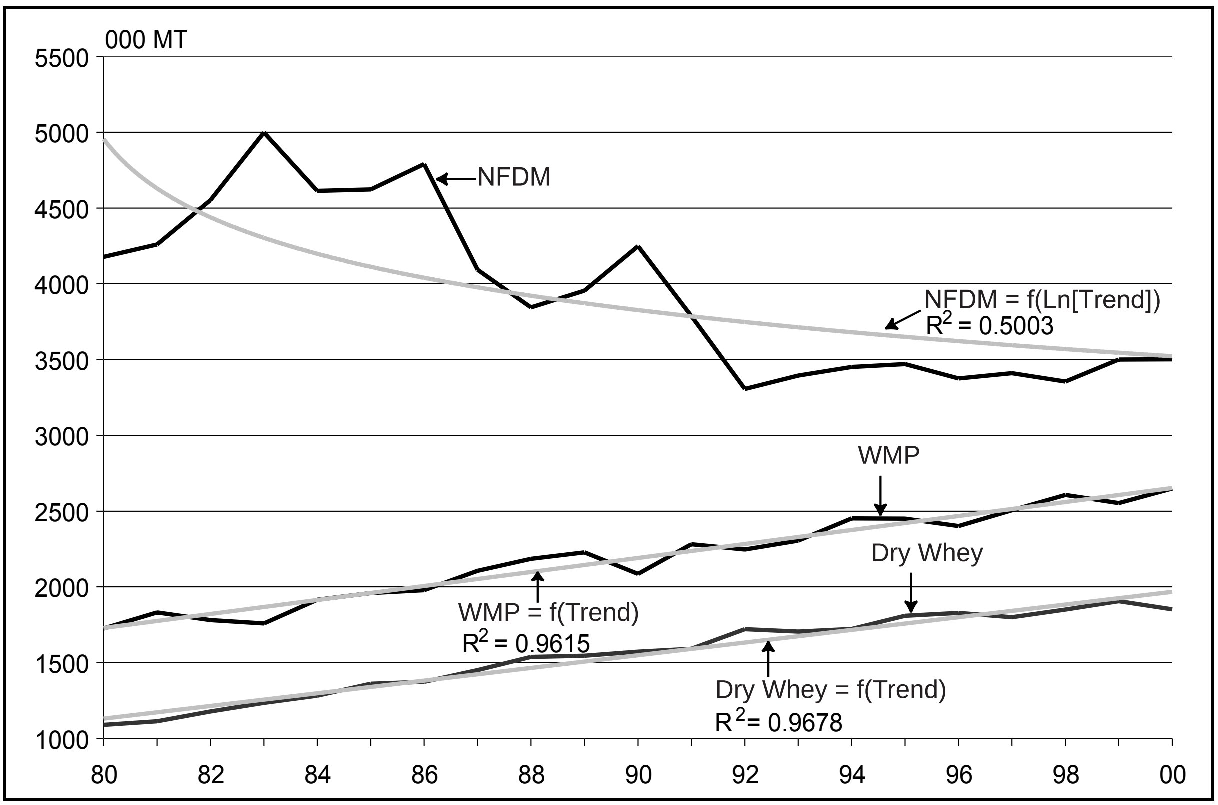
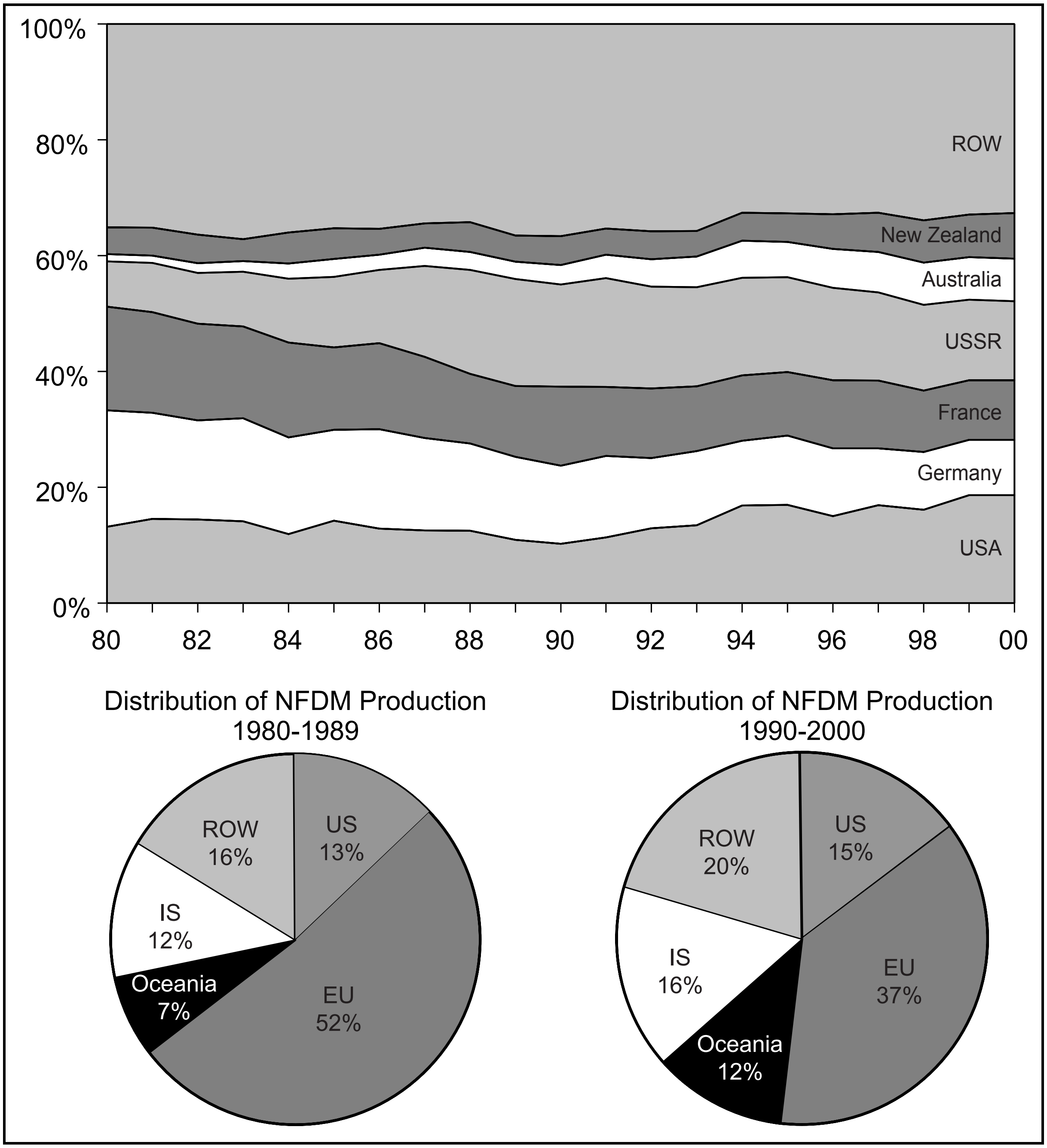


Figure 7 provides a graphical representation of the trend in world NFDM, WMP and dry whey production.[18] In this figure, besides graphing the actual series over the 1980-2000 period, we plot a regression line where the dependent variable is the amount of dry product produced and the explanatory variable is simply the production year. We also show the associated R^2 measures for

[18] Production data for NFDM, WMP and dry whey was obtained from the U.N.'s Food and Agriculture Organization's web site statistical database at: http://apps.fao.org.

each regression.[19] From these simple time trend regressions we explain approximately 50% in the variation in NFDM production, compared to more than 96% of world WMP and dry whey production over the 21-year study period. Over this time period, annual world NFDM production exhibited a declining production trend. In contrast, WMP production increased by more than 50% and world dry whey production approximately doubled over this time period.

Figure 8. Distribution of World NFDM Production: 1980-2000



[19] The R^2 measure represents the percentage of the total variation of the variable of concern explained by the regression equation. The range is between 0 and 1, with the larger value associated with greater predictive ability.

Non-Fat Dry Milk

World NFDM production reached a maximum value of approximately five million MT in 1986, but four years later world production had decreased by approximately 20%. From 1980 to1989, average yearly world NFDM production was approximately 4.4 million MT. Over the next 10-year period, average world NFDM production was approximately 3.5 million MT, with a range from 4.2 million MT in 1990 to a low of 3.3 million MT in 1992. Over the 1980-1989 period, the coefficient of variation of world NFDM production was relatively small, with a value of 0.086 implying that the standard deviation is less than 10% of average annual production.

The majority of the world's NFDM production takes place in a limited number of countries. In 1980, three producers (U.S, France, and Germany) accounted for more than half of world NFDM production (Figure 8). Over the last two decades, the relative share of the world's production occurring in the U.S. has steadily increased from approximately 12% in 1980, to more than 20% by 2000. The former Soviet Union has also increased its share of production from approximately six percent in 1980 to an average of 15% in the 1990's. Germany and France have reduced their share of world production from near 20% in the early 1980's to approximately 10% each in 2000. In 1980, Australia produced 40,150 MT of NFDM and New Zealand 192,600 MT, representing 1.3% and 4.6% of world production. By 2000, Australia produced 257,000 MT, and New Zealand 276,000 MT, representing 7.3% and 7.9% of world production, respectively.

In the bottom portion of Figure 8 we show the average distribution of world NFDM production for the major producing regions over the 1980-1989 and 1990-2000 periods. The most notable trend is the decrease in the share of production originating from the European Union, decreasing from an average of 52% over the 1980-89 period to 37% over the last decade.

Production of Whole Milk Powders

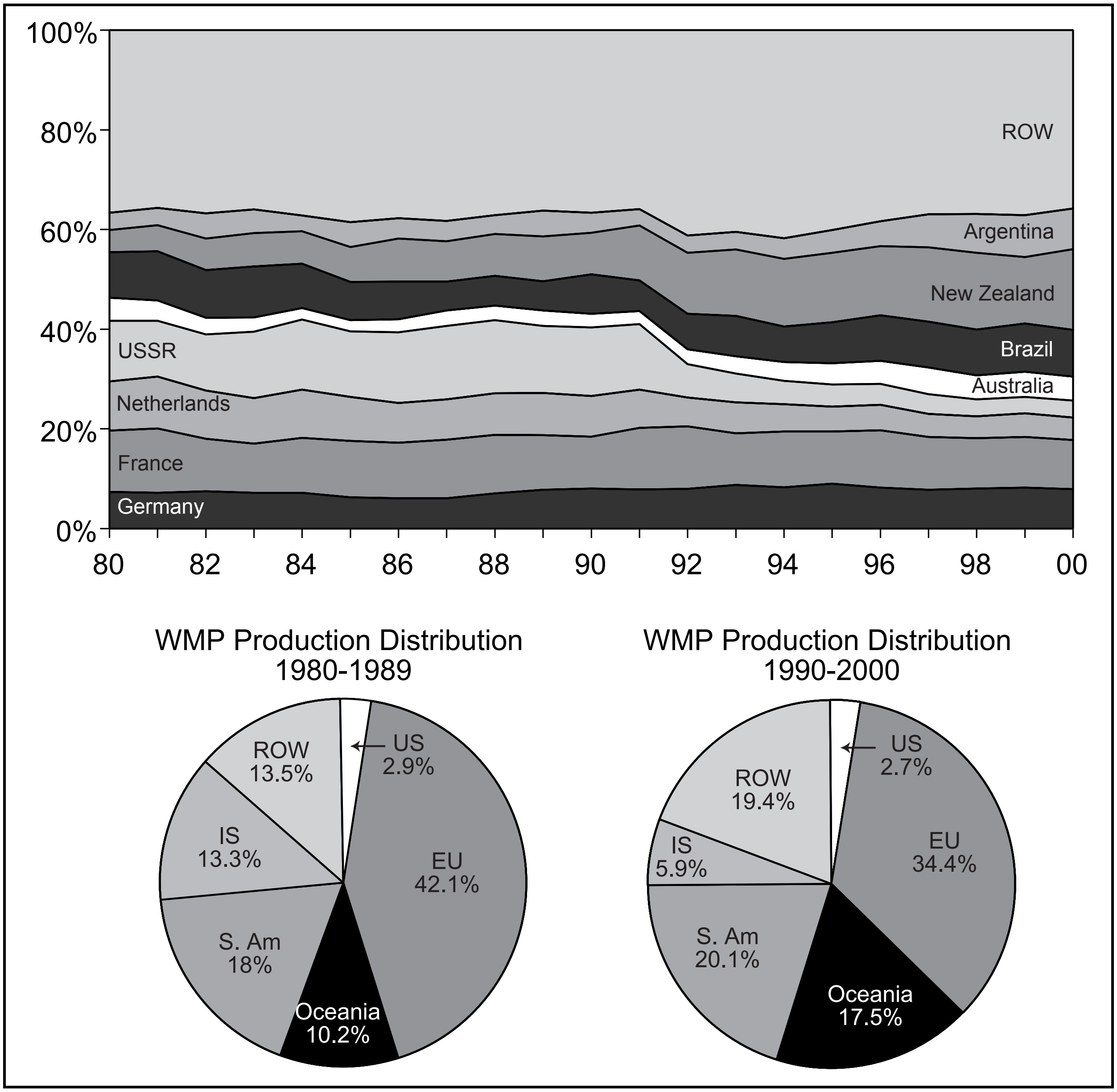
In contrast to NFDM, the U.S. produces relatively little whole milk powder. The U.S accounted for between 2.0% and 3.5% of world WMP production over the 1980-2000 period. Over this time period, France was one of the more important producers with a world production share of approximately 12% (Figure 9). Germany was also very important, accounting for about seven percent during the last twenty years. Participation in The Netherlands, which in 1980 had about eight percent of the world production, was reduced to about three percent by 2000. The former Soviet Union was one of the more significant producers in 1980; however, by the year 2000 its production accounted for roughly two percent of world production. Argentina and Brazil have also been significant producers of WMP. Together, by 2000, they accounted for more than 14% of world production. New Zealand has dramatically increased its production of WMP from three percent of world production in 1980 to approximately 17% by 2000.

The graphs at the bottom of Figure 9 show the average distribution of world WMP production over the 1980-1989 and 1990-2000 periods. An obvious trend observed from these figures is the increased importance of the Oceania region, with an increase in the average share from 10.5% to 17.5%, and a decrease in the importance of the European Union and former Soviet Union.

Production of Dry Whey

As noted above, whey is a by-product of cheese manufacturing. Not surprisingly, the major dry whey-producing countries (regions) are also regions that produce significant amounts of cheese. Four countries account for more than 80% of world dry whey production, with the their production shares remaining relatively stable over the 21-year study period (Figure 10). The U.S. is the largest dry whey producer, with an average share of more than 31% of annual world dry whey production. France follows with an average share of 28%. The Netherlands averaged a 15% share, and Germany averaged slightly less than 10% of world production. The relatively stable shares shown for the above countries are also observed when examining the important producing regions of the world. The graphs in the bottom half of Figure 10 show average regional production shares over

Figure 9. Distribution of World WMP Production: 1980-2000



the 1980-1989 and 1990-2000 periods with little change across region. The EU accounts for more than 60% of world dry whey production. Combined, the U.S. and EU account for more than 90% of world dry whey production.

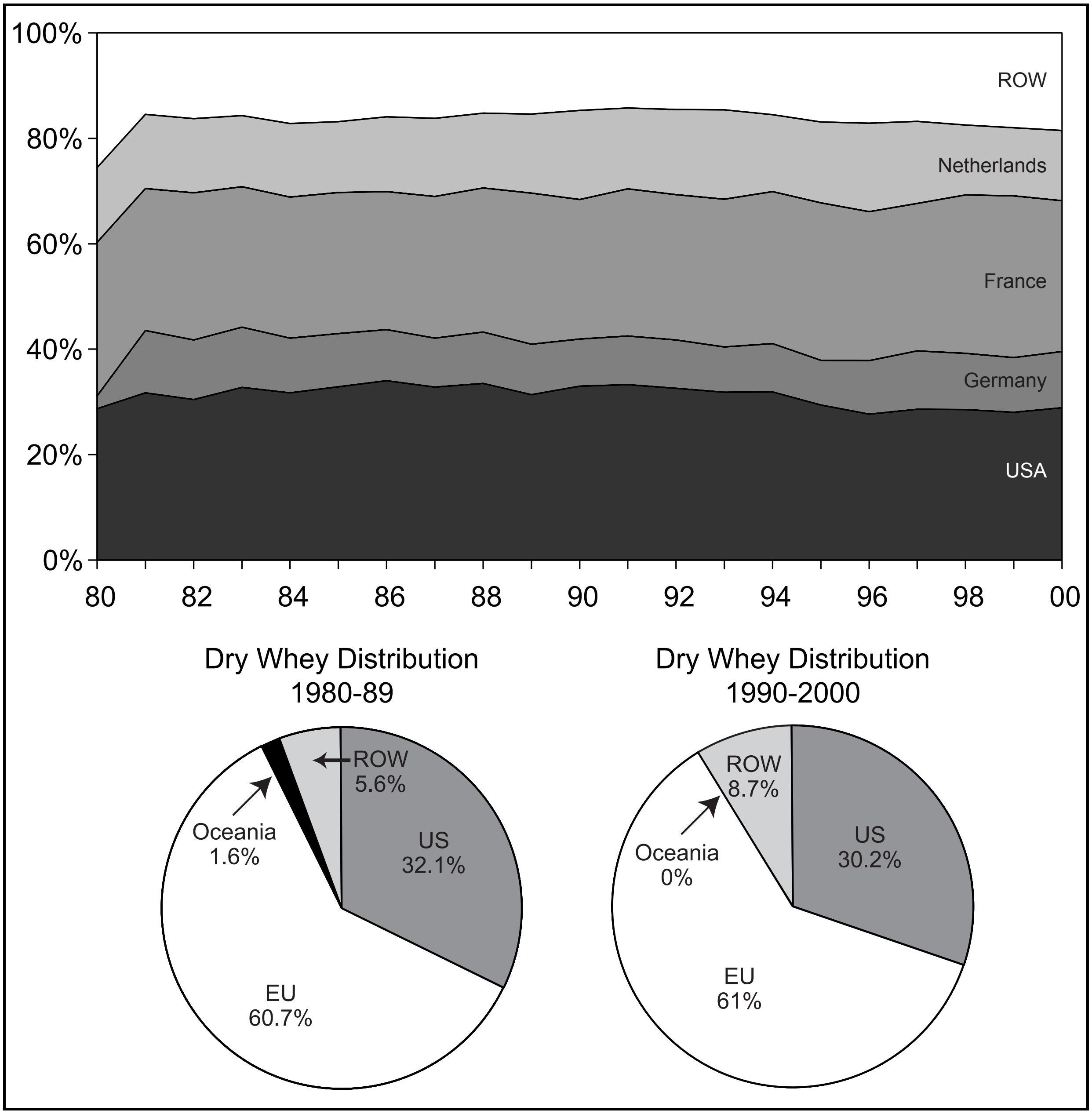
Production of Casein

As noted above, there is limited information on the level of world casein production. Using information from the OECD, we were able to obtain casein production data for three of the more important producers: New Zealand, Australia, and the European Union.[20] The upper portion of Figure 11 shows the trend in total production for these three areas over the last 30 years. Given the apparent nonlinear production profile, we also show a quadratic time trend regression line.[21] More

[20] For casein production data, see the OECD web site at: http://www.sourceoecd.com.

[21] The quadratic time trend regression can be represented as: Casein production = $\alpha_1+\alpha_1$ year + α_2 year,^{2} where the α_I's are estimated coefficients.

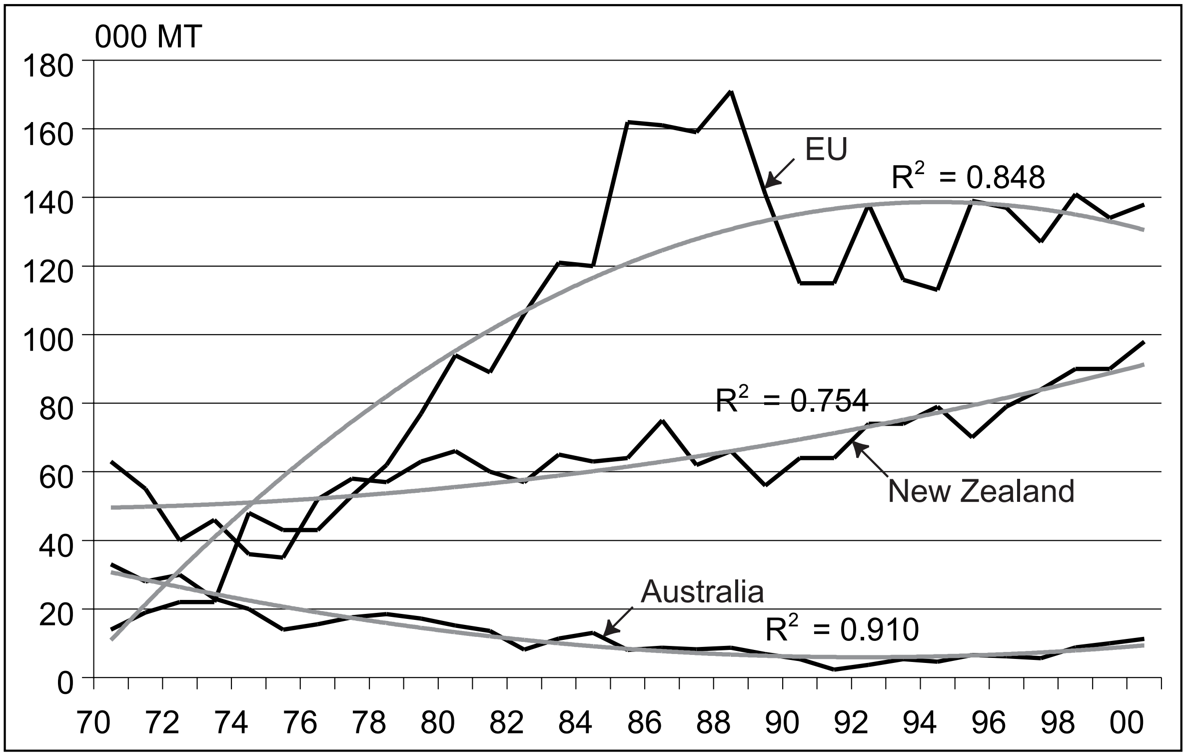
Figure 10. Distribution of World Dry Whey Production: 1980-2000

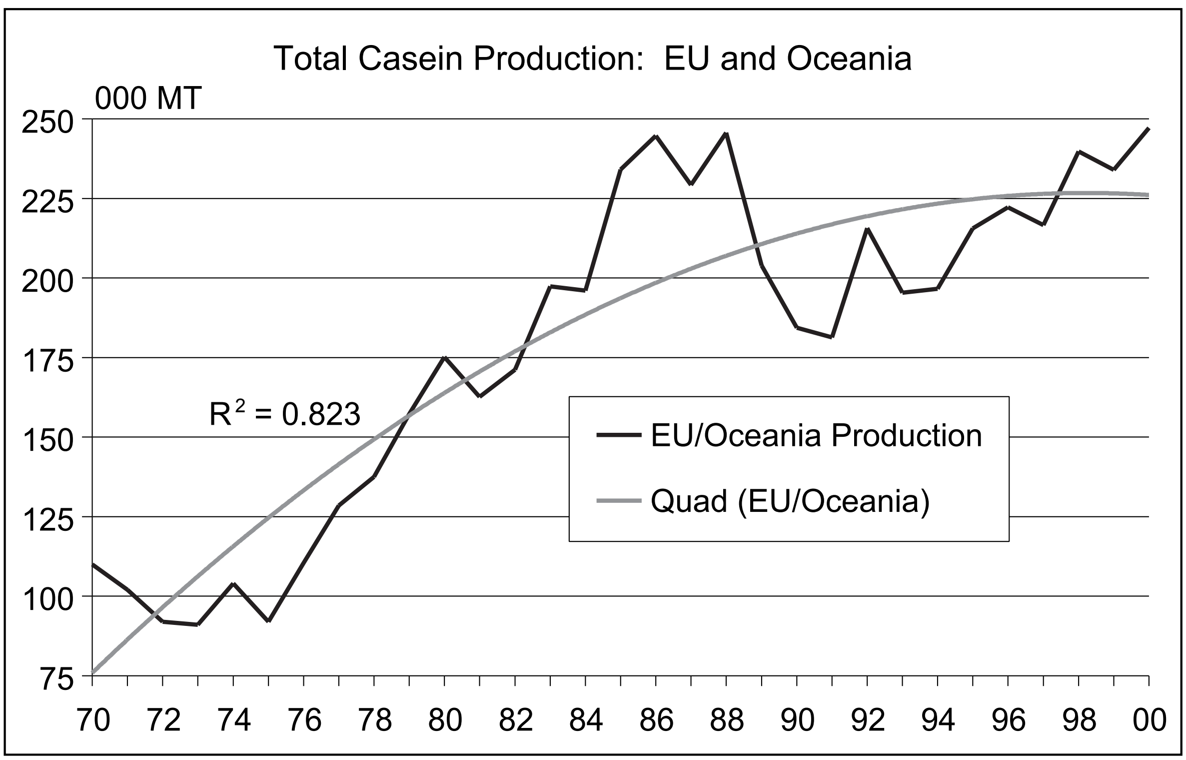


than 82% of the total variation is explained by this trend regression. Examining this production profile, there appear to be two distinct production periods—1970-1988 and 1992-present. Prior to 1989, there was a dramatic increase in production followed by a precipitous decline during the early 1990's. Production has finally recovered to the point where production in 2000 exceeded the previous maximum value obtained in the late 1980's.

Area-specific production profiles are presented in the bottom section of Figure 11. From 1974 to 2000, production in New Zealand increased by more than 150%. In contrast, during the 1985-1986 period, the EU produced record amounts of casein not equaled since that period. The reduced production levels observed during the late 1990's, however, represent an increase of more than 150% over the levels observed during the early 1970's. Since the 1970's, Australia's share of production has decreased dramatically and this country is now a relatively insignificant casein manufacturer.

Figure 11. Annual Casein Production, Selected Countries: 1970-2000





The increasing importance of the EU in the production of casein can be seen in Figure 12. In 1970, the EU's casein production represented slightly more than 12.7% of production in the EU and Oceania. This increased dramatically to close to 70% of total production by the mid-1980's, and has decreased to approximately 55% since the mid-1990's.

Figure 12. Share of Casein Production from EU: 1970-2000

IV. An Overview of International Trade of Dry Milk Products

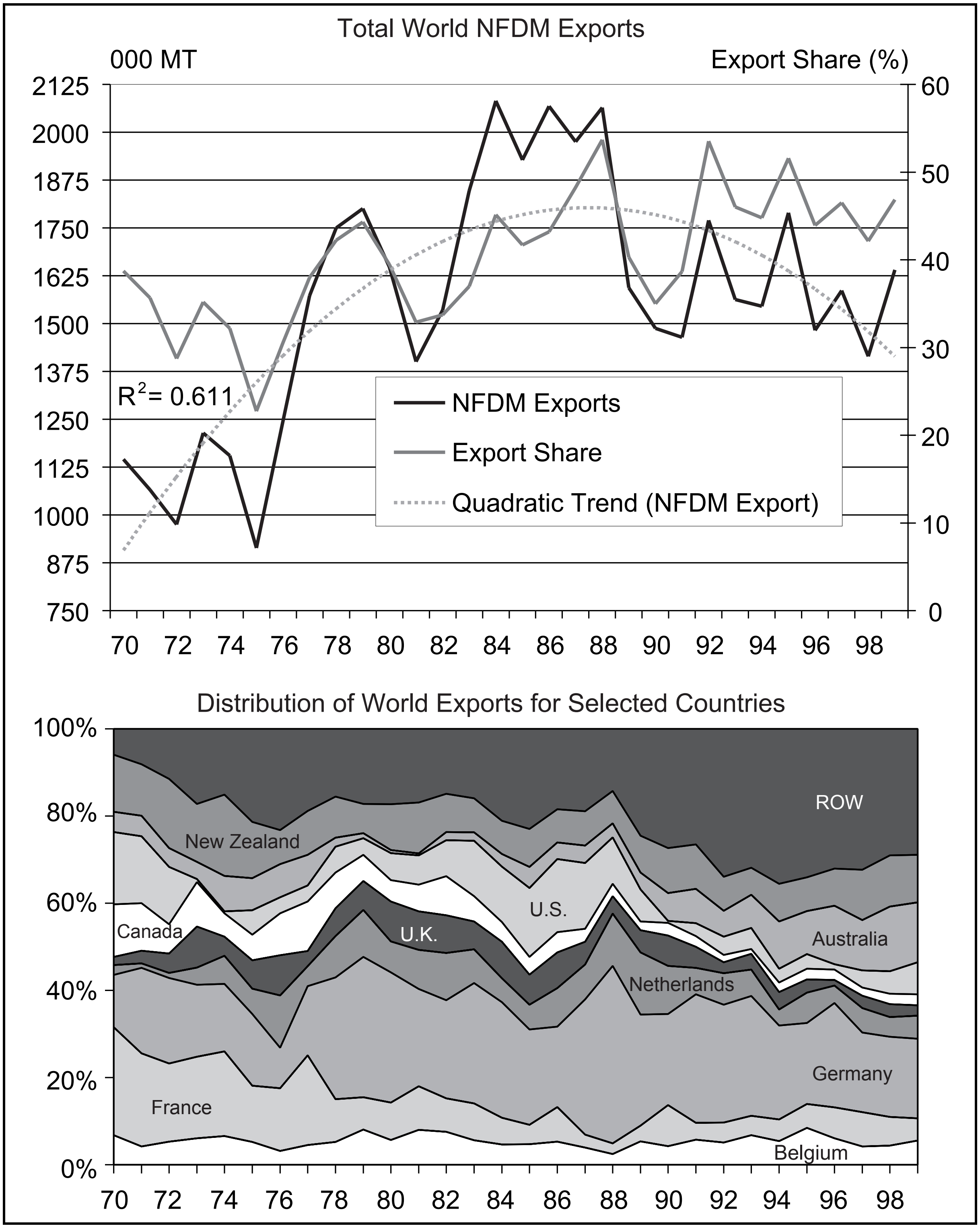
Below we provide an overview of recent international trade in NFDM, WMP and dry whey. As in the analysis of production, there is limited information available concerning trade in casein and MPC's. We were able to obtain U.S. import data for these two commodity categories, but were unable to obtain world trade flows. The last section of this report provides an overview of U.S. imports of casein and WPC.

Trends in NFDM Trade

Figure 13 shows total world NFDM exports over the 1970-1999 period, the share of world NFDM production that is exported, and a quadratic trend line applied to the export profile. Prior to the mid-1980's there was a dramatic increase in exports with a maximum export level of 2.08 million metric tons in 1984. Over the 1980-89 period, NFDM exports averaged 1.81 million metric tons compared to 1.57 million metric tons over the 1990-99 period. There was a general trend of the increased relative use of export markets as an outlet for world production. Over the 1970-1979 period, world exports averaged 34.8 % of annual production. This percentage increased to 41.5% from 1980 to 1989, and to 44.9% from 1990 to 1999. Less than a quarter of annual production was exported in 1975, as compared to more than 50% being exported in 1988 and 1995. Not surprisingly, this quadratic trend regression explains only 61% of NFDM exports.

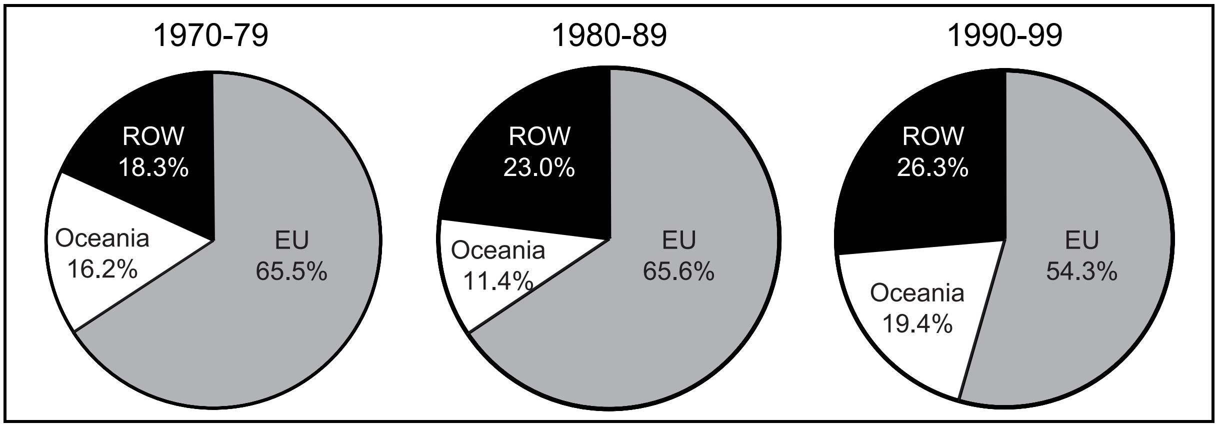
In the bottom portion of Figure 13, we portray the distribution of these exports among nine of the major exporting countries. The country with the greatest level of NFDM exports over the thirty-year period was Germany, which averaged close to a quarter of the world's exports. During the later part of the 1990's, Australia and New Zealand dramatically increased their export presence. Australia is now the second largest NFDM exporting country behind Germany. During the period from 1980 to 1989, Australia's annual NFDM exports averaged 52,500 metric tons. The average from 1990 to 1999 increased to 159,400 metric tons. By 1999, the nine countries shown in this Figure accounted for approximately 72% of world NFDM exports. Note that this is significantly less than accounted for during the 1970's. In 1970, these countries accounted for approximately 95% of world exports.

Figure 13. Overview of NFDM Exports: 1970-1999



In Figure 14, we display the importance of the European Union and Oceania in terms of their share of world NFDM exports. Over the last decade, the relative importance of the EU versus Oceania as originators of NFDM exports decreased dramatically. In 1999, the EU accounted for 46.5% of total world exports compared to 24.6% for Oceania.

Figure 14. Importance of EU versus Oceania for NFDM Exports



In contrast to the above export market share patterns, the eight largest importing countries typically account for less than 50% of total world imports (Table 4). The Netherlands, Italy, and Mexico tend to be the largest NFDM-importing countries. The case of The Netherlands is interesting given that it is also a major NFDM exporting country. This implies that The Netherlands is a major transshipment point or generates some additional value to their NFDM imports for later re-export. Table 4 shows average import levels and percentage of total world

Table 4. Comparison of NFDM Imports, Selected Countries, 1970-1999

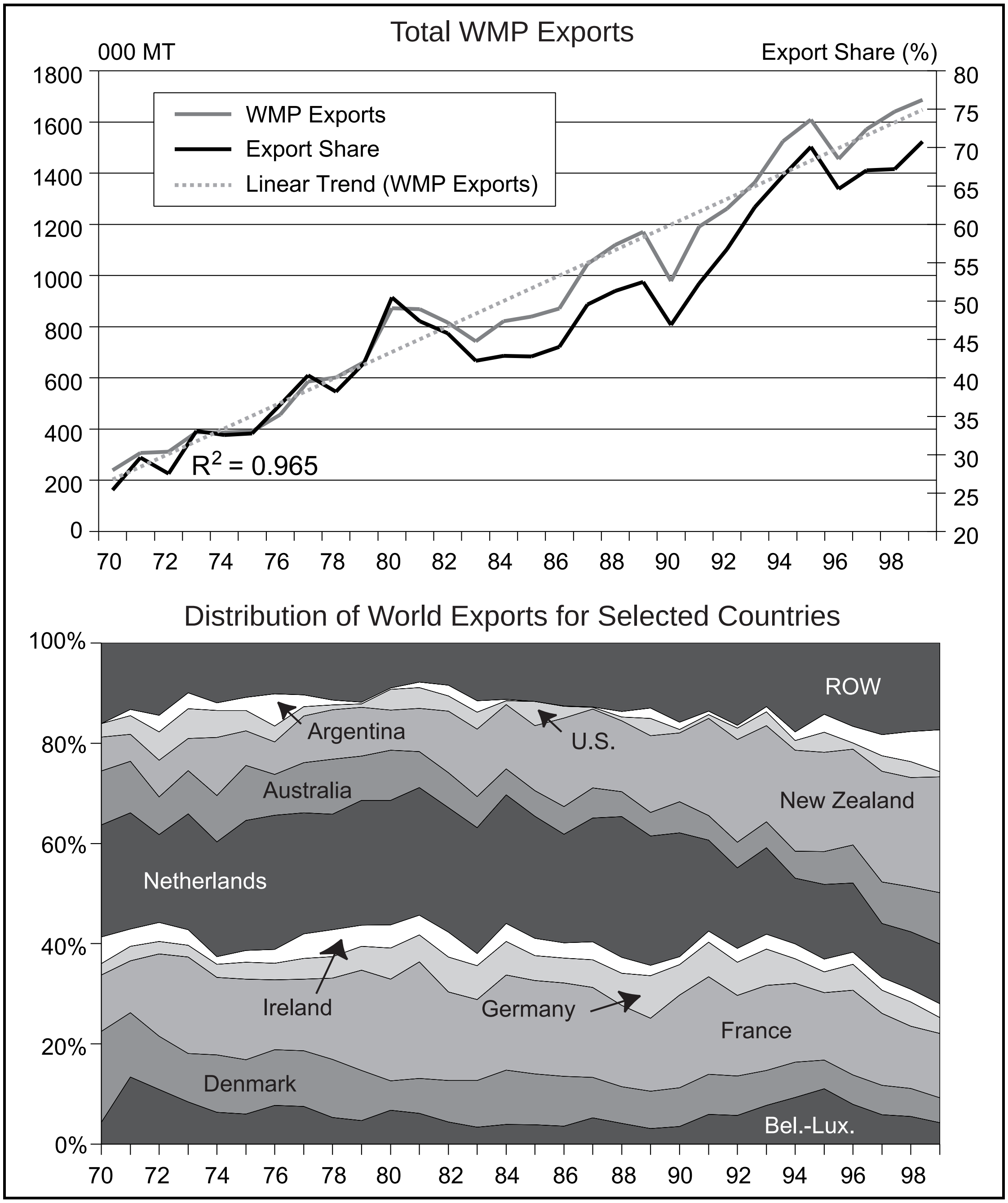
Country	Average Imports 1970-79		Average Imports 1980-89		Average Imports 1990-99		Average Imports 1999	
	MT	% of World	MT	% of World	MT	% of World	MT	% of World
World	1,353,512	100.0	2,005,504	100.0	1,754,122	100.0	1,874,295	100.0
Netherlands	92,639	14.2	33.862	16.6	240,362	13.7	230,438	12.3
Italy	201,145	14.9	208,524	10.4	143,255	8.2	121,779	6.5
Mexico	51,720	3.8	139,808	7.0	123,892	7.1	125,137	6.7
Japan	86,954	6.4	101,748	5.1	81,746	4.7	56,466	3.0
Philippines	51,649	3.8	57.329	2.9	83,960	4.8	86,729	4.6
Germany	36,753	2.7	99,854	5.0	42,719	2.4	40,512	2.2
Algeria	15,530	1.2	58,704	2.9	92,744	5.3	97,000	5.2
Belg-Lux.	30,002	2.2	45,297	2.3	52,905	3.0	45,150	2.4
Malaysia	23,713	1.8	25,113	1.3	68,972	3.9	71,879	3.8
Thailand	25,262	1.9	30,887	1.5	61,187	3.5	56,036	3.0
Cuba	48,029	3.6	36,908	1.8	29,980	1.7	18,000	1.0
Saudi Arabia	16,224	1.2	62,983	3.1	30,301	1.7	27,000	1.4
Indonesia	26,100	1.9	32,563	1.6	46,113	2.6	98,348	5.2
Brazil	17,517	1.3	43,871	2.2	39,403	2.2	46,122	2.5
France	16,272	1.2	32,126	1.6	50,789	2.9	63,791	3.4
Nigeria	24,973	1.9	29,236	1.5	38,229	2.2	54,551	2.9
China	7,654	0.6	40,580	2.0	38,171	2.2	51,150	2.7
Spain	28,926	2.1	18,230	0.9	26,432	1.5	30,087	1.6
Singapore	18,926	1.4	22,482	1.1	30,778	1.8	40,158	2.1
India	29,247	2.2	30,231	1.5	1,556	0.1	1,634	0.1
Iraq	10,936	0.8	42,893	2.1	6,005	0.3	1,900	0.1
Yemen	7,160	0.5	29,186	1.5	21,944	1.3	23,154	1.2
Peru	25,192	1.9	21,517	1.1	9,924	0.6	13,484	0.7
Egypt	9,283	0.7	25,254	1.3	18,186	1.0	25,787	1.4

imports over the 1970-1999 period for 24 major importing countries. The Netherlands typically accounts for more than 12% of world NFDM imports. Over the 1970-1979 period, the first ten countries shown in Table 4 accounted for an average 51% of total world imports. This decreased slightly over the period from 1990 to 1999, when these countries accounted for 48% of world NFDM imports.

Trends in WMP Trade

In contrast to the trends observed in NFDM exports, the level of world exports of Whole Milk Powder (WMP) have been consistently increasing over the 1970-1999 period (Figure 15). In 1970, fewer than 240,000 metric tons of WMP were exported. By 1980, world exports had increased by more than 300% to 872,000 metric tons. The strong positive growth in exports is shown by the linear trend regression displayed in Figure 15. This trend line accounts for more than

Figure 15. Overview of WMP Exports: 1970-1999



96% of the total variation in annual WMP exports over the 30-year study period. The increase in exports is occurring at a rate much faster than domestic utilization, as shown by the increase in the ratio of exports to domestic production. In 1970, a quarter of world WMP production was exported. Over the 1970-1974 period, the ratio of exports to production was 0.296. This ratio increased to a value of 0.679 over the 1995-1999 period. In 1999, the ratio of world WMP exports to production was 0.708.

The three most important exporters of WMP are New Zealand, The Netherlands, and France. In addition, Belgium, Denmark, Germany, and Australia have considerable WMP export share (Figure 15). Typically, the seven largest exporters have accounted for approximately 80% of world

Figure 16. Importance of EU versus Oceania for NFDM Exports

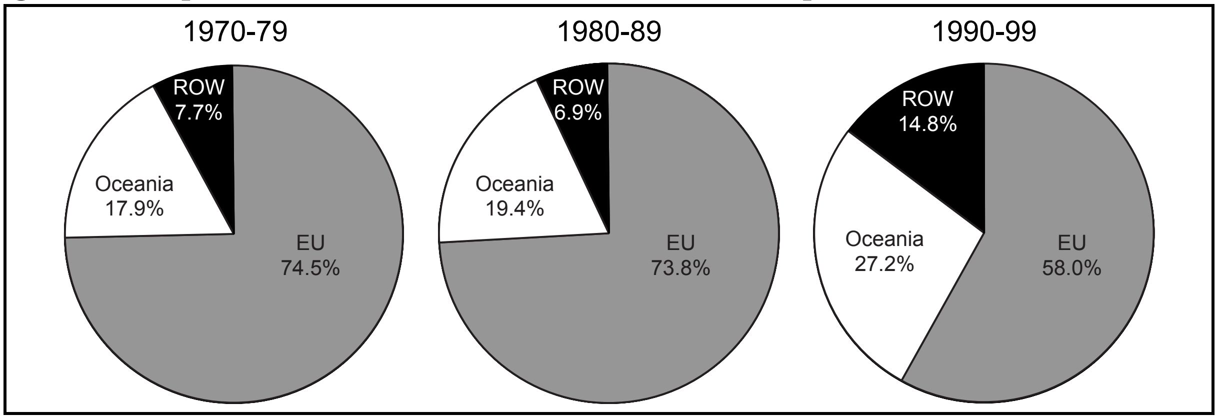


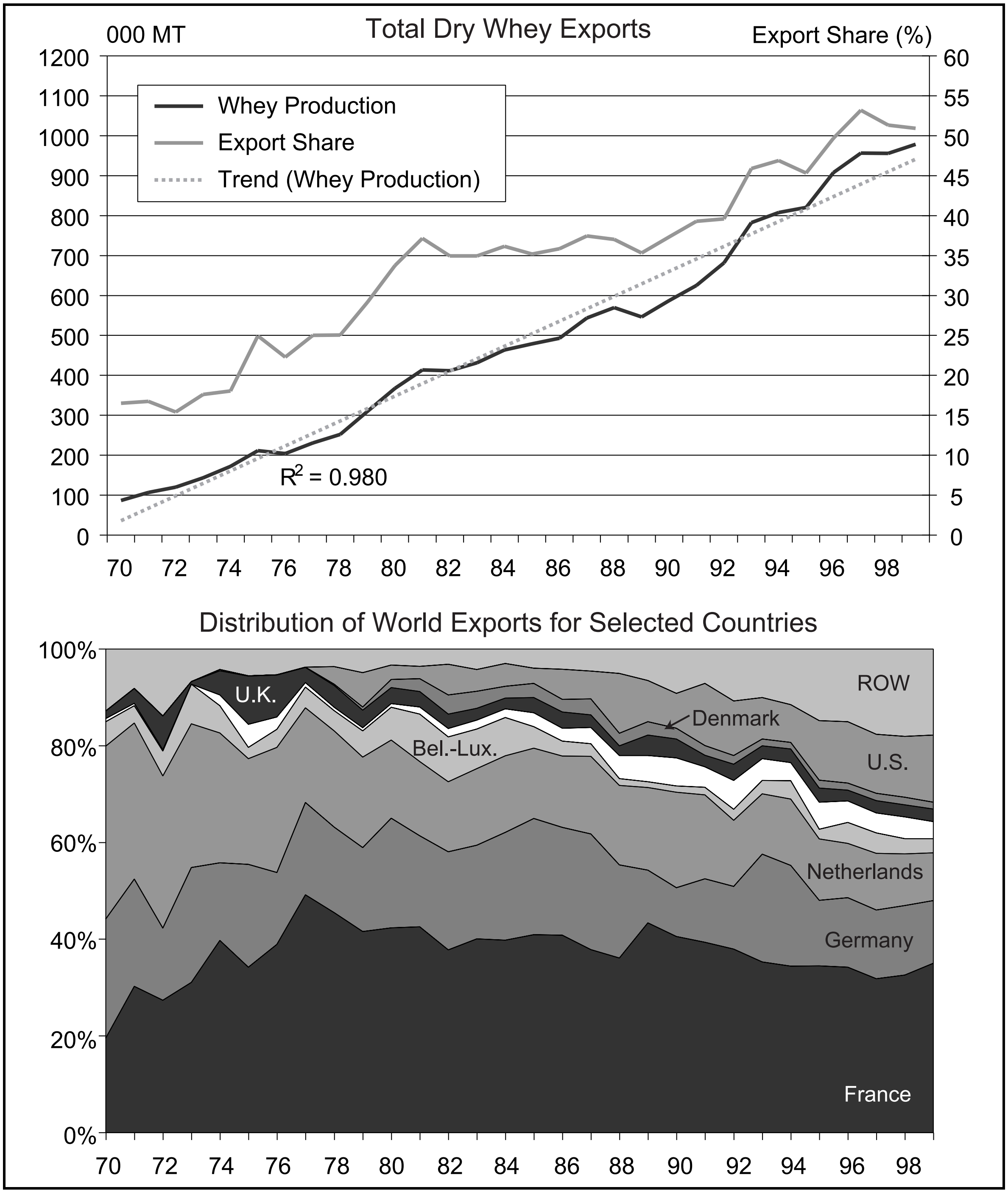
Table 5. Comparison of WMP Imports, Selected Countries, 1970-1999

Country	Average Imports 1970-79		Average Imports 1980-89		Average Imports 1990-99		Average Imports 1999	
	MT	% of World	MT	% of World	MT	% of World	MT	% of World
World	391,595		815,940		1,236,302		1,408,491	
Netherlands	20,394	5.2	70,497	8.6	81,130	6.6	101,713	7.2
Venezuela	38,051	9.7	75,374	9.2	56,967	4.6	52,042	3.7
Algeria	7,442	1.9	49,469	6.1	100,268	8.1	117,000	8.3
China	27,231	7.0	39,545	4.8	70,989	5.7	83,985	6.0
Malaysia	25,533	6.5	52,834	6.5	50,921	4.1	54,203	3.8
FSU	26,874	6.9	70,991	8.7	43,644	3.5	38,865	2.8
Brazil	5,183	1.3	14,319	1.8	89,175	7.2	145,983	10.4
Belg-Lux.	11,052	2.8	16,437	2.0	59,007	4.8	46,786	3.3
Mexico	3,029	0.8	26,085	3.2	49,210	4.0	35,225	2.5
Philippines	13,853	3.5	25,688	3.1	35,907	2.9	36,958	2.6
Germany	19,261	4.9	21,517	2.6	27,397	2.2	26,073	1.9
Sri Lanka	12,376	3.2	19,659	2.4	32,418	2.6	48,308	3.4
Spain	33,848	8.6	17,144	2.1	11,734	0.9	13,355	0.9
Thailand	7,262	1.9	16,820	2.1	37,673	3.0	49,791	3.5
Singapore	9,388	2.4	20,324	2.5	26,776	2.2	19,567	1.4
Hong Kong	1,720	0.4	10,560	1.3	41,149	3.3	46,708	3.3
Italy	7,649	2.0	15,673	1.9	24,691	2.0	18,227	1.3
UA Emirates	4,263	1.1	17,569	2.2	21,755	1.8	27,000	1.9
Saudi Arabia	548	0.1	10,062	1.2	29,005	2.3	33,814	2.4
Nigeria	0	0.0	1,529	0.2	35,741	2.9	59,127	4.2
Bangladesh	2,822	0.7	17,907	2.2	14,306	1.2	17,472	1.2
Peru	0	0.0	10,658	1.3	22,950	1.9	21,912	1.6
Chile	13,729	3.5	10,127	1.2	9,450	0.8	2,743	0.2
El Salvador	6,332	1.6	8,245	1.0	11,236	0.9	16,739	1.2
ROW	93,756	23.9	176,907	21.7	252,803	20.4	294,895	20.9

WMP exports. In Figure 16, changes in the relative export share of the EU versus Oceania regions is evident. On average, there was a 15.8 percentage point decrease in export share for the EU from 1980 to 1989 as compared to the 1990-1999 period, while the Oceania region experienced an average 7.8 percentage point increase in WMP export share.

Table 5 shows the relative importance of the top 24 WMP importing countries. The top nine major importing countries (The Netherlands, Venezuela, Algeria, China, Malaysia, Former Soviet Union [FSU] Brazil, Belgium-Luxembourg, and Mexico) account for about 50% of world imports. Again, two of the major importers—Belgium and The Netherlands—are also major exporters. Brazil has dramatically increased its imports of WMP. During the 1970-79 period, Brazil's imports accounted for less than 1.5% of world imports. From 1990 to 1999, Brazil's imports

Figure 17. Overview of Dry Whey Exports: 1970-1999



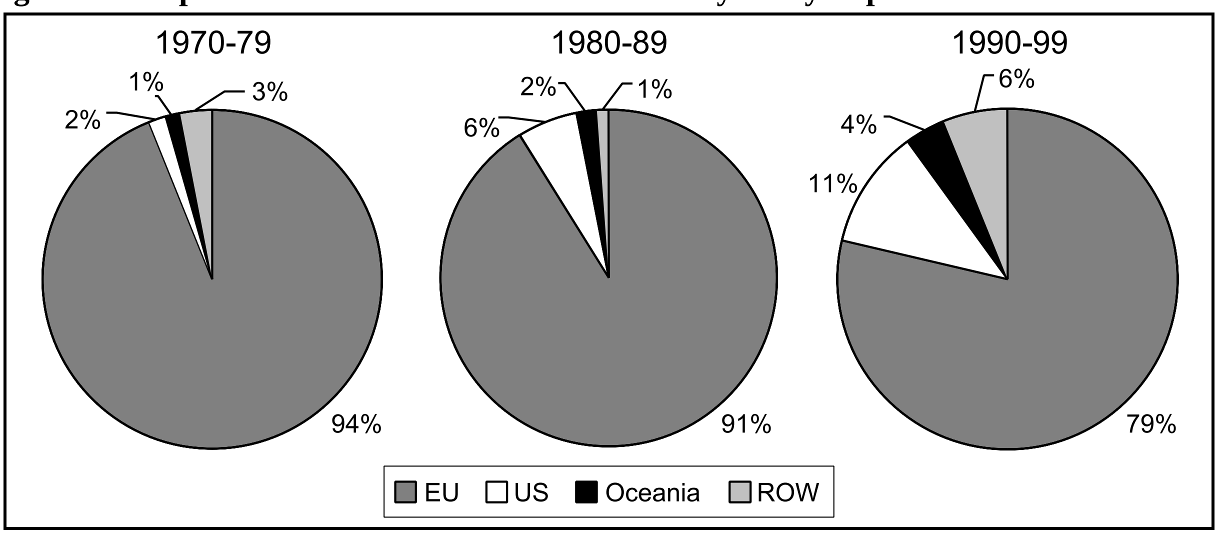
averaged 7.2% of world imports. In 1999, this figure was 10.4%, making Brazil the world's most significant WMP importer.

Trends in Dry Whey Trade

The tremendous growth in the WMP market is similar to the pattern observed in world trade of dry whey. In 1970, 87,000 metric tons of dry whey were exported. By 1999, world exports of dry whey reached a record 979,000 metric tons (Figure 17). Similar to the trend observed for WMP for a majority of years, each year's exports represented a new record high level of world dry whey exports. Only in 1976 and 1989 was there a decrease over the previous year's export level. The linear trend line shown in Figure 16 points to the strength of this growth in dry whey exports. Over 98% of the variation is explained by the simple linear trend. This is surprising given the more than ten-fold increase in export levels over this 30-year period. Again, similar to WMP, the increase in dry whey exports are occurring at a faster rate than production as shown by the increased ratio of dry whey exports to production. From 1970 to 1979, dry whey exports represented an average 21% of world production. During the 1980-1989 period, this value had increased to 36% and by the 1990-1999 period the level of dry whey exports represented 45.9% of annual production. In 1999, this value was greater than 50%.

The importance of the EU as a source of dry whey exports is the most pronounced of any of the commodities analyzed. In the bottom of Figure 17, we see that the eight exporting countries listed accounted from more than 90% of total world exports. France has a history of being a major world exporter. Over the 30-year history shown in Figure 17, France accounted for an average 36.4% of world dry whey exports with a range of 19.3% in 1970 to 48.9% in 1977. The U.S. experienced a significant increase in dry whey exports. Despite virtually no exports in 1970, the U.S. was the source for 13.2% of world exports by 1999. The dominance of the EU as a source of dry whey exports can be further appreciated in Figure 18.

Figure 18. Importance of EU as Source for World Dry Whey Exports



The most significant importer of dry whey products has historically been The Netherlands, accounting for more than a third of world imports (Table 6). In recent years, however, there has been a relatively dramatic shift in the distribution of world imports. Over the period from 1980 to 1989 an average of 66.8% of the world's dry whey imports were imported by The Netherlands, Germany and Italy. From 1990 to 1999, this value had decreased to 45.2%, and in 1999 only 37.7% of dry whey imports came from these countries. This implies growth in non-traditional import markets. China and Mexico have dramatically increased their dry whey imports. Prior to 1980 these two countries accounted for less than 1% of imports. In 1999, China's imports represented 8.4% of world imports and Mexico's imports accounted for 5.6%.

Table 6. Comparison of Dry Whey Imports, Selected Countries, 1970-1999

Country	Average Imports 1970-79		Average Imports 1980-89		Average Imports 1990-99		Average Imports 1999	
	MT	% of World	MT	% of World	MT	% of World	MT	% of World
World	163,977		456,093		763,361		993,784	
Netherlands	56,143	34.2	180,242	39.5	233,501	30.6	292,637	29.4
Germany	27,243	16.6	74,420	16.3	66,714	8.7	45,997	4.6
Italy	29,297	17.9	50,168	11.0	45,234	5.9	37,194	3.7
Belg-Lux.	12,964	7.9	36,645	8.0	52,500	6.9	54,842	5.5
Spain	5,298	3.2	11,211	2.5	38,315	5.0	42,266	4.3
China	1,231	0.8	10,537	2.3	41,793	5.5	83,269	8.4
France	6,809	4.2	12,384	2.7	34,243	4.5	49,264	5.0
Japan	9,936	6.1	13,802	3.0	28,036	3.7	41,157	4.1
UK	4,809	2.9	10,918	2.4	20,474	2.7	21,191	2.1
Mexico	125	0.1	1,785	0.4	31,206	4.1	55,947	5.6
Korea	684	0.4	9,559	2.1	20,814	2.7	30,619	3.1
Philippines	1,364	0.8	4,785	1.0	15,685	2.1	24,312	2.4
Denmark	2,648	1.6	6,529	1.4	7,907	1.0	4,836	0.5
Ireland	2,624	1.6	5,959	1.3	7,365	1.0	8,423	0.8
Canada	0	0.0	501	0.1	15,270	2.0	32,621	3.3
Thailand	0	0.0	847	0.2	13,916	1.8	22,765	2.3
Hong Kong	13	0.0	1,477	0.3	11,732	1.5	6,363	0.6
ROW	2,788	1.7	24,323	14.8	78,657	10.3	140,081	14.1

U.S. Imports of MPC and Casein

As noted above, very little milk protein concentrate (MPC) and casein are produced in the U.S. Figure 19 shows the monthly imports of MPC (HTS Codes 0404.90.10 and 3501.10.10) and casein (HTS codes 3501.10.50 and 3501.90.60) over the January 1989 to September 2001 period.[22] The upper portion of this figure shows the trend in terms of MPC. Besides monthly imports, average monthly total MPC and casein imports for each year are displayed.

Prior to 1996, the average monthly imports changed very little and increased from less than 500 MT in 1989 to about a 1,000 MT monthly average in 1995. After 1995 there was a tremendous increase in MPC-04 purchases. In 1996, average monthly total MPC imports increased to more than 5000 MT. Since then monthly averages ranged from less than 3000 MT in 2001 to slightly less than 5500 MT in 2000. For most years, monthly MPC-35 imports were significantly less than 1000 MT. As noted by Bailey (2001), the level of MPC imports in 2000 were between 1.6-1.9% of U.S milk production. On a casein basis, imports were equivalent to 3.8-4.4% of the casein contained in U.S. cheese production and equivalent to 17.9-21.2% percent of the casein contained in U.S. NFDM production.[23]

The bottom portion of Figure 19 shows the level of casein and caseinate imports. From month to month, there is significant variability (e.g., coefficient of variation = 0.24). The average monthly total casein imports are close to 6000 MT higher than those in the 1989-2001 period. There is a slight decrease in the role of casein versus caseinates over this period. For example in 1989, the average share of total casein plus caseinate imports that were classified as being casein (e.g. HTS code 3501.10.50) was 79.6%. There was a steady decrease from 1989 to 2001, so that in the year 2000 68.1% of total casein imports originated from HTS code 3501.10.50.

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[22] Import data obtained from USDA, FAS, http://www.fas.usda.gov/ustrade.

[23] K.W. Bailey, *Imports of Milk Protein Concentrates: Assessing the Consequences*, Penn. State University, Department of Agricultural Economics and Rural Sociology, Staff Paper #343, Nov. 2001.

Figure 19. Trends in U.S. MPC and Casein Imports

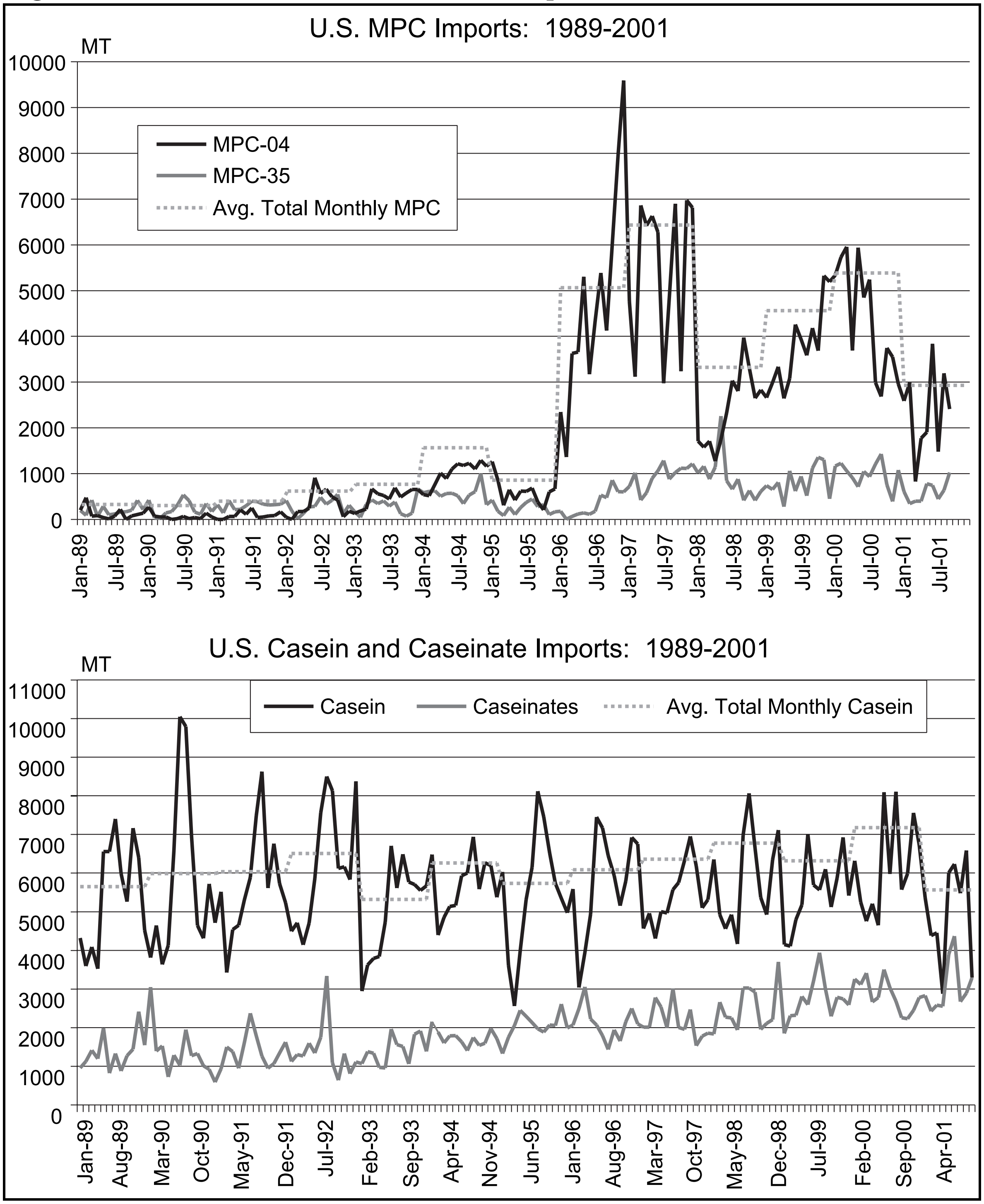

Table 7 shows the annual distribution of the above MPC-04 and Casein-35 imports by country of origin from1995 to 2001. The importance of Oceania as a source of MPC-04 imports ranged from a low of 37.2% of total U.S. imports in 1997 to 71% of imports over the period from January to September 2001. New Zealand is the major source of these exports. The EU countries shown in this table account for 43.3% of total U.S. imports in 1999 and less than 10% during the first nine months of 2001. Ireland and Germany have typically been the major EU countries exporting WPC-04 to the U.S. The sources of U.S. casein imports are shown in the bottom portion of Table 7. Once again, the EU is a significant source of casein imports with a range of 29.8% of U.S imports in 1995 to 45.8% in 2001. Ireland is also a major source, accounting for more than 40% of imports in 1995 and close to 30% over during the period from 1996 to 2000.

Table 7. Distribution of U.S. Imports of MPC-04 and Casein-35, Selected Countries

Country	Year						
	1995	1996	1997	1998	1999	2000	2001
MPC-04 (%)							
New Zealand	41.2	30.7	43.2	33.0	31.5	36.7	69.4
Australia	2.1	6.5	6.2	6.6	10.7	13.2	11.6
Ireland	7.2	19.3	21.5	21.4	21.1	13.1	6.4
Germany	19.3	11.6	6.5	4.3	11.3	13.3	2.3
Netherlands	0.3	0.0	0.2	2.7	9.9	9.8	0.0
Canada	4.7	8.2	5.5	5.7	7.3	4.2	0.0
Hungary	2.1	0.9	1.0	1.2	0.9	2.4	6.1
Switzerland	0.0	0.0	0.0	0.0	0.1	2.3	0.0
France	0.1	0.3	1.7	0.0	0.7	1.8	0.3
Denmark	0.8	0.0	0.0	0.3	0.2	1.8	0.6
Poland	3.3	10.8	6.3	15.2	3.3	0.1	1.6
ROW	19.0	11.6	7.7	9.7	3.0	1.2	1.6
Casein-35 (%)							
New Zealand	26.0	26.8	34.4	39.5	32.9	32.2	38.8
Australia	3.8	3.6	5.5	5.3	8.6	7.1	7.0
France	10.4	13.9	11.7	9.5	10.3	11.1	14.9
Ireland	41.3	34.8	30.9	27.2	28.5	28.0	22.6
FSU	8.0	9.8	11.3	9.6	8.8	10.0	4.9
Germany	0.6	1.3	1.5	2.7	3.3	1.0	1.4
India	0.0	2.0	2.0	4.6	6.3	7.2	6.5
ROW	9.9	7.6	2.7	1.7	1.2	3.5	3.9

IV. Summary

The dramatic increase in international NFDM prices during the period from 2000 to 2001, combined with recent dairy industry concerns with respect to the importation of milk protein concentrates, has stimulated renewed interest in the world market for dry milk products. This discussion paper provides background information as to recent trends in the international market for such products.

There is no doubt that the international market for dry milk products is extremely competitive, with Oceania and the EU dominating most markets. In terms of products produced and the location of such production, the character of these markets is changing, however. For example, world production of NFDM has been steadily declining since the early 1990's (Figure 7). The share of this production that enters the world market varies but in general is declining (Figure 13). World whole milk powder (WMP) production is quickly approaching NFDM production levels. The same can be said for exports—by 1999, world NFDM and WMP exports were virtually the same.

The production and trade of "nontraditional" dry products reflects the trend of the customization of dry milk products for specific end uses. That is, with recent developments in membrane and ultrafiltration technologies, dry milk products are being produced for specific end uses. One dairy-based product for which there has been a tremendous increase in utilization as a food ingredient is dry whey. World dry whey production has steadily increased over the last 30 years, with a ten-fold total increase (Figure 17). This increased production is clearly targeted to export markets, as evidenced by more than 50% of world production entering the world market. More than 90% of world dry whey exports originate from the European Union.

The observed growth in casein production follows that of dry whey, although not as dramatically. Over the period from 1970 to 2000, casein production in the EU and Oceania has more than doubled, with a shift in production away from the EU in recent years (Figure 11).

This discussion paper provides a descriptive analysis of recent trends in the production, pricing, and trade of a number of dry dairy-based ingredients. These trends are obviously the result of a combination of production environments, domestic dairy policies, export policies and international economic conditions. We have not provided an analysis of the role of each of these factors in determining these trends. While such an analysis is the subject of another discussion paper, we can provide a few implications of major results of the present study for the U.S. dairy industry:

- World prices of NFDM have risen, at times, to near U.S. prices for the product. If such price parity should persist, the U.S. could become a major commercial exporter of the product. But, to date, such episodes of price parity have not persisted for extended periods.
- The decline in world exports of NFDM means that the market for this product has become thinner. This suggests that world NFDM prices will be more volatile than in the past.
- The U.S. dairy industry's aggregate product mix decisions have produced mixed results. U.S. production and exports of large quantities of NFDM and relatively small quantities of whole milk powder suggest that the product mix decisions of the U.S. dairy industry are partially out of sync with world demand. However, the large and growing U.S. production and export of dried whey and related products represent a more positive development. Dried whey products—which are a by-product of the burgeoning U.S. cheese business—promise to be strongly in demand in world markets for the foreseeable future.
- U.S. imports of products such as casein and milk protein concentrates—which are subject to zero or low tariffs—are in demand in the U.S. for customization into specific end uses. These imports will continue to be a concern to parts of the U.S. dairy industry unless competing products are developed through import substitution or other efforts.

In addition, we have not attempted to develop a predictive model as to observed prices, production, exports, etc. Again this is a subject of later research. For example, it may be useful to develop a time series (in contrast to econometric) model of biweekly FOB EU/Oceania NFDM prices to enable potential exporters set some limits as to expected future prices over the next two to three months. The material presented in this paper forms the foundation of this future analysis.

Appendix A: Methods Used to Produce Various Dried Milk Products