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WORLD MALT AND MALTING BARLEY: COMPETITION, MARKETING, AND TRADE

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Abstract

Recent trends in production marketing, trade, and policies affecting world malting barley and malt sector are examined. A spatial equilibrium model of production and trade is used to assess the effects of alternative levels of supply, demand, and policy variables on composition and direction of malting barley and malt trade flows.

Key words: malting barley, malt, beer, trade, spatial equilibrium

Preface

This project was supported under USDA/CSRS Agreement No. 91-34192-6204 titled "Economic Growth via Export of Northern Plains Agricultural Products," Agricultural Experiment Station, North Dakota State University, Fargo. Constructive comments were received from Dr. Won W. Koo, Dr. George Flaskerud, and Dr. Paul Schwarz. However, errors and omissions remain the responsibility of the authors.

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Abstract

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Key words: malting barley, malt, beer, trade, spatial equilibrium

Highlights

Several important changes are affecting trade and competition in malt and malting barley. Agricultural policy reforms in several major producing countries have led to a decline in the production of malting barley. Trade polices are also undergoing change. Of particular interest are prospective reductions in European Union (EU) and U.S. export subsidies, and changes in tariffs on malt and malting barley in major import markets. Traditional markets for malting barley and malt, North America and Europe, have experienced negligible growth in recent years. In contrast, demand is growing rapidly in other world regions, notably China. Shifts in world demand, in combination with policy factors, are likely to induce changes in trade patterns and the relative competitiveness among exporting regions.

The purpose of this report was to analyze effects of these changes on the malting barley and malt sector. To do so, a linear programming model was constructed of the world malt and malting barley sector. All major producing countries and regions were included, as well as all importing countries and North American domestic demand regions. Shipping activities allowed for trade in either malt (in bulk or container) or malting barley. Using a base case scenario, simulations were conducted to evaluate the effects of alternative assumptions about regional supplies, trade policies, and other model parameters.

Optimal flows of malt and malting barley (from producing regions to demand regions and import markets) were identified in model simulations. Two-rowed (2R) malting barley dominated world trade in barley. In addition, there was a much greater and more dispersed trade in malt than in malting barley. All shipments from the EU and the U.S. were subsidized. Exports of malting barley from the United States were very sensitive to the existence of subsidies. Targeted markets were identified for U.S. exports. For U.S. six-rowed (6R) malting barley, these include northern and eastern South America and East Africa. Markets for U.S. malt exports include Central and South America, the Philippines, and West Africa.

The model was used to evaluate the effect of changes in malting barley supplies in the EU, changes in EU and U.S. export subsidies, and changes in import tariffs. In addition, the model was used to simulate the effects of projected growth in world beer production to the year 2000. Given the existing composition of supplies, results suggest that only 48 percent of the projected increase in malt demand could be satisfied. This suggests that the availability of malting barley might soon become a major problem confronting the brewing industry.

World Malt and Malting Barley: Competition, Marketing, and Trade[1]

Vidyashankara Satyanarayana, William W. Wilson, D. Demcey Johnson, and Frank J. Dooley*

1. INTRODUCTION

Policies and developments in the European Union (EU) have dominated world trade in malt and malting barley for at least two decades. The EU was both the largest producer of barley and the largest exporter of malt. The former was due in part to relatively favorable intervention prices and agronomic practices, and the latter was due in part to its pricing and subsidy regime. Other major producers of malting barley include Canada, Australia, the United States, and, more recently, South America.

Malting barley is exported predominately in the processed form as malt. The world malt trade annual growth rate has been about 3 percent, with recent growth concentrated in Asian and South American regions. Major malt exporting countries in the EU include France, Belgium, the United Kingdom, and Germany. Other exporters include Australia, Czechoslovakia, and Canada. The U.S. and Argentina are relatively small exporters, though exports from these countries have increased rapidly in the past few years. Malting barley trade is dominated by Australia, despite its being a relatively small producer. Exports from Canada increased sharply in recent years with increased sales to the U.S., China, and Colombia. Malting barley exports from the U.S. have been negligible.

Several important changes are affecting this industry. Reductions in malting barley supply have occurred in several major producing countries, due in part to major policy changes. Most notable are reductions in planted area and production in the EU. Production of malting barley (or barley) in those countries declined by 25 percent over the past 10 years--a trend that should continue because of Common Agricultural Policy (CAP) reform. U.S. production has also declined, as barley acreage has shifted to other crops or been retired under the Conservation Reserve Program (CRP). Over 20 percent of U.S. barley acres were taken out of production under CRP (Johnson and Wilson, 1994). Recent changes in transport policies in Canada, along with the increased profitability of canola, could reduce production of barley (or at least limit potential increases). Preliminary analysis from the Producer Payment Panel indicated that Canadian barley production would be reduced by 19.2 percent because of these policy changes. Taken together, the effects of policy changes in major producing countries are substantial. From a situation of relative surplus, malting barley is now moving into relative shortage, particularly in view of the steady growth in world demand.

Major changes are also occurring in trade policies. The EU has traditionally used subsidies to dispose of surplus barley. Export restitutions (subsidies) on malt have contributed to EU dominance in the world malt trade. In response, the U.S. initiated the Export Enhancement Program (EEP) in 1985. Extensive use has been made of this program, particularly on malt, though recent initiatives have targeted malting barley. Both the EU and the U.S. are under pressure to reduce their use of explicit export subsidies, although it remains to be seen how that will be executed in the malt and malting barley sector. Other policies relevant to this sector are import tariffs. Some importing countries have configured their

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[1]This report is part of a larger research project on the world malt trade supported under USDA/CSRS Agreement No. 91-34192-6204. Other related publications are cited in the text and listed in the references. These, and several other forthcoming papers, are available from the authors.

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tariffs to favor local processing, despite the logistical efficiencies associated with shipping malt instead of malting barley. Under the General Agreement on Tariffs and Trade (GATT), importing countries are expected to reduce their import tariffs.

North America and Europe remain the world's largest markets for malt. However, these traditional markets have experienced negligible demand growth in recent years. In contrast, rapid growth is occurring in other world regions, notably China. Other countries experiencing rapid growth in beer production (and hence malt utilization) are Brazil, Korea, Japan, and Mexico. Whether their imports take the form of malt or malting barley depends on numerous factors, including relative shipping costs and tariff differentials.

Two characteristics of trade in this industry are crucial to inter-country competition. First, there are important quality differentials both in the supply and demand for malting barley and malt. The supply side is affected by the distribution of varieties planted and the proportion of the crop that is of malting quality. Both vary substantially across major malting barley production regions. Brewers also have rigid preferences for quality characteristics. These are affected by the types of beer produced, technology used, and tradition. In practice, many brewers have adopted processes and products that favor the use of malt produced with two-rowed (2R) varieties. Two-rowed varieties dominate production of malting barley in most countries of the world, except the U.S., where six-rowed (6R) varieties are more common.

Second, logistics play an important role. In contrast to many other value-added grain products, it generally costs less to ship malt rather than malting barley. Consequently, it is generally advantageous to locate processing (malting plants) near barley production, and in those countries that produce malting barley. Thus, the predominant form of trade is as malt rather than malting barley. A related issue concerns the type of shipment, bulk versus containers. Much of the world trade in malt is in containers. Only a small portion of world malt trade occurs in bulk, a type of shipment where the U.S. enjoys a comparative advantage.

Previous Studies

There have been several important studies on malting barley and malt. Johnson and Wilson (1995b) analyzed the effects of agricultural and trade policy changes within the North American barley sector. Important trade policies analyzed were the effect of changes in the EEP, CRP, transport subsidies, and the single desk status of the Canadian Wheat Board (CWB). Results illustrated how North American trade flows (both feed and malting barley) were affected by these policies. Johnson and Wilson (1995a) demonstrated the effect of transport policy changes, particularly the WGTA, on North American barley trade and competition. Wilson and Johnson (1995) analyzed the effects of marketing regulations on North American malting barley and malt trade. Important issues included the effects of different selection rates, yield differentials between malting and feed barley, and restrictions in Canada in licensing of six-rowed white (6RW) varieties.[2]

A principal issue confronting the Canadian barley marketing system has been whether to remove

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[2]Six-rowed malting varieties are divided into white aleurone and blue aleurone varieties. White varieties are dominant in the U.S. (and favored by U.S. brewers), while blue varieties are more common in Canada. For further background, see Johnson and Wilson (1994), pp. 21-23, 38-39, 44.

the monopoly status of the CWB, at least for North American trade. The issues and policy recommendations are reported in Carter (1993a). Other studies contributed to this debate, including (CWB 1992), and are summarized in the *Canadian Journal of Agricultural Economics* (Brooks; Carter [1993b]; Gray, Ulrich and Schmitz; Veeman). Major policy reforms, allowing Canadian producers unrestricted access to the U.S. market, were adopted in 1993 but quickly rescinded.

There have also been several studies on the world market for beer, malt, and malting barley. Riley and the *Cargill Bulletin* each described the historical evolution in world malt trade, and Pollock and Pool analyzed trends in beer production and malt trade. Satyanarayana, Wilson, and Johnson analyzed malt import demands for Brazil, Japan, the Philippines, and Venezuela using time series data in an Almost Ideal Demand Systems framework. Results of interest were that 1) import demand for EU malt is less responsive to changes in prices, 2) EU malt is less substitutable with malt originating from other sources, and 3) the elasticities indicate that importers spend more of additional income on EU malt than on malt from other sources.

Moor analyzed the future market demand for Australian malting barley and malt to 2000 in the eastern Asian market. Projections were based on changes in the size of the beer market and beer consumption per capita. Results indicated China would have the largest increase in malting barley requirements and that major increases would have to occur in Australian production to fulfill that demand.

A study commissioned by the Grains Council of Australia made strategic recommendations for the malting barley sector. Findings of interest include 1) Australia lags its competitors in breeding programs, 2) there are significant price premiums for malt suppliers who can conform to the increasingly specific demands of brewers, and 3) Australia's growth has been heavily dependent on China for exports of malting barley.

Wesolowski analyzed growth markets for beer and malt demand and made projections to 2000. The fast-growing markets as indicated by beer production were Brazil, China, Japan, and Mexico with annual growth of more than 2,000 barrels. For comparison, negative annual growth rates of similar magnitude were estimated for the U.S. and the Former Soviet Union (FSU). Countries were categorized according to four phases of the product life cycle: growth, sustained maturity, decaying maturity, and decline. Far more countries were in the growth category than in the other three combined. Similar analyses were conducted on malt imports. The fastest growing markets for malt imports were Brazil, Korea, Japan, and Mexico, each with annual growth exceeding 20,000 metric tons (mt).

Purpose and Method

The purpose of this study was to analyze effects of these changes on the spatial distribution of malt and malting barley in the world market. Specific objectives were 1) to identify markets in which the U.S. has the greatest competitive advantage, and 2) to analyze impacts of changes in barley production in selected exporting countries, changes in trade policies, and changes in worldwide beer production.

A linear programming model was developed for this analysis. The model is an extension of a previous model developed by Johnson and Wilson (1994), which focused on the North American barley sector. The model developed here is of the world market, including all the major producing regions and import markets.

Organization

In section II, the background on some major issues affecting this industry is presented. Developments in each of the major producing countries and effects of some important agricultural and trade policies are reviewed. Import policies are described with respect to tariff treatment of malt and malting barley. In addition, some of the logistical issues confronting the industry are outlined. The analytical model is described and documented in section III. In addition, background data used to establish the base parameters are shown. The results are presented in Section IV. The report closes with a summary and discussion of policy issues.

II. WORLD MARKETING AND TRADE IN MALT AND MALTING BARLEY

Barley Supply and Demand in Major Producing Countries

Barley is a major grain in the world, ranking fourth after wheat, maize, and rice. It is grown mainly in areas where other grains are not suitable. Barley is cultivated on more than 70 million hectares of land worldwide. Average annual production between 1990 and 1994 was 169 million mt (U.S. Department of Agriculture, *PS&D View*). Barley is used as either a feed grain or to manufacture malt, which is primarily used in beer production. Feed comprises about 70 percent of barley use. Trade accounts for between 10 and 25 percent of total production.

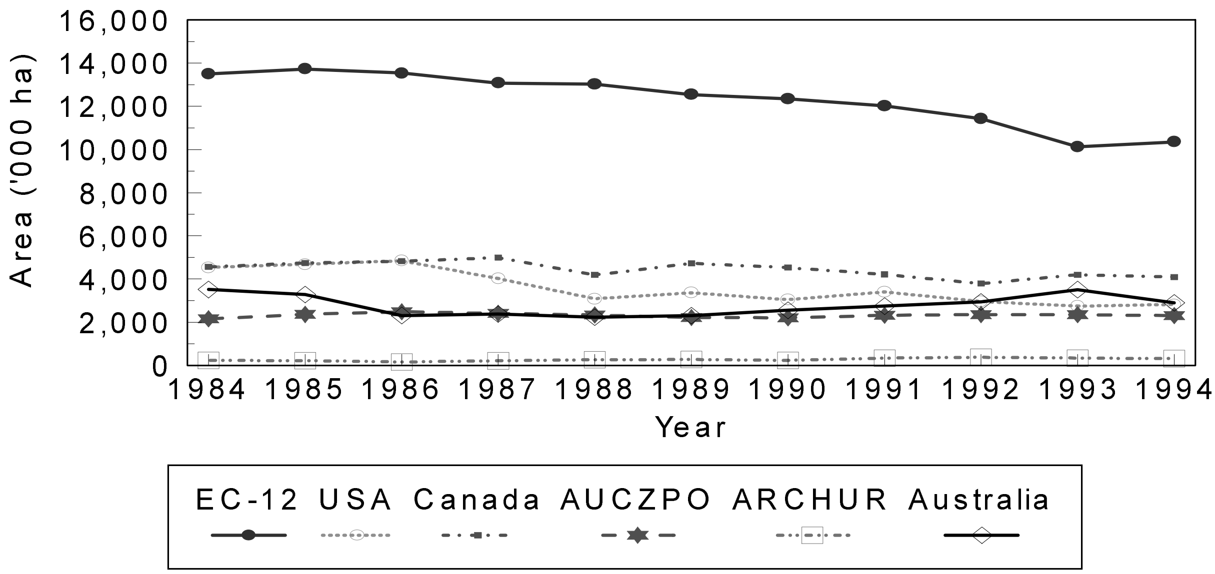
Table 2.1 shows data on barley supply and utilization for 1981-85 and 1990-94. An obvious change is the decrease in area planted to barley of 7 percent from 1981/85 levels, due primarily to decreasing area planted in Europe and North America. However, the decline in area is compensated by increased yields of 12.5 percent. Production, trade, and consumption have each risen between the two periods.

TABLE 2.1. TRENDS IN WORLD BARLEY SUPPLY: 1981/85 AND 1990/94 AVERAGES

Variables	81-85	90-94	% Change
Area (mil ha)	80	73	-7.2
Yield (tons/ha)	2	2.3	12.5
Production (mmt)	162	170	4.4
Imports (mmt)	21	21	3.9
Exports (mmt)	21	22	8.4
Consumption (mmt)	160	168	4.9
Ending Stocks (mmt)	22	34	58.6
Feed (mmt)	119	120	00.7

Source: PS & D View, USDA

The EU has the largest area and produces the greatest volume of barley in the world. Area planted to barley in the EU peaked during the early 1980s (Figure 2.1). Since then, barley area in the EU has decreased due to reduced intervention prices. Similar declines are apparent in the U.S. and Canada. Canada, Australia, and the U.S. also have considerable area planted to barley. Area planted to barley in Australia declined initially, but has increased since 1989. Non-EU Europe's barley area is relatively stable at 2 million hectares while South America has the least area planted to barley of all exporters.



AUCZPO- Austria, Czechoslovakia, Poland

ARCHUR- Argentina, Chile, Uruguay

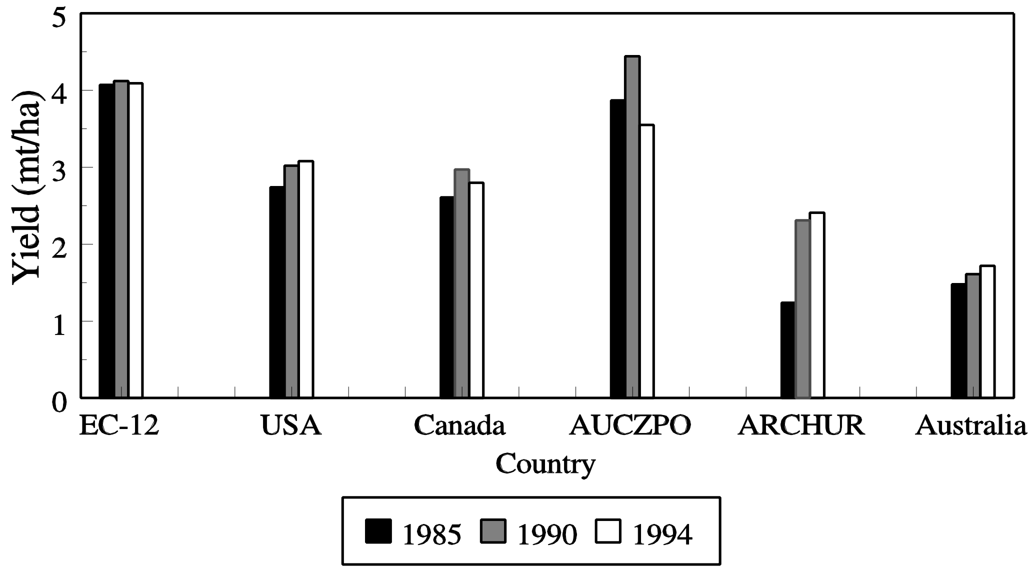
Figure 2.1. Area Planted to Barley in Major Exporting Countries: 1984-1994

Figure 2.2 illustrates barley yield in major exporting countries for 1985, 1990, and 1995. Yields in the EU have been constant at 4 mt per hectare, but have increased in the U.S., Canada, South America, and Australia. Higher yields in the EU are ascribed to rainfall, longer growing seasons, deeper and rich soils, and well-established breeding programs (Kendall, 1993). Yields are lowest in Australia. The increase in yield was greatest in South America, almost doubling between 1985 and 1994. Yields in Non-EU Europe decreased between 1990 and 1994.

Trends in barley production are shown in Figure 2.3 for major exporting regions. Declines in EU production since the mid-1980s are especially notable. Of all exporting regions, production is lowest in South America.

Malting Barley Supply in Major Producing Countries

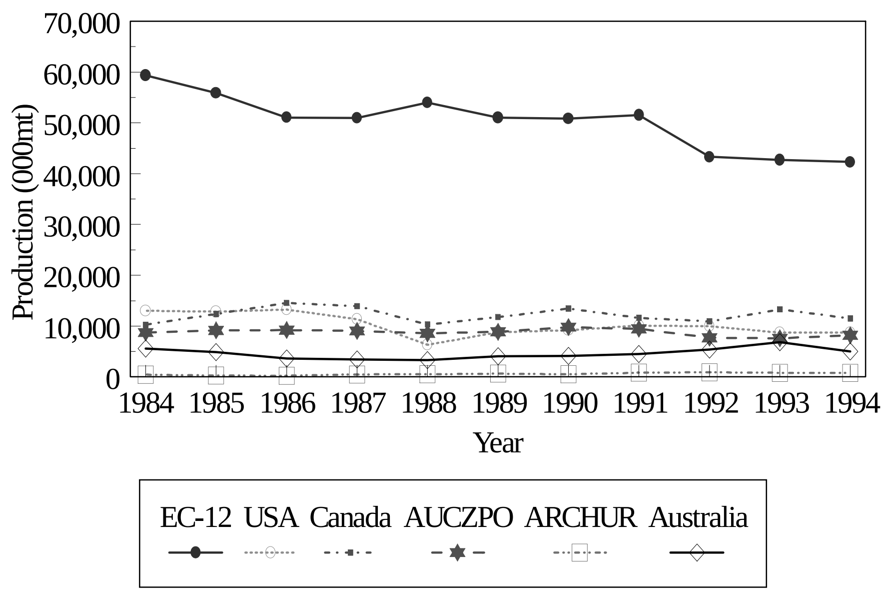
Some regions produce feed barley exclusively, while others produce both feed and malting varieties. However, the distinction between feed and malting barley concerns not just varieties planted, but crop quality. To be used for malting, barley must meet certain quality standards. Barley raised as malting varieties, that fail to meet these standards must be sold as feed. Thus, to estimate regional



AUCZPO- Austria, Czechoslovakia, Poland

ARCHUR- Argentina, Chile, Uruguay

malting barley, but in no other region are there shifts in the composition of trade (Table A2.6). Eastern Figure 2.2. Barley Yield in Major Exporting Countries: 1985, 1990, 1994



AUCZPO- Austria, Czechoslovakia, Poland

ARCHUR- Argentina, Chile, Uruguay

Figure 2.3. Barley Production in Major Exporting Countries: 1984-1994

supplies of malting-quality barley, it is necessary to have information on the area planted to malting varieties and on the percentage judged to be of malting quality (called the "selection rate" in Canada). Since such information is not available for all world regions, precise estimates of malting barley supplies are difficult to develop. This section summarizes available data for the EU, Australia, and North America.

To illustrate the components of supply, let M_{ih} denote the supply in region i of malting type h (6R white, 6R blue, or 2R); A_i is the total planted acreage in region I; V_{ih} is the fraction of acres planted to malting type h; G_i is the fraction of production grading as malting; and Y_i is the average (planted) yield. Regional supplies of malting quality barley are given by:

$$M_{ih} = A_i \cdot V_{ih} \cdot G_i \cdot Y_i$$

The value of A_i is determined by market conditions, subject to farm program provisions such as the Acres Reserve Program (ARP) and Conservation Reserve Program (CRP) in the case of the U.S. Other supply components are affected by regulations and marketing practices, which differ by country. Feed barley supply is calculated as the residual of total barley production in a region, less malting barley. Each of these elements is discussed for major producing regions.

European Union (EU)

Winter and spring barley are grown in Europe. Winter barley forms a small portion of total annual production (around 1.5 million tons). All 6R barley grown in France is grown during the winter season. The U.K. is also a major producer (Figure 2.4). Winter barley production in Germany and Denmark is very limited.

Spring is the major barley growing season in Europe. Details regarding EU production are presented in Table 2.2 and Figures 2.5 to 2.8. Total production of malting barley in the EU in 1994 was nearly 16 million tons. In 1994, barley was sown on 4.6 million hectares of land with Spain alone accounting for more than 2 million hectares. Other EU countries that account for considerable area planted to barley are Germany, Denmark, France, and the U.K. France and the Netherlands have the highest yields while Spain has the lowest yield (Table 2.2). Spain ranks first in terms of production followed by Germany, France, and Denmark.

A crucial variable that determines availability of malting quality barley is the selection rate (Figure 2.7). The Netherlands has the highest selection rate with 79 percent of malting barley production selected for malting, while Spain, with 9.5 percent selection, has the lowest. Germany, France, and the U.K. all have selection rates around 50 percent and account for most of the malting barley that qualifies for malting. Germany, France, and the U.K. account for 75 percent of the total availability (Figure 2.8). Domestic production fell short of requirements in Germany, Benelux, Netherlands, and Spain. France, Denmark, the U.K., and Ireland were surplus producers of malting barley in 1994 (Table 2.2).

Australia

Barley is the second largest field crop after wheat in Australia, with area planted at 2.5 million hectares and production of 4.3 million tons (Table 2.3). Twenty-five to 30 percent of the production is used within Australia. Of this, 70 percent is for feed and the remaining is divided between human

TABLE 2.2. ELEMENTS OF EU MALTING BARLEY SUPPLY (1994)

Countries	Area (000 ha)	Yield (mt/ha)	Production (000 mt)	% Malting Barley (11.5% protein max)	Malting Barley Availability (000 mt)	Demand (000 mt)	Net Surplus(+) or Deficit (-) (000 mt)
Germany	780	4.29	3,346	48	1,606	2,170	-564
France	479	5.21	2,496	55	1,375	810	565
Belgium & Luxembourg	9	4.60	41	20	8	541	-533
Netherlands	40	5.20	208	79	165	215	-50
Denmark	502	4.80	2,410	35	840	178	663
United Kingdom	463	4.58	2,121	50	1,050	1,013	37
Ireland	135	4.75	641	30	192	181	11
Spain	2,240	2.00	4,480	10	426	430	-4
Total	4,648	3.39	15,743	36	5,662	5,538	124

SOURCE: H.W. Gauger, August, 1994.

consumption and carryover stocks. The remaining barley is exported either as feed (70 percent) or as malt (Table 2.3). All five states produce 2R malting barley. Six-rowed barley production is limited to Victoria, South Australia, and Western Australia and is used mainly as feed. Both area and production have increased over time. Malt exports have declined while feed exports have more than doubled since 1989 (Tables 2.3 and 2.4). Barley used for domestic malting and malting barley exports have increased over time (Table 2.4).

Data on selection rates were available only for Victoria and South Australia. Selection rates in Victoria averaged around 90 percent, while those in South Australia were below 20 percent.

Barley producers in Australia have limited varietal options (Grains Council of Australia, 1995). The most common Australian varieties were released in early 1980s, making them old by world standards. One reason for the relatively poor performance of the breeding program in Australia, compared to either the U.S. or Canada, is the small size of the Australian barley industry (Grains Council of Australia, 1995). This relatively small size prevents the kind of coordination among breeders that is common in North America.

Canada

Johnson and Wilson (1994) described the North American barley sector, covering patterns of production, availability, trade, and the factors that have influenced these variables. The following summary pertains to issues addressed in that study.

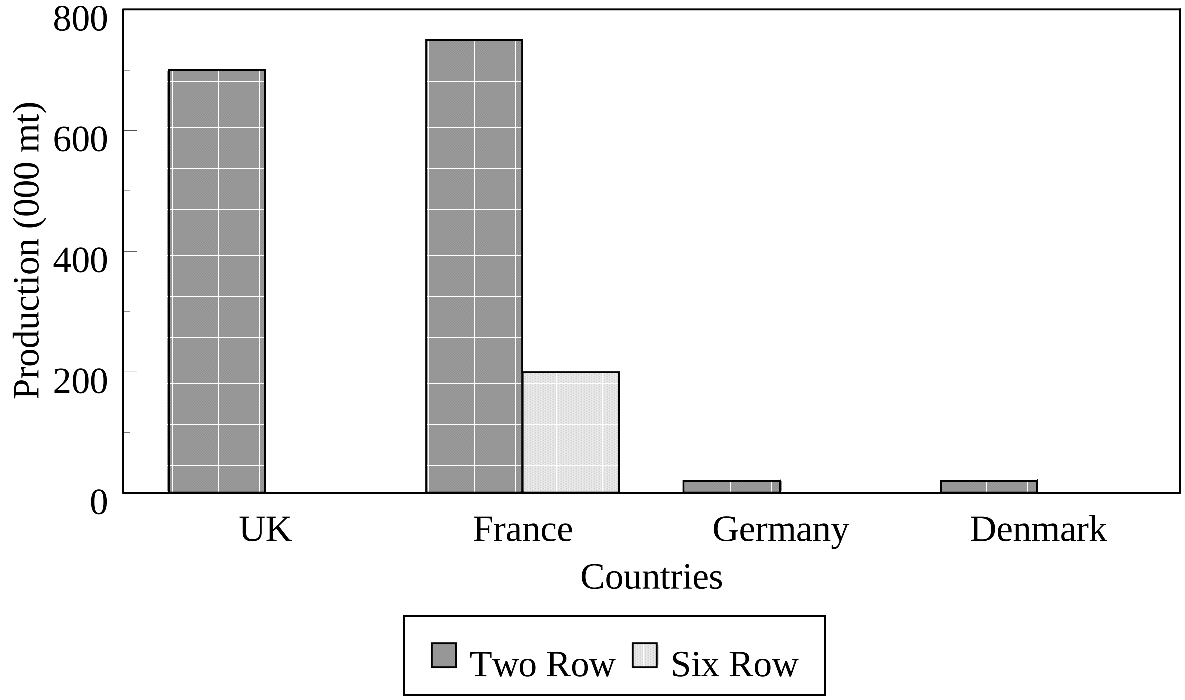


Figure 2.4. Winter Malting Barley Production in EU Countries, by Type: 1994

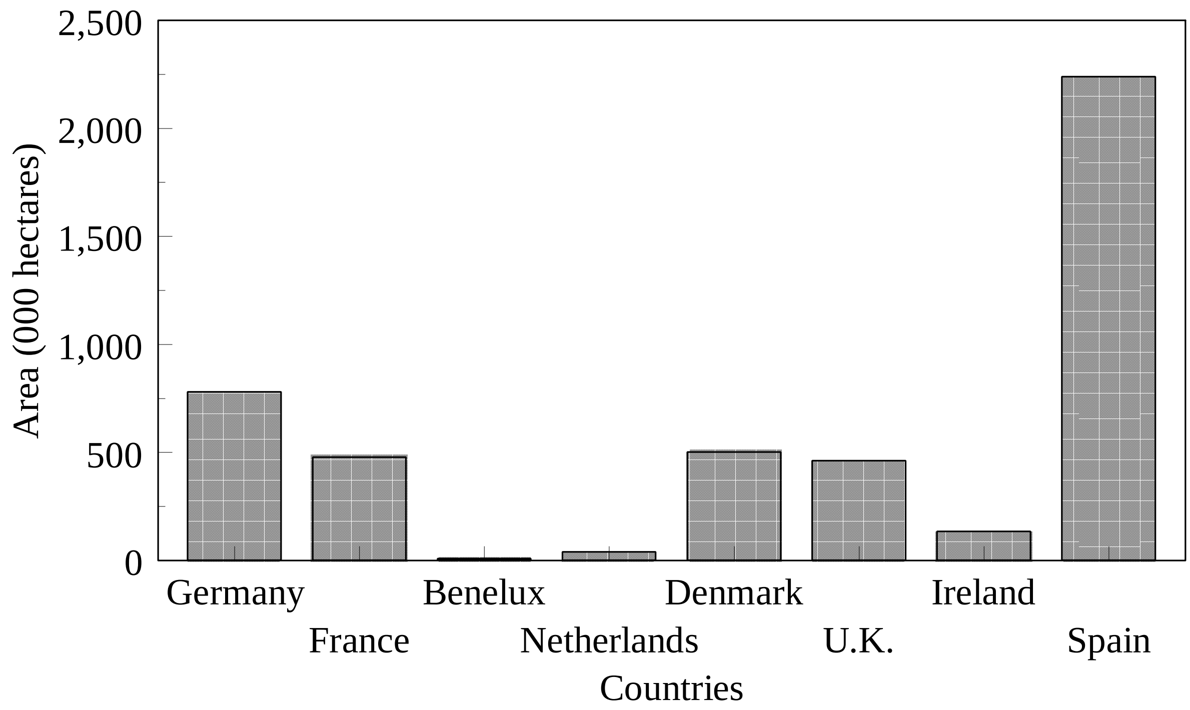


Figure 2.5. Spring Malting Barley Area in Selected EU Countries: 1994

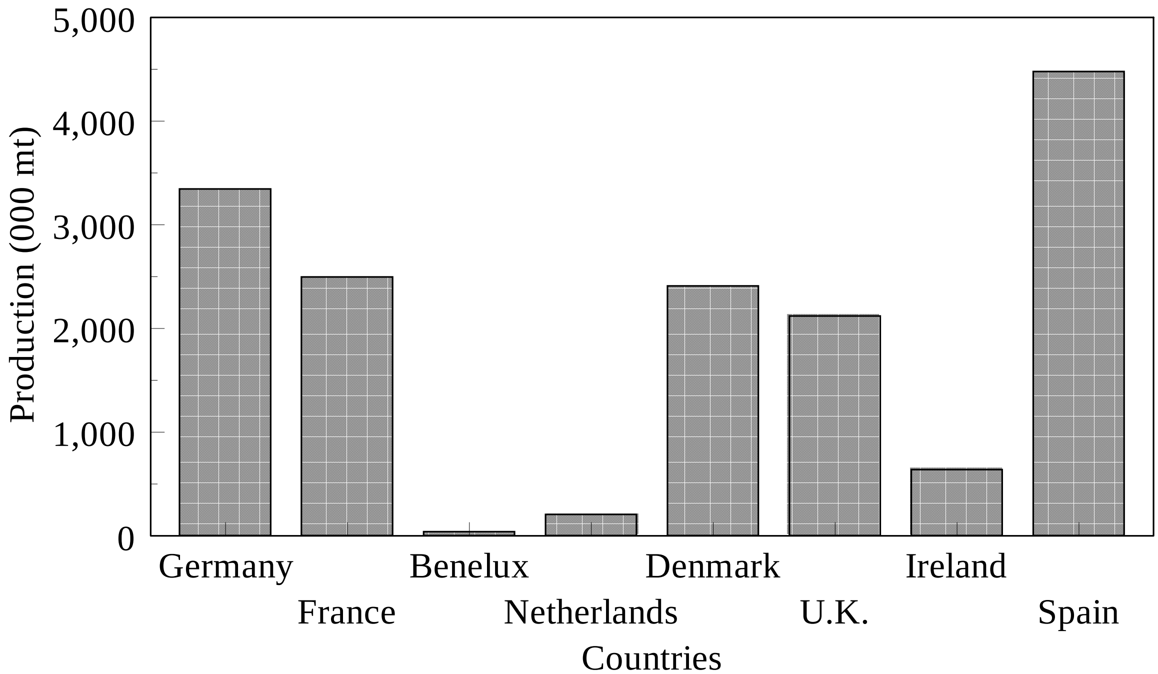


Figure 2.6. Spring Malting Barley Production in Selected EU Countries: 1994

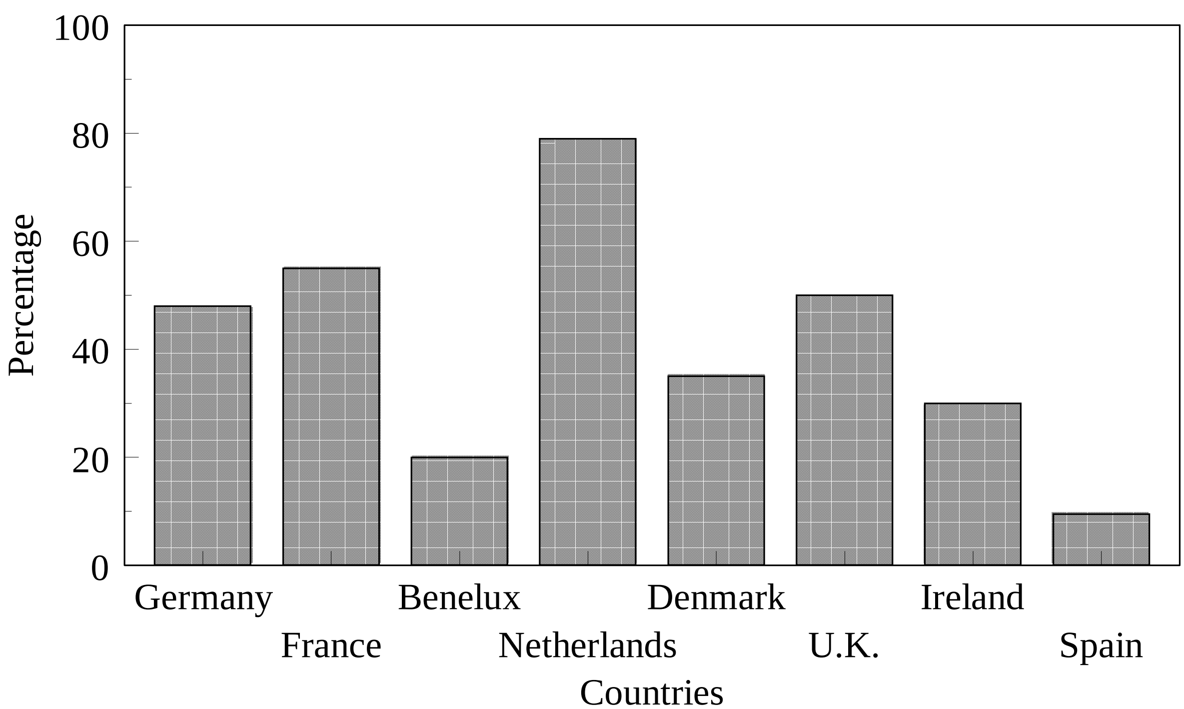


Figure 2.7. Spring Malting Barley Selection Rates: 1994 Percentages

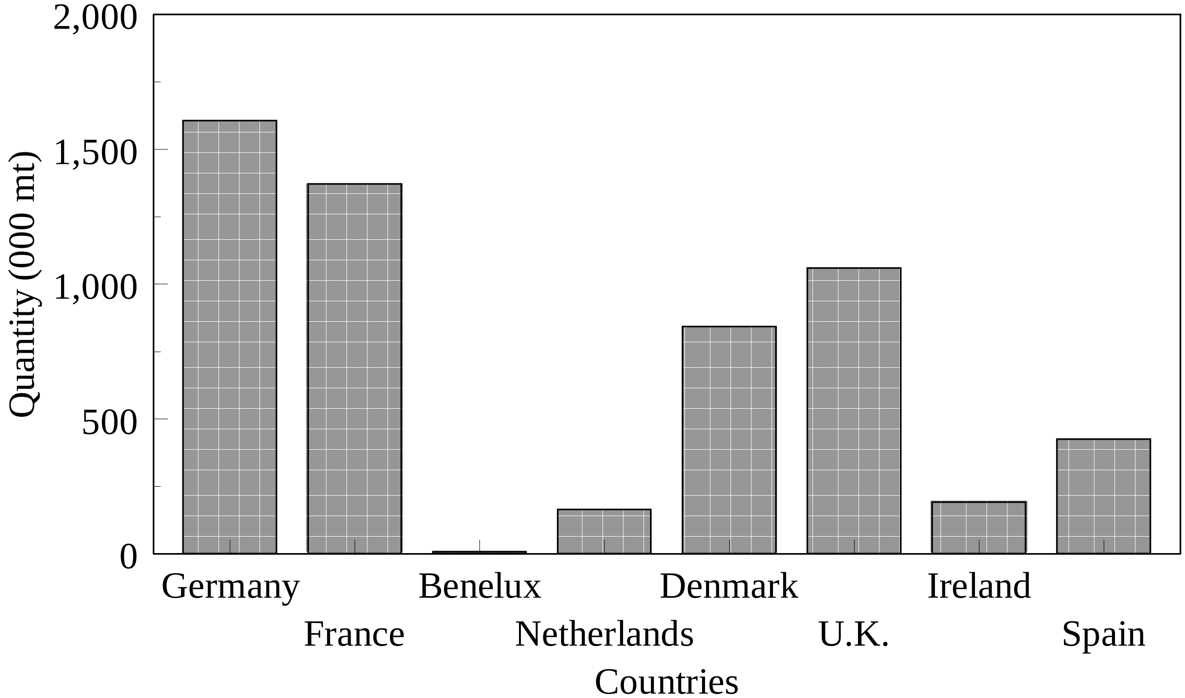


Figure 2.8. Spring Malting Barley Availability: 1994

TABLE 2.3. AUSTRALIAN BARLEY SUPPLY AND DISPOSAL: 1988/89 TO 1993/94

Year	Area (000 ha)	Production (000 mt)	Exports Feed	Exports Malt	Domestic Use	Seed Use Beg. Stk	Seed Use End. Stk
1988-89	2,191	3,242	1,413	461	1,253	110	116
1989-90	2,310	4,044	2,488	505	923	116	128
1990-91	2,556	4,108	2,483	449	1,039	128	137
1991-92	2,744	4,530	2,049	428	1,906	137	147
1992-93	2,946	5,396	2,576	377	2,267	147	176
1993-94	3,515	6,815	3,568	364	2,727	176	156

SOURCE: Commodity Statistical Bulletin, Australian Bureau of Agricultural and Resource Economics, 1994.

TABLE 2.4. RECEIVAL AND DISPOSAL BY AUSTRALIAN BARLEY MARKETING BOARDS

Year	Receival (000 tonnes)	Barley for Malting		Domestic Feed Use	Exports	
		Domestic	Export		Malting Barley	Feed
1985-86	3,762	216	275	113	408	2,745
1986-87	2,599	221	361	107	343	1,563
1987-88	2,370	257	407	182	476	1,042
1988-89	2,302	383	335	222	390	960
1989-90	3,560	288	376	396	992	1,504
1990-91	3,089	292	370	187	725	1,509
1991-92	3,436	267	469	263	1,006	1,376

SOURCE: Commodity Statistical Bulletin, Australian Bureau of Agricultural and Resource Economics, 1994.

Canada produces 2R and 6R malting barley. Production of these two types in 1993 was at 4.4 million tons and 1.9 million tons, respectively. Due to low selection rates, supplies of these two types of malting barley amounted to 1.4 million mt. However, this probably understates the true availability of malting-quality barley in Canada. For purposes of our analysis, supplies of malting-quality barley are estimated at 2.5 million mt. This compares to total barley production (feed and malting) of 12 million mt.

Area planted to barley in Canada ranges between 11 to 12 million acres, with Alberta, Saskatchewan, and Manitoba accounting for most of the area. Barley acreage has declined. Oil crops such as canola and grains (i.e., spring and durum wheat) compete with barley in farmers' acreage decisions. Area planted to malting varieties has remained relatively constant at 68 percent of all barley acres. Area under 6R blue barley has declined, while 2R and 6R white area have increased. Canadian barley yields have shown considerable year-to-year variability around an upward trend. Between 1974 and 1992, the average yield increased from a little more than 30 bushels per acre to more than 50 bushels per acre.

Total supplies increased from 0.6 million tons in 1985/86 to 1.7 million tons in 1991/92 (Table 2.5). Exports consumed most of this increase. Domestic malt use has remained relatively constant, while malt exports have increased steadily since 1986.

Barley breeding in Canada is conducted by private institutions, universities, and Agriculture Canada. Traditionally, 6R varieties were dominant in Canada (Kendall, 1993). This was the result of a breeding program that concentrated on 6R varieties. However, recognizing the preference for 2R varieties in offshore markets, breeding of 2R varieties was initiated. Since 1986, 2R varieties have accounted for more area than 6R varieties.

Variety approval in Canada differs from that in the U.S. Non-approved malting barley varieties can be grown under a specific contract or for feed purposes only. All approved varieties are either white

TABLE 2.5. CANADIAN MALTING BARLEY AND MALT SUPPLY AND DISPOSITION DETAILS: 1985-1986 TO 91-92 ('000 TONS)*

	85-86	86-87	87-88	88-89	89-90	90-91	91-92
	----------------	----------------	----------------	---000 mt---	----------------	----------------	----------------
Total Supplies	662	1,036	1,166	1,074	843	1,455	1,684
Grain Exports	59	329	498	325	181	637	935
Malt Exports	202	185	228	223	267	287	344
Brewer Use	374	363	365	373	364	363	367
Stock Change	(13)	(3)	14	28	5	(29)	(32)

* Total supplies equal disposition, discrepancy may be due to clean out and loss.
Malt exports are in barley equivalent terms.

aleurone or 6R blue aleurone. White aleurone (6W) has been grown primarily under contract and has increased in recent years (Wilson and Johnson, 1995).

Beer quality depends on the quality of the barley used in malting. Maltsters and brewers follow rigid specifications when purchasing malting barley for brewing. These specifications define the range of protein, test weight, moisture content, diastatic power, and other factors. These specifications restrict selection of malting barley to a certain proportion of all malting barley grown. Of all barley grown in Canada, only 15 percent is selected for malting (Kendall 1993, p. 1048). Barley selected for malting earns a substantial price premium.

United States

Major states that grow barley in the U.S. are California, Colorado, Idaho, Minnesota, Montana, North Dakota, Oregon, South Dakota, Washington, and Wyoming. These states account for 90 percent of planted barley acreage. Barley area in the U.S. has declined. Barley yields vary over time and by region. Western states generally have higher yields than the Midwestern states (Johnson and Wilson, 1994).

Factors affecting supply of malting barley in the U.S. vary from one region to another. Agronomic practices, soil characteristics, and climatic conditions determine types of malting barley grown and yields. Similar factors determine the acreage of competing crops. In western states, these crops include feed barley, potatoes, alfalfa, edible beans, sugar beets, and vegetables. In the Midwestern states, hard red spring wheat, durum wheat, and sunflower compete with malting barley acreage. The difference in yield between feed and malting barley is not wide enough for feed barley to compete with malting barley in Midwestern states.

Malting barley production is concentrated in the Midwestern states of North Dakota, Minnesota, and South Dakota. All 6R barley is grown in this region. Two-rowed production is increasing in the Dakotas. Western states, on the other hand, produce 2R feed and malting varieties.

An important aspect in estimating supply is the proportion of malting barley production that qualifies for malting. This selection rate varies by state. In the Dakotas, 45 to 50 percent of the production qualifies for malting. In Minnesota, this rate is around 70 percent. In the western states, rates are generally higher than in the Midwest, typically ranging from 80 to 90 percent. Idaho has the highest selection rate of 91 percent, reflecting a more controlled growing environment.

Nationally, selection rates for 2R varieties are higher than for 6R varieties. In 1993, production of 2R malting varieties was 1.01 million mt, and production of 6R malting varieties was 4.04 million mt. Quantities of 2R and 6R suitable for malting (graded No. 3 or better) were 0.87 million mt, and 2.7 million mt, respectively.

Comparisons

In summary, several important points are drawn about malting barley supply in the major producing countries:

- The EU, Canada, and the U.S. account for most of the area and production of barley in the world. Both area and production are declining in these regions.

- Both 2R and 6R barley are grown in Europe and North America. Only 2R barley is used for malting in Europe. In North America, both types are used for malting. Malting barley that fails to meet quality standards is used for feed.

- Barley yields in Europe are the highest in the world. Australia has the lowest yield. Between 1985 and 1994, Latin American countries, namely, Argentina, Chile, and Uruguay, recorded a considerable increase in barley yield.

- European countries have long-established breeding programs for malting barley. Varietal release programs vary considerably between the U.S. and Canada. A major difference between the breeding program in Europe (the U.K., in particular) and North America is the nature of coordination among breeders. In the U.K., breeding programs are privately funded and receive their revenues from royalties. As a result, breeding programs are a strategic issue, and coordination would play into the hands of competitors. North American breeding programs, most often, are publicly funded, and collaboration among research efforts is the key to their success.

- The crucial variable that determines the quantity of malting barley availability is the proportion of malting barley supply selected for malting. Data from EU, Australia, and the U.S. suggest that the selection rates vary considerably from one region to another within a country.

Changes in Agriculture Policies Affecting Supply

Several important policies affecting supply are undergoing change in exporting countries.

CRP in the United States

The Conservation Reserve Program has had an important impact on barley production in the U.S. (Johnson and Wilson, 1994). About 23 percent of the area planted in 1986 was set aside under the CRP. Annual entries of barley acreage into the U.S. Conservation Reserve Program during 1986 to 1992 are shown in Figure 2.9.

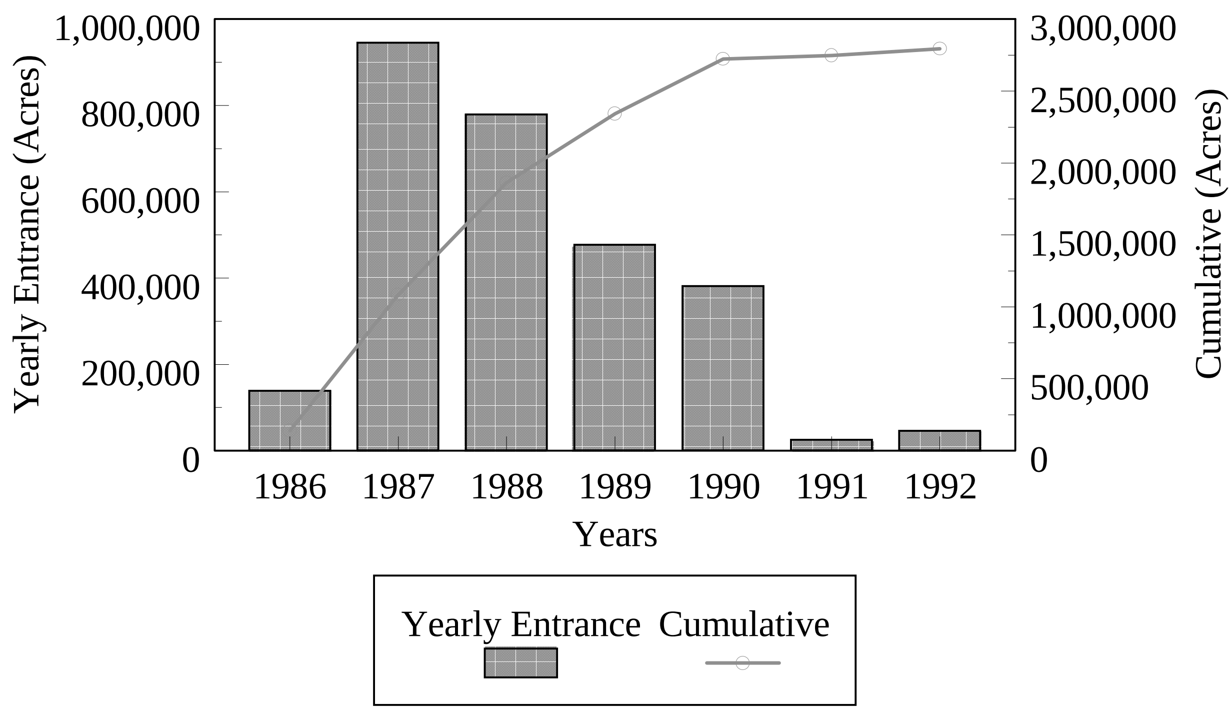


Figure 2.9. CRP Area Under Barley in the United States, Yearly Entrance and Cumulative Acres

CAP Reform in the EU

One important element of the EU agriculture policy is the intervention mechanism, consisting of internal price supports and export subsidies. Intervention, target, and threshold prices for barley in the EU, measured in ECU/ mt, are shown in Figure 2.10.

The CAP functioned fairly smoothly until the mid-1980s, when mounting grain production and budgetary costs led to serious discussion of policy reforms. The European Commission attempted to exert control through reductions in price supports and through introduction of a producer co-responsibility levy

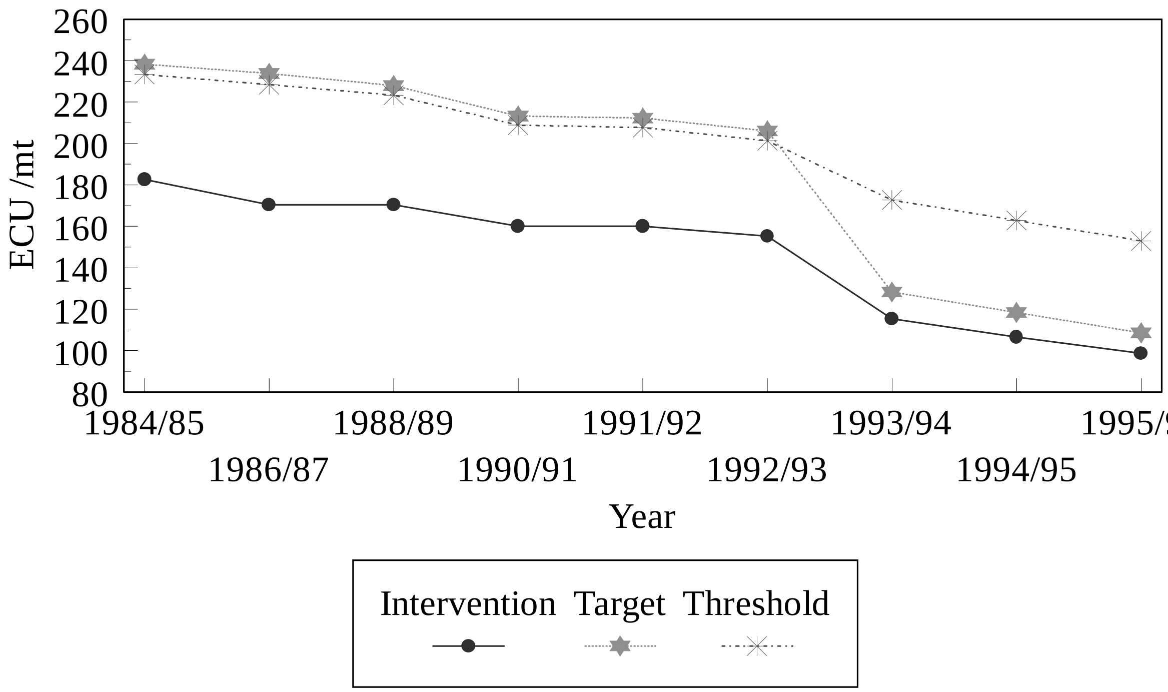


Figure 2.10. Intervention, Target, and Threshold Prices in EU: 1984/85 to 1995/96

(penalizing production beyond a mandated quantity). Finally, under the MacSharry Reforms of the CAP, accepted in May 1992, a land set-aside was introduced. The objective was threefold: 1) to reduce cereal production directly, 2) to eliminate costly intervention, and 3) to avoid costly disposal of the surplus. Commission officials estimated that this program, expected to cost ECU 1.2 billion, would reduce the crop 15 percent in 1994.

Effects of CAP reforms are expected to be more severe on barley than other grains. The USDA (1993) reported that farmers in the EU are more willing to remove coarse grains, particularly barley, from production because their yields are lower than those common for wheat. Lower relative returns have encouraged a long-term shift out of barley that has intensified under CAP Reform. Barley area in the EU declined 8.5 percent between 1992 (12.7 million ha) and 1993 (10.45 million ha).

A key element of the 1992 CAP Reform was to reduce cereal support prices by 30 percent over three years to improve the competitiveness of cereals used in animal feed relative to competing products (Sewell, 1994). To maintain competitiveness of EU cereals, export refunds will be reduced by 60 to 80 percent, depending on world prices. With lower internal support prices, the gap between the EU market price and the world price is reduced, allowing for a reduction in export refunds. Export refunds enable the EU to sell products at world prices, and equal the difference between EU internal market prices and the world market prices (measured at EU ports).

Besides the CAP Reforms, the Uruguay Round GATT agreement requires that EU reduce budgetary outlays on export subsidies by 36 percent, cut the volume of subsidized exports by 21 percent, and reduce the value of domestic supports by 20 percent. The new rules apply from the beginning of 1995 and are phased in through the year 2000.

Changes in WGTA Rates in Canada

An important policy affecting supply of most grains in Canada is the Western Grain Transportation Act (WGTA) subsidy. This subsidy on rail shipping costs is paid by the Canadian government indirectly to the railroads (Johnson and Wilson, 1995a). Beginning with the 1995/96 crop year, this subsidy was reduced. As a result, shipping costs on barley increased approximately 50 percent. However, given that barley generally has a lower value than other crops, the effect on barley supply would be greater. Preliminary analysis (by the producers' payment panel) indicated that land under barley production would decrease by 13.6 percent, compared to 10.6 percent and 0.4 percent reductions for wheat and canola, respectively (CRAM).

Trade Policies Affecting Malting Barley and Malt

Several important trade policies affect trade and competition in the malting barley sector.

EEP

The Export Enhancement Program was announced on May 15, 1985, and was authorized by the Food, Agriculture, Conservation, and Trade Act of 1990. The 1990 legislation required the Commodity Credit Corporation (CCC) to allocate at least $500 million in funds or commodities each fiscal year through 1995 to carry out the program. Under the program, the USDA pays cash to exporters as bonuses, allowing them to sell U.S. agricultural products in targeted countries at prices below the exporter's costs of acquiring them. Major objectives of the program are to challenge unfair trade practices, encourage other countries exporting agricultural commodities to undertake serious negotiations on agricultural trade problems, and expand U.S. agricultural exports. Commodities and products eligible for EEP initiatives are wheat, wheat flour, semolina, rice, frozen poultry, barley, barley malt, table eggs, and vegetable oil.

Malt exports have been targeted under the export enhancement program as a value-added agricultural product since 1986. Between 1985/86 and 1991/92, 41 percent of malt exported from the U.S. has been subsidized under EEP. Algeria, Brazil, Burundi, Cameroon, Caribbean countries, Central American countries, Colombia, Iraq, Nigeria, Peru, Philippines, and Venezuela have been targeted for malt exports.

The bonus for barley decreased substantially during 1989, but has increased steadily since then (Figure 2.11). Over time, EEP bonuses for malt remained about $100/mt, until increasing to about $140/mt in 1993.

Table 2.6 presents EEP expenses allocated to malt and the share of EEP funds allocated to all value-added products. The latter includes barley malt, canned peaches, dairy cattle, eggs, frozen poultry, poultry feed, semolina, vegetable oil, and wheat flour. The maximum amount allocated to barley malt was $10 million in 1987. The year with the smallest allocation was 1989 at $0.3 million.

EEP has been used to a limited extent on malting barley. Algeria, Bulgaria, Cyprus, Hungary, Iraq, Israel, Jordan, Malta, Morocco, Poland, Romania, Saudi Arabia, Switzerland, Tunisia, Turkey, and FSU have been targeted for malting barley exports. Allocations were made to China, Colombia, the Czech and Slovak Republics, Romania, and Slovenia during 1993-94. However, it was not until 1995 that China bought malting barley from the U.S. under EEP.

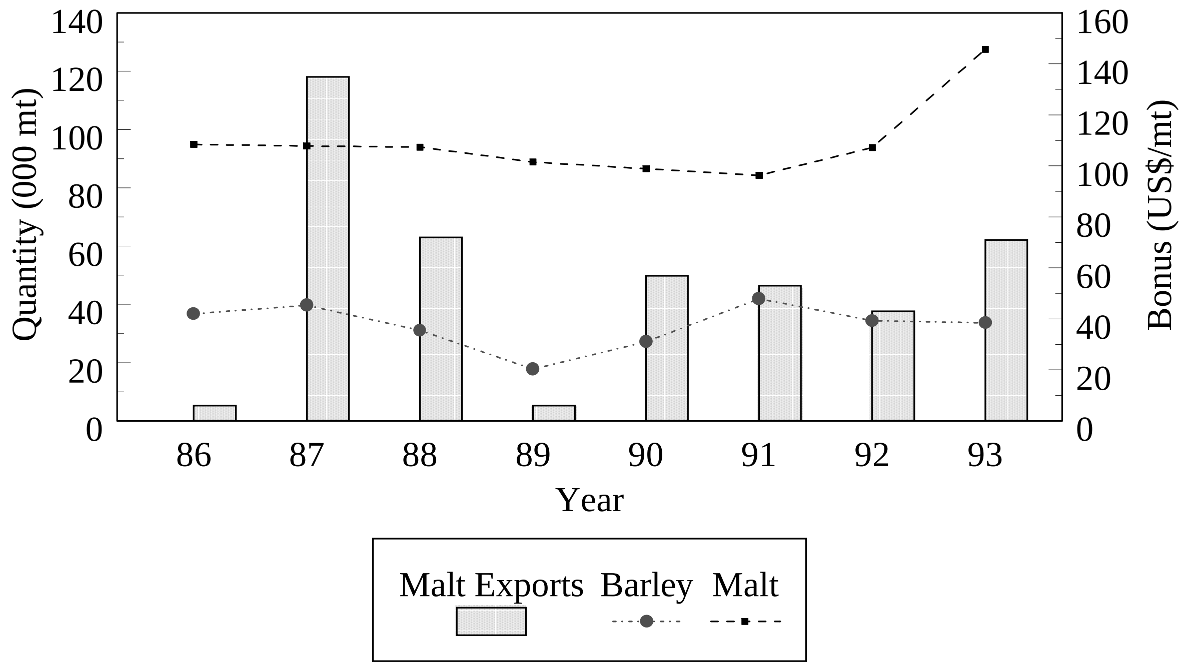


Figure 2.11. Malt EEP Exports and Average Barley and Malt EEP Bonuses: 1986-93

TABLE 2.6. VALUE AND PERCENT OF EEP SPENT ON BARLEY MALT

Year	Value of EEP Spent on Barley Malt	Percent of EEP Spent on Barley Malt of All VAP
	- mil US$ -	-% -
1986	0.4	0.4
1987	10	4.1
1988	5.6	4.81
1989	0.3	6.55
1990	5.6	15.64
1991	2.8	3.97
1992	2.1	2.76
1993	4.4	3.24

SOURCE: High-Value Agricultural Exports and the Contribution to the Rural Economy; Hearing before the subcommittee on foreign agriculture and hunger of the committee on agriculture, House of Representatives, One hundred third congress, second session, April 28, 1994, Serial No., 103-65.

EU Export Restitution

The EU's CAP has led to large surpluses of grains. To reduce stocks, an elaborate trade policy is used to promote grain exports. This is accomplished via export restitutions (subsidies), administered so that EU grain exports are competitive in the world market. Essentially, the difference between the EU world market price and the EU internal price is the export restitution, which is paid by the government. Similarly, imports are excluded through a variable levy, which bridges the difference between low world prices and high internal prices.

The EU trade policies relevant to barley are the export restitution and import levies (Figure 2.12). Import levies have always been higher and are maintained that way to improve the "Community Preference." Over time, both export refunds and import levies have declined. Barley export refunds and import levies are more volatile and have declined by more than half between 1986/87 and 1988/89. Since then, they increased slightly, but not to their levels of 1986/87.

Malt Exports From Major Exporters

Malt exports average a little over 3 mmt and have grown since 1979 at an annual compound rate of 2.9 percent (Appendix II, Table A2.3).[3] Between 1979 and 1992, about 30 countries have exported malt.

The EU is the major exporter, accounting for an annual average share of 64 percent of world malt exports (including intra-EU trade). France, Belgium, the UK, and Germany are the major exporters of malt among EU countries. Between 1979 and 1989, EU exports increased from 1.55 million mt to 2.17 million mt.[4] Over time, EU malt exports have increased at an annual rate of 3.5 percent.

Australia, Czechoslovakia, and Canada are other major exporters of malt. Canadian malt exports declined since 1979. Changes in average malt exports are presented in Figure 2.13. EU exports have increased substantially. Canada, Finland, Chile, Sweden, Poland, and Kenya have observed reductions in exports over time.

The EU dominates malt exports followed by Australia, Czechoslovakia, and Canada (Figure 2.14). The U.S. is ranked fifth, followed by numerous countries with comparable exports. Malt exports from the U.S. increased threefold between 1980 and 1992. Major importers of U.S. malt are Mexico, the U.K., Japan, and the Philippines. Caribbean and South American countries import malt from the U.S. as well. Exports to Mexico have increased markedly since 1989.

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[3]Compound growth rates were computed from an estimated equation, $Y_t = a(1+r)^t + e_t$, where Y_t is the level of malt exports in year t, a is the intercept, r is the compound growth rate, t is time index, and e_t is the disturbance term. A non-linear least squares procedure was used to obtain the parameter estimates.

[4]Malt trade statistics on total volume and unit values of the world, the EU, and the rest of the world are presented in Appendix II, Table A2.2. Shares of the EU and the rest of the world are also presented. The unit value of exports from the EU is consistently higher than the unit value of exports from the rest of the world. Despite this, the EU has a higher market share than the rest of the world.

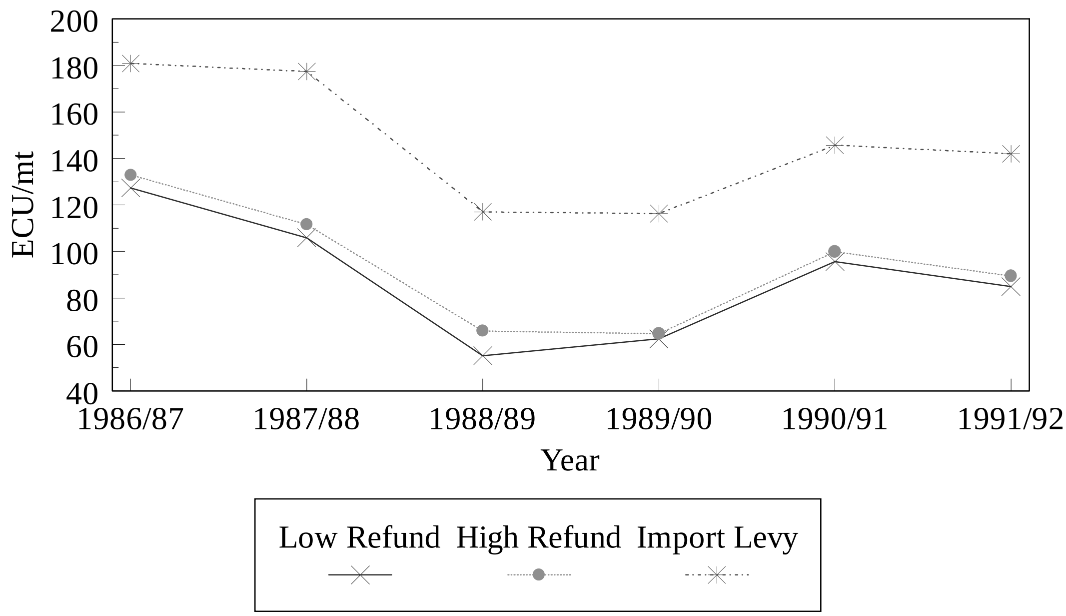

Figure 2.12. EU Barley Export Refunds and Import Levy: 1986/87 to 1991/92

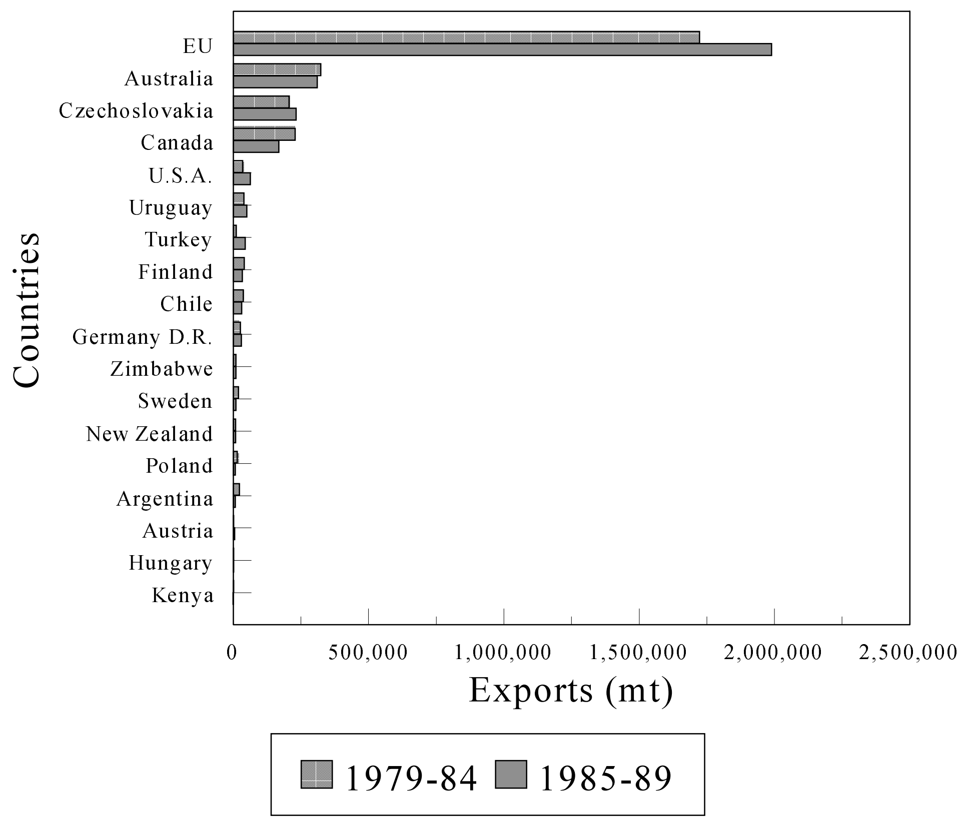

Figure 2.13. Average Malt Exports From Major Exporting Countries: 1979-84 and 1985-89

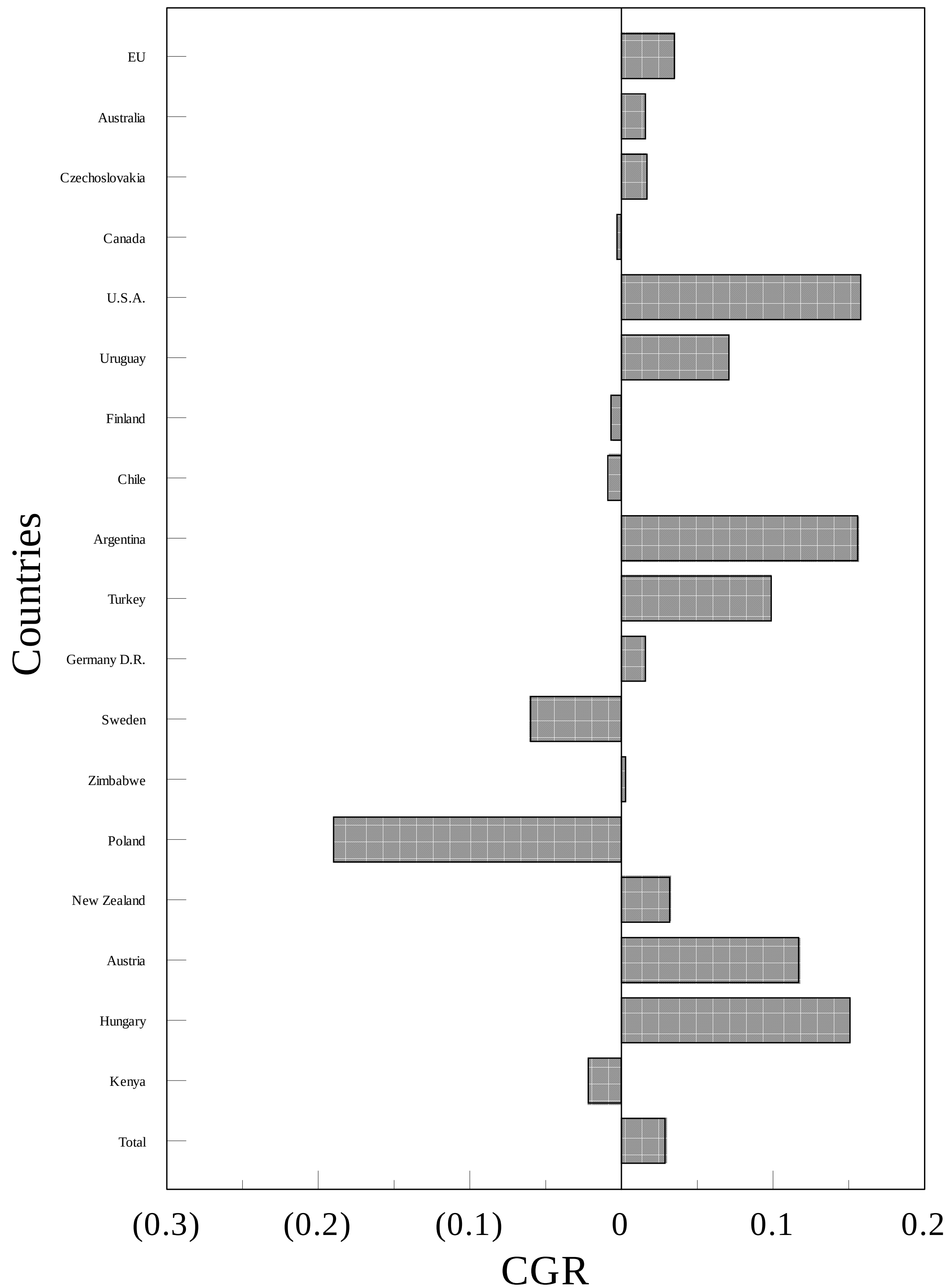

Figure 2. 14. Malt Export Growth Rates: 1979-89

The growth rates presented in Table A2.3 of Appendix II are shown in Figure 2.13. The U.S., Argentina, and Uruguay, whose share is around 2 percent, have had very high growth rates in malt exports since the late 1970s. Malt exports from Austria and Hungary have also shown substantial growth over time.

Malting Barley Exports

Australia has a small share of world barley production, yet it plays a significant role in world malting barley trade. In 1991, Australia accounted for 30 percent of world malting barley trade and 11 percent of world malt trade (Boston Consulting Group).[5] Countries that import Australian malting barley are Europe; South American countries, such as Brazil, Chile, Colombia, Ecuador, Peru, and Uruguay; and Asian countries, such as China, Japan, South Korea, and Taiwan. The increase in Australian malting barley is attributable largely to trade with China. Australian malting barley exports to China have increased from 190,000 mt in 1986/87 to 400,000 mt in 1992/93. Japan and Brazil are the major importers of Australian malt.

Malting barley exports from Canada have been approximately 400,000 mt per year, but this has increased sharply. Canadian malting barley is exported mainly to the U.S. and in recent years to China. Colombia and Ecuador also import from Canada. Most Canadian malt exports are to Japan. Besides Japan, the U.S. is one of the major importers of Canadian malt (CWB 1992).

Malting barley exports from the U.S. are small compared to feed barley exports, comprising less than 10 percent of all barley exports (Johnson and Wilson, 1994). Major importers of U.S. malting barley are Israel, Mexico, and Japan. China also imported malting barley from the U.S. under EEP in 1994 and 1995.

Beer Production and Malt Import Demand in Importing Regions

Between 1970 and 1989, world population increased by 44 percent. During the same period, beer production increased by 70 percent, from 647 million hectoliters to 1,101 million hectoliters. Per capita beer consumption also increased from 17.6 liters per annum to 21.2 liters per annum.

World beer production has grown by 1.8 percent annually.[6] Beer production growth rates by country are shown in Figure 2.15. Countries are listed in descending order, ranked by beer production. The U.S. is the largest beer producer, accounting for 23 percent of world production. However, beer production is stagnant as indicated by the 0.5 percent growth rate. Of 124 countries, 34 had negative growth rates from 1979-89, including the U.K., the U.S.S.R., France, Czechoslovakia, Ireland, and the Netherlands. Countries with positive growth included Brazil, Japan, China, and the Philippines.

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[5]Destinations for Australian malting barley and malt exports between 1986/87 and 1993/94 are presented in Table A2.1.

[6]Table A2.4 shows average beer production for 1979-89, corresponding shares, compound growth rates, and their t-values.

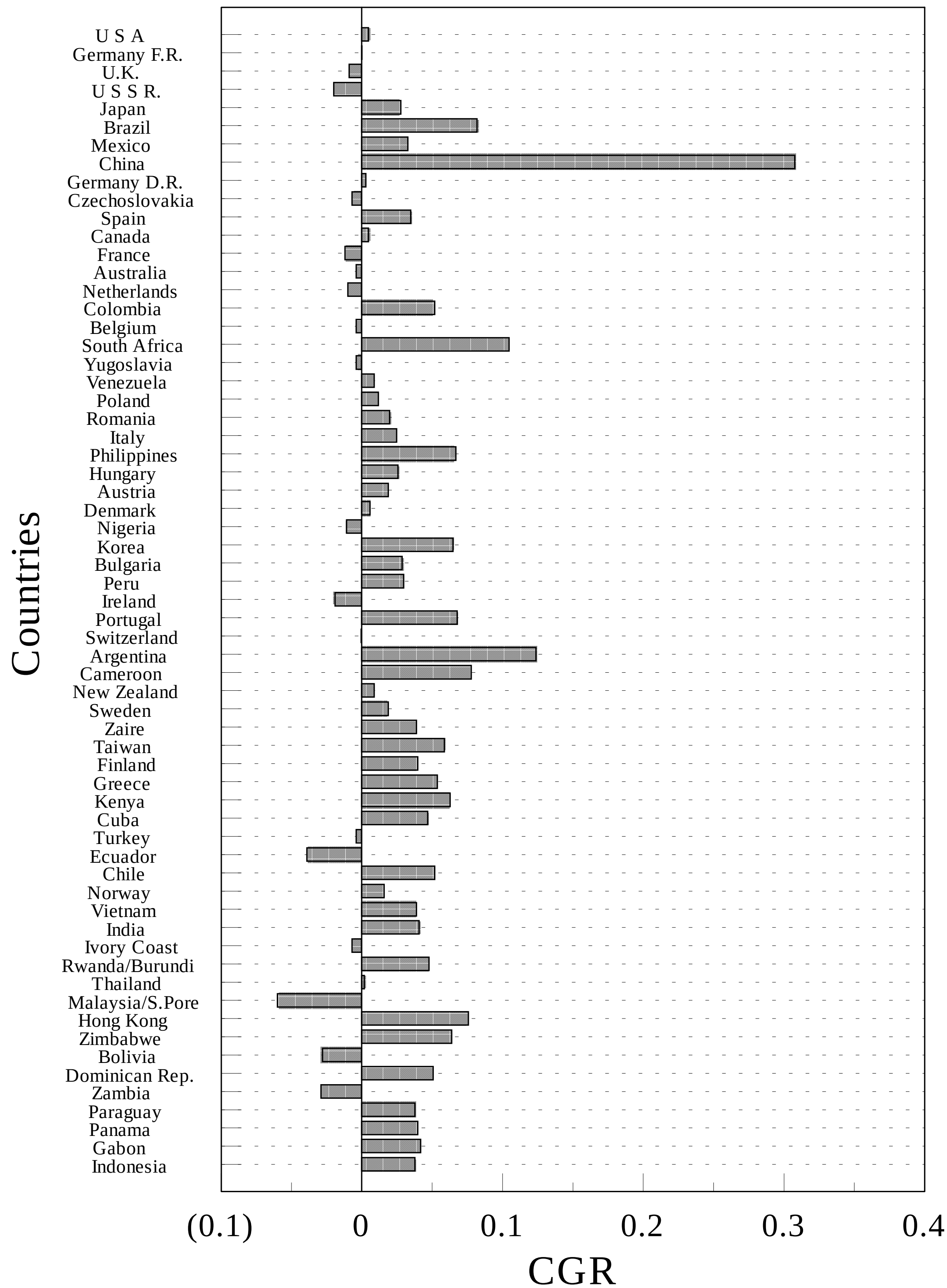

Figure 2.15. Beer Production Growth Rates

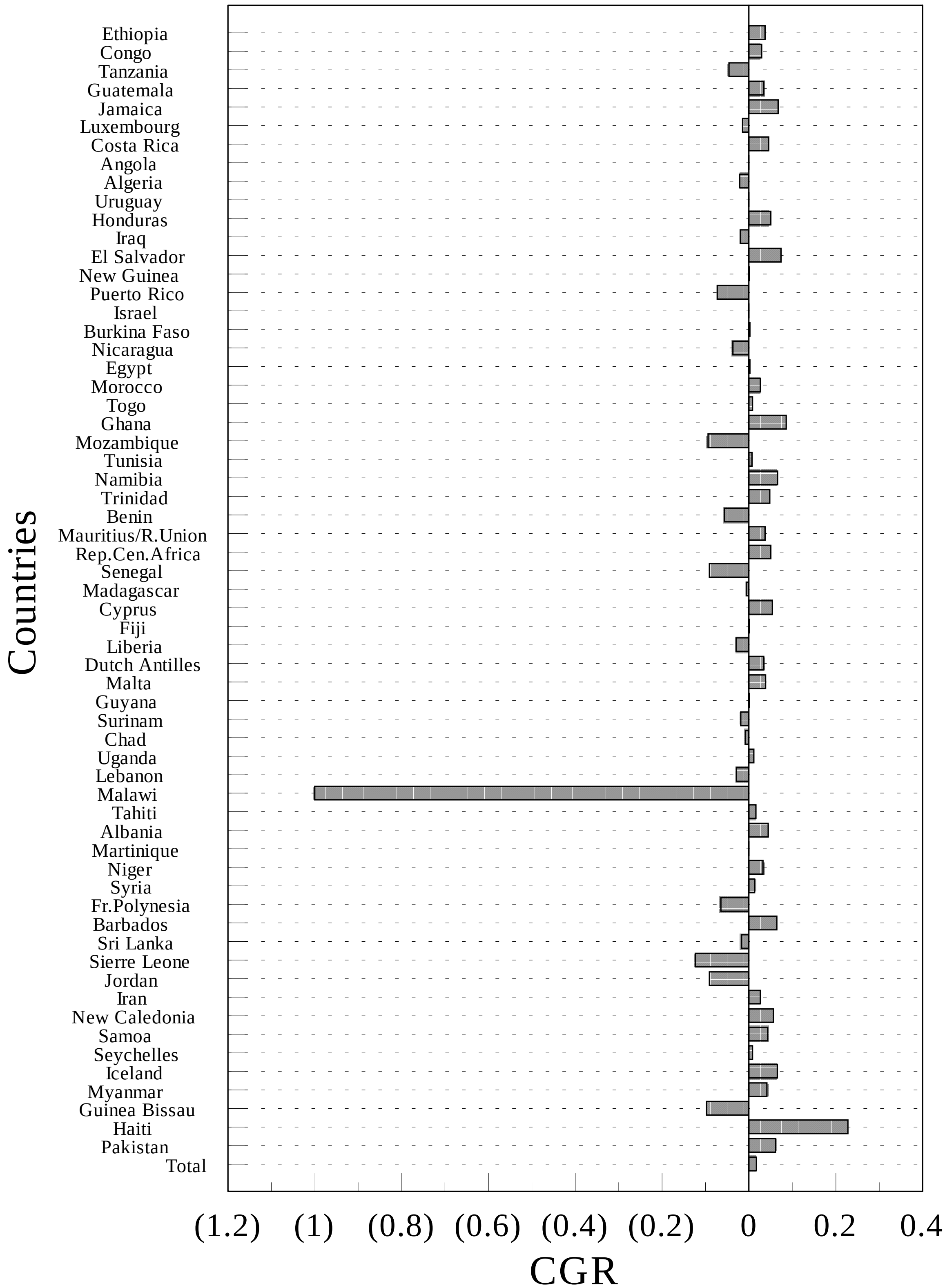

Figure 2.15. (Continued)

The majority of beer-producing countries depend on imports for their malt requirements. Malt import growth rates are shown in Figure 2.16.[7] Countries are listed in descending order, ranked by average malt imports during 1985-89. Malt imports declined in more than 30 countries. U.S.S.R. malt imports registered a drastic 165,000 mt reduction between 1980-84 and 1985-89. Nigeria, the U.S., and Korea are among the other countries with declining malt imports.

Japan is the largest malt importer with more than 500,000 mt per year. Brazil, Venezuela, and the Philippines are among the large markets (outside Europe) that have experienced growth in malt imports.

Malting Capacity

Many importing countries produce malt with imported malting barley. The extent of local processing is limited by malt plant capacity (Figure 2.17). The U.S. is the largest producing country with more than 2.5 mmt of capacity, followed by Germany and France. Australia, Belgium, Canada, China, and Czechoslovakia also have considerable malt plant capacities. Countries without malt plants (or insufficient capacity) must import malt to satisfy the needs of their brewing industries.

Ocean Freight Costs

An important aspect of trade patterns in malt and malting barley is ocean freight costs. For many countries, trade may occur either in the raw commodity, malting barley, or in the processed product, malt. The form of trade is determined, in part, by shipping cost differentials.[8]

Ocean shipping costs were derived for malt and barley for each movement incorporated in the analytical model. Malt can be transported by container or by bulk shipment, depending on port handling facilities. Both barley and malt are light commodities. Thus, it is possible for shipments to "cube out," using the full volume of a vessel before weight limits are met. Barley and malt weigh 48 and 32 pounds per bushel, respectively. A metric ton of barley is 45.9 bushels, while a metric ton of malt is 68.9 bushels. Several other facts are worth noting. First, costs for both malt and barley increase for longer haul movements. Second, malt rates on a per mt basis are typically about 1.5 times the rates for barley. Third, rates for malt in containers are generally about U.S.$5/mt greater than for bulk shipments. As demonstrated in the analysis, these have an important effect on the composition of trade and competitiveness among exporting countries.

Import Tariffs

Import tariffs affect the magnitude of trade in malting barley and malt, and the spatial distribution of processing. Changes in tariff rates are expected from the Uruguay Round of the GATT. This could have important consequences for trade flows in the barley and malt sector.

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[7]Table A2.5 compares average imports over 1980-84 and 1985-89, their differences, and compound growth rates along with t-values.

[8]Several studies have considered the effect of ocean freight rates on grain trade (Harris; Koo; Sarwar and Anderson; Koo, Thompson, and Larson; Dunn and Gianoulades).

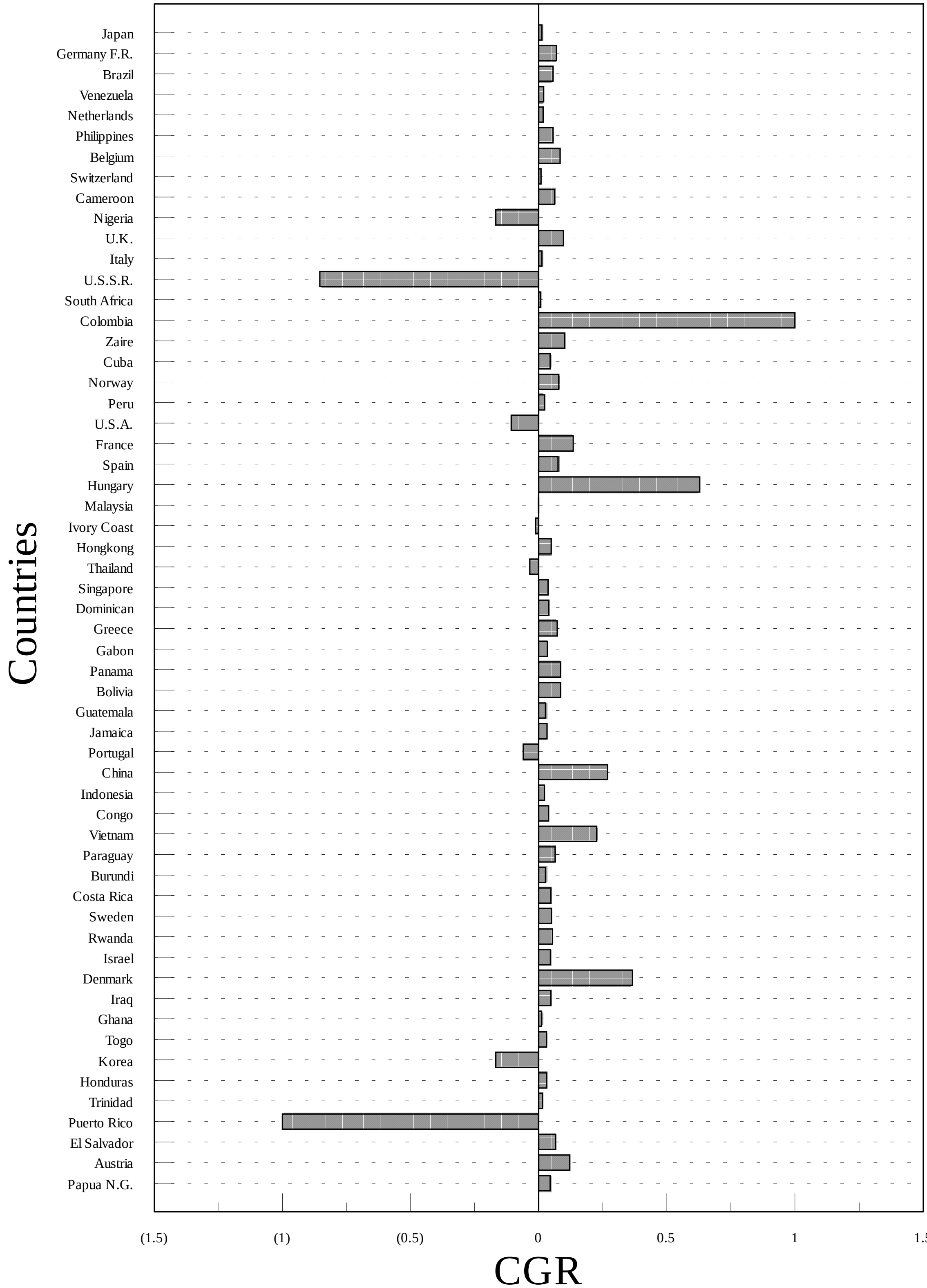

Figure 2.16. Malt Import Growth Rates

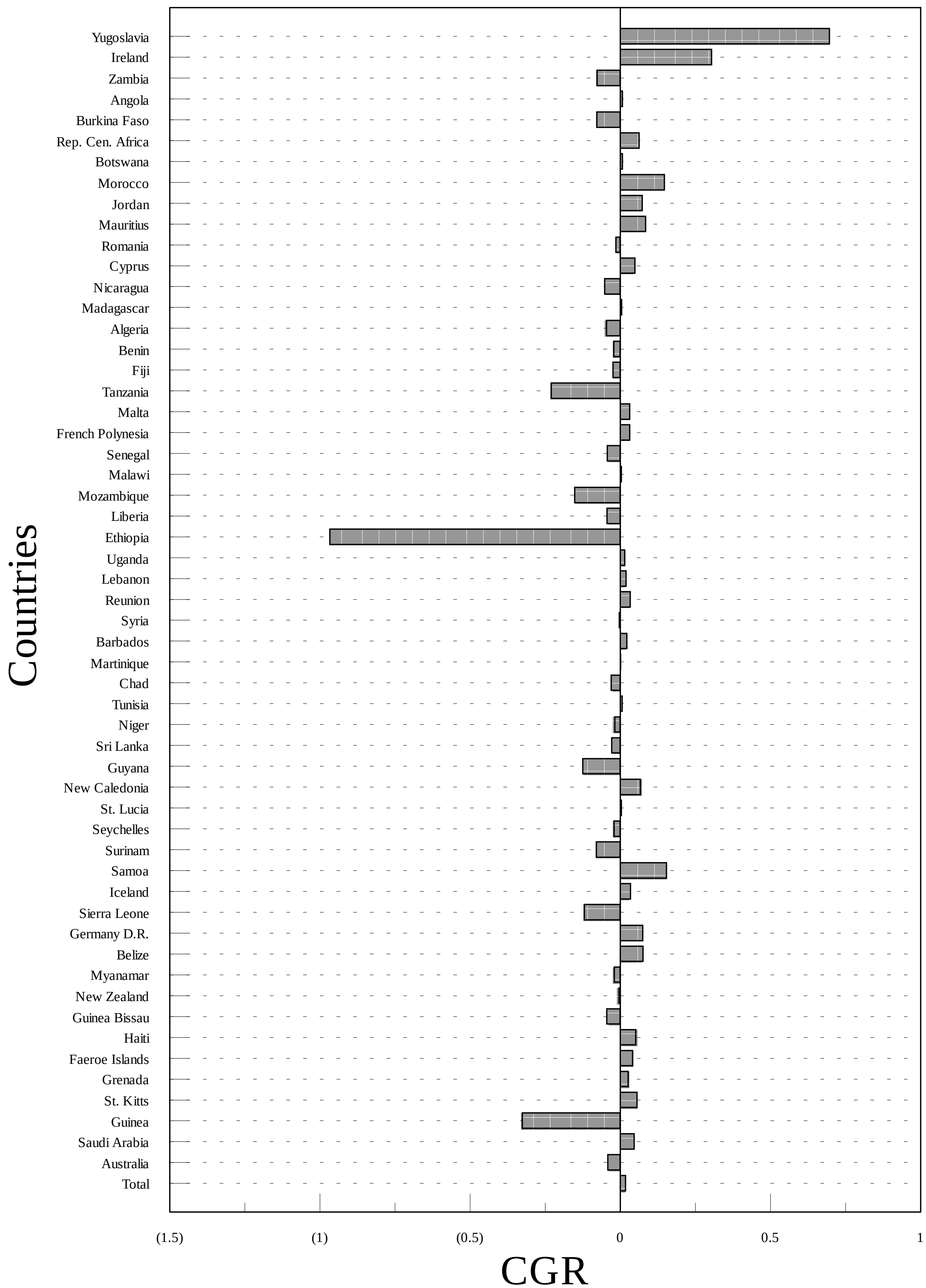

Figure 2.16. (Continued)

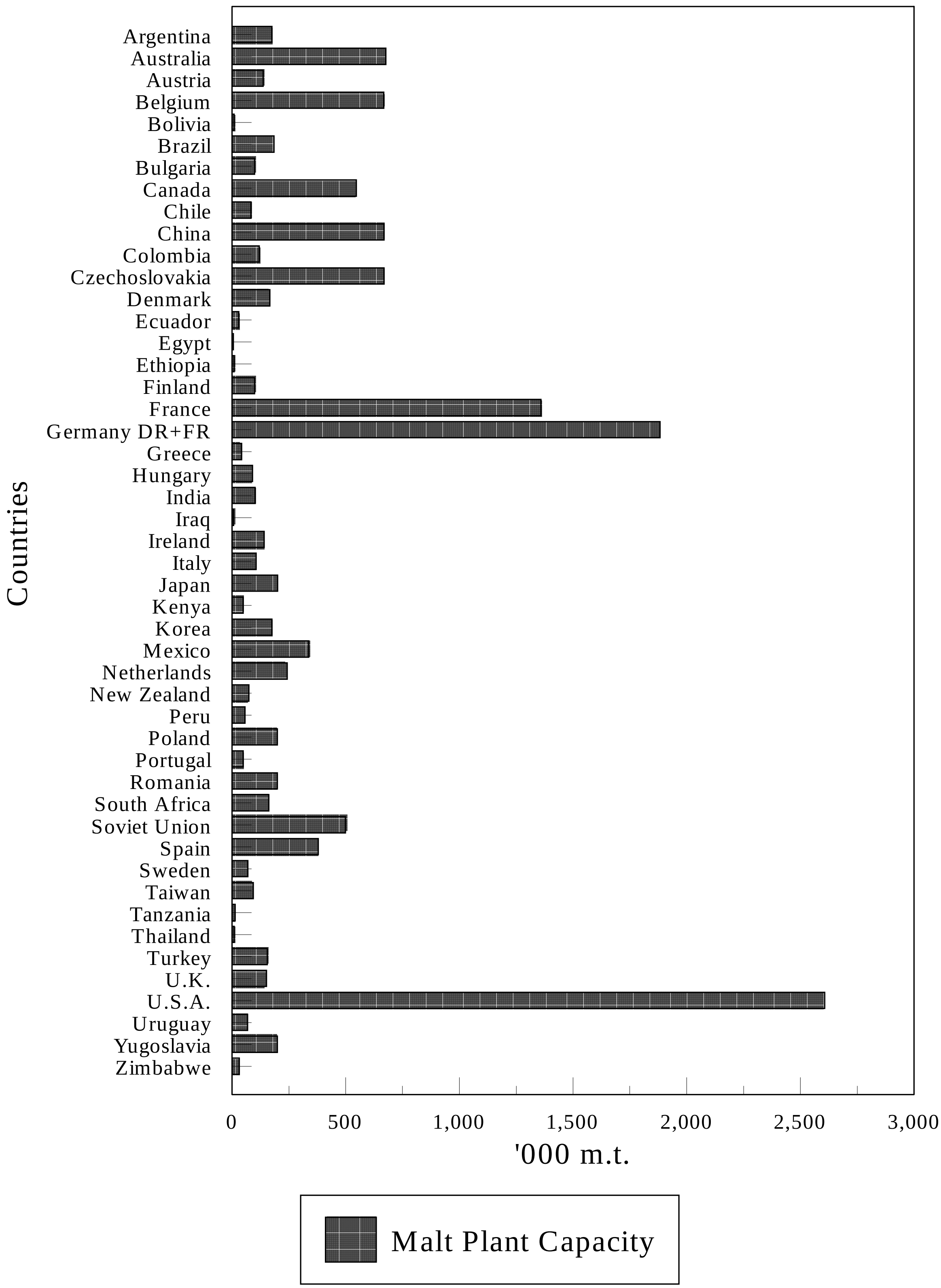

Figure 2.17. Malt Plant Capacities, By Country: 1990

A survey was conducted to gather barley and malt import tariff information. There were two components of the survey. First, a letter was sent to the embassies of various countries in Washington, D.C., requesting information on import tariffs and/or value-added tariffs for barley and malt. Second, U.S. Department of Commerce country desks were contacted by telephone and asked for information on tariff rates. The intent of the survey was to document tariff treatment for barley and malt in approximately 60 importing countries. Information was received for about 30 countries. In most cases, importer tariffs were of an *ad valorem* type. Thailand and Sweden were exceptions, applying fixed tariffs per metric ton. In general, import tariffs were applied uniformly across supply regions.

Tariffs vary substantially across importing countries. For malting barley, the range was from no tariff, signifying free trade, in Cyprus, Hong Kong, and Singapore, to 50 percent *ad valorem* in Pakistan. For malt, the range was from no tariff in countries, such as Singapore, Barbados, and St. Lucia, to 50 percent ad valorem tax in Pakistan.

In some countries, the tariff structure encourages local processing of malt. China, Brazil, and Japan each apply greater tariffs to malt than malting barley. Figure 2.18 highlights this aspect of tariffs. China applies an import tariff of less than 3 percent on malting barley, while that for malt is 35 percent. Japan and Brazil have a similar strategy, although the gap between the two tariffs is smaller.

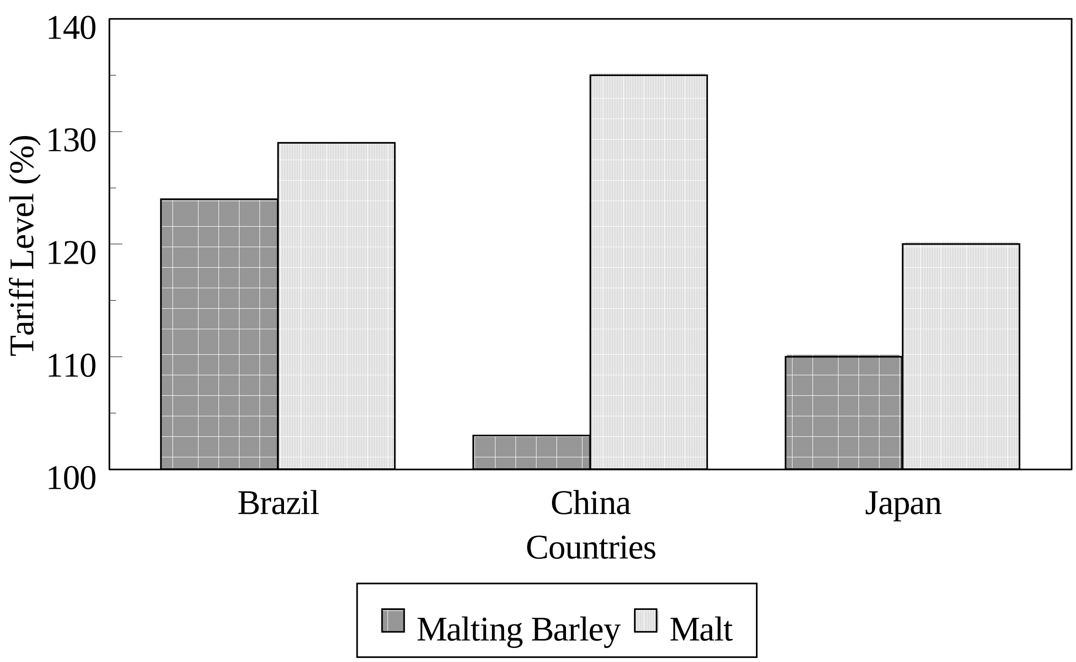

Figure 2.18. Malting Barley and Malt Import Tariffs in Brazil, China, and Japan

III. ANALYTICAL MODEL

The model used to analyze malt and malting barley trade flows is presented in this section. The mathematical specification is presented in Appendix I. The following section discusses base case assumptions and parameters. Data are presented on supply regions and availability, demand regions, transportation and logistics, and trade policies. Data sources are also identified.

The trade model is formulated as a linear programming problem. The objective is to minimize the cost of satisfying world demand for malt and malting barley subject to supply constraints, given transportation costs and limitations, trade policies, and quality requirements. The model is static and treats barley supplies (by region) as exogenous. Malt demand is fixed by region based on estimated beer production. Supply and demand parameters for the base case are broadly representative of conditions in the early 1990s. Supply and demand are varied parametrically in alternative model simulations.

The analysis builds upon a previous model developed by Johnson and Wilson (1994), which focused on North American trade. As a result, the model incorporates more detail for North America than for other parts of the world. However, the present model does not consider flows of feed barley.

Model Specification

Malting barley and malt flows are analyzed using a spatial transshipment model. The objective function is to minimize the total cost of satisfying world malt requirements. Cost elements included in the model are the value of feed barley (treated as the opportunity cost of malting barley), barley shipment costs to malt plants (within North America and to importing countries), malt shipment costs from malt plants to brewery locations (bulk or container), the value of import tariffs on malting barley and malt, and the value of export subsidies on selected movements. Shipment alternatives within North America are from specific production regions to specific malt and brewery plants.

Figure 3.1 provides an overview of flows in the model. Malting barley is shipped from supply regions to malt plants where it is converted into malt. Malt is then shipped to malt demand regions. Some regions (e.g., China, Japan, and Brazil) are importers of both barley and malt. Other regions do not have their own malt plant capacity and import malt (e.g., North and West Africa, Caribbean, and Central America). Internal malting barley flows from production regions to malt plants and from plant to breweries are included for North America.

The objective function includes nearly all of the costs associated with malting barley procurement and distribution. Results from the model identify flows from specific origins to specific destinations of both malting barley and malt. These flows are optimal, given the demand requirements for malt at each destination and other model parameters. They represent movements that would occur under conditions of competitive spatial equilibrium.

Base Case Assumptions

Base case parameters were chosen to provide a representation of malting barley and malt flows in the early 1990s. Flows of malting barley and malt are distinguished by type (2R, 6RW, and 6RB). The model also incorporates details on trade policy intervention and ocean shipping. Following are some important features of the base case:

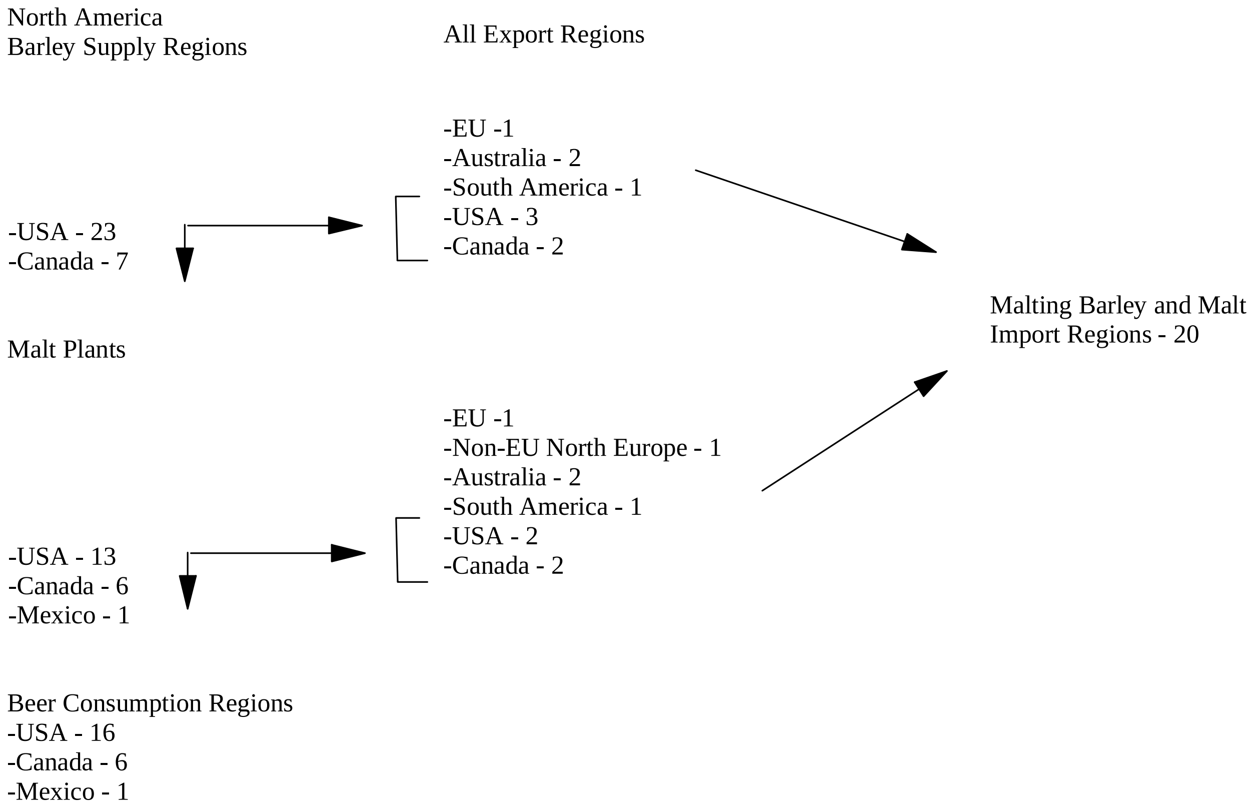

Figure 3.1. Malting Barley and Malt Flows in the Model

- Availabilities of malting barley and malt in various exporting regions are based on 1990-92 averages.
- Feed barley prices in exporting regions are based on 1990-92 averages.
- Subsidies on malting barley and malt exports are based on the 1988-92 average for the U.S. and 1989/90 to 1991/92 for the EU.
- Tariffs applied by importing countries are a weighted average of constituent countries in each trade region in 1993.
- Lower and upper bounds on six-rowed malting barley and malt imports are determined by minimum and maximum imports from the U.S. and Canada between 1988 and 1990. Other suppliers export two-rowed malting barley and malt exclusively.
- Bulk shipments are allowed from all exporters to importing regions having bulk receiving facilities. Container movements are allowed to all importing regions.

There are 989 individual constraints grouped into 55 blocks. Purposes of these constraint blocks are summarized in Table 3.1.

TABLE 3.1 RESTRICTIONS AND CONSTRAINTS IN THE BASE CASE

Constraint Blocks	Purpose
1 - 2	Malting barley moving from US and Canadian production regions to North American (NA) malt plants and export locations are limited to malting barley availabilities in the production regions.
3	Malting barley moving from NA malt plants, in processed form, is greater than malt moving from malt plants to NA breweries.
4 - 6	Malt produced out of malting barley moving from NA production regions to US, Canada, and Mexico malt plants is greater than malt moving from malt plants in US, Canada, and Mexico to breweries and respective export locations in US, and Canada and breweries in Mexico.
7 - 8	Malt shipped out of US ports is made with US barley and that shipped out of Canadian ports is made with Canadian barley.
9	All malt moving from NA malt plants to NA breweries meet annual malt requirements at NA breweries.
10	Malting barley and malt flows from export locations to import demand regions meet the requirements.
11 - 14	Malt shipments from export locations to import regions are constrained to be with in a range of bulk and container shipment specifications stipulated by import demand regions.
15 - 26	Malt shipments from export locations to import demand regions are constrained to be with in the ranges of malting barley type specifications set by breweries in NA and Import demand regions.
27 - 28	Malting barley flows from production regions and export locations are limited to malt plant capacities in NA and import demand regions, respectively.
29 - 36	Define trade volumes.
37 - 48	Vertical coordination in Anheuser Busch and Coors restrict malt flows from these plants to breweries owned by the respective companies.
49 - 50	Malting barley and malt shipments from export locations outside of NA to import demand regions are limited to availability.
51 - 52	Malting barley shipments from export locations in US and Canada to import demand regions are limited to malting barley flows from respective production regions to export locations.
53 - 54	Malt shipments from US and Canadian export locations to import demand regions are limited to the malt moving from US and Canada malt plants to export locations.
55	US EEP shipments to import demand regions are limited to historical initiatives.

Malting Barley Supply and Malt Availability

There are 23 barley production regions in the U.S. and 7 in Canada. Barley from these regions moves either to malt plants (13 in the U.S., 6 in Canada, and 1 in Mexico) or to North American export locations (3 in the U.S. and 2 in Canada). There are four malt export locations in North America (two each in the U.S. and Canada).

For North American regions, the malting barley supply is based on production levels during 1990-92 and average crop quality conditions (Johnson and Wilson, 1994). Only a portion of the production of malting varieties is sold for malting; the remainder is sold for feed. The model adjusts malting barley supplies (by region) to reflect quality variations. For Canadian regions, the adjustments reflect average selection rates, while for the U.S., they reflect average results of crop quality surveys (percent grading as No. 2 or better).

Table 3.2 shows data used to derive malting barley supply for each of the North American regions and the feed barley price. Feed barley prices represent the opportunity cost for malting use. Hence, these are included explicitly in the optimization problem along with transportation costs. For all regions, 1993 average feed prices are used.

Five malting barley supply regions outside North America are included. These include two in Australia and one each in the EU, rest of Europe, and South America. Availability of malting barley for export is set at recent levels for regions outside North America. The EU has been both a net importer and exporter of malting barley in recent years. Therefore, under our base case, we assume the EU has a small exportable surplus. Malting barley availabilities along with feed barley prices in these regions are presented in Table 3.3.[9]

Malting barley supplies are divided into three types: 2R, 6RW (white aleurone), and 6RB (blue aleurone). The 6R varieties are grown exclusively in North America, with Canada accounting for all the 6RB. This is an important feature of barley supply because many regions of the world use 2R varieties exclusively.

Malt Production

There are 20 malt production regions in the North American component of the model, including shipment through Canadian ports. Within North America, we use the plant locations and capacities outlined in Johnson and Wilson (1994) with minor modifications. Individual plants are constrained by their rated capacity, expressed in terms of annual throughput (barley equivalent). Barley is converted into malt by a ratio of 4:3. Some individual plants (those owned by Anheuser Busch and Coors) are also constrained to ship only to beer plants owned by their parent companies. This mimics vertical coordination of selected malt plants in the North American market. Export malt availabilities in North American ports are solved endogenously, based on transportation costs and other factors.

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[9]For southern South America, feed barley prices were not available, so we used a factor for .75 times the fob corn price ($/ton).

TABLE 3.2. SUPPLY PARAMETERS FOR NORTH AMERICAN MALTING BARLEY

Region	Area Planted (000 ac)	Yield (bu/ac)	Malting Varieties (%)	2-Row Varieties (%)	6-Row White Varieties (%)	6-Row Blue Varieties (%)	Malting Quality (%)	Feed Barley Price ($/mt)
ND-1	283	42	69	0	100	0	50	67.51
ND-2	362	47	89	0	100	0	50	67.51
ND-3	734	57	97	0	100	0	70	67.51
ND-4	113	38	26	0	100	0	50	67.51
ND-5	194	47	87	0	100	0	50	67.51
ND-6	515	61	96	0	100	0	70	67.51
ND-7	124	35	5	0	100	0	50	67.51
ND-8	98	33	21	0	100	0	50	67.51
ND-9	222	52	73	0	100	0	70	67.51
MN-1	633	62	97	0	100	0	70	67.51
MN-4	118	60	95	0	100	0	70	67.51
SD-2	179	45	68	0	100	0	45	65.73
SD-3	111	51	87	0	100	0	45	65.73
SD-O	182	39	45	0	100	0	45	65.73
MT-E	255	32	5	86	14	0	80	88.82
MT-W	1,203	48	40	90	10	0	80	88.82
CA	205	59	0	0	0	0	0	95.93
CO	140	78	51	89	11	0	90	79.94
ID	785	73	41	46	54	0	91	94.15
OR	159	68	6	31	69	0	80	90.60
UT	107	80	52	82	18	0	90	95.93
WA	473	57	9	78	22	0	90	101.26
WY	125	76	67	100	0	0	90	79.94
ALB-N	1,150	49	37	62	0	38	7	58.53
ALB-C	2,150	54	49	70	0	30	8	58.69
ALB-S	1,801	53	63	93	0	7	55	57.87
SAS-N	2,768	44	87	74	1	25	31	57.87
SAS-S	572	41	84	81	0	19	42	58.85
MAN-N	227	53	43	18	2	80	13	60.97
MAN-S	1,135	56	53	12	0	88	21	59.84

Source: Johnson and Wilson (1994)

We lacked information necessary for such detailed specification of malt production for exporting regions outside North America.[10] Instead, we specify an exportable surplus of malt for different exporting regions. The EU exportable surplus is based on average exports to third countries (omitting intra-EU trade) during 1988-90. For the remaining exporting regions (eastern Europe, Australia, and South America), we use average exports during the same period. Malting barley and malt availability for regions outside North America are presented in Table 3.3.

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[10]For the EU and other regions outside North America, we lacked comparable information on internal transportation costs and logistical channels for malt. Hence, each of these regions is treated as a composite, and intra-EU trade is ignored.

TABLE 3.3. MALTING BARLEY, MALT EXPORT AVAILABILITY AND FEED PRICES OUTSIDE NORTH AMERICA

Regions	Port Outside of NA	2RW Malting Barley	2RW Malt	Feed Price
		(000 mt)	(000 mt)	($/mt)
Australia	Fremantle	400	204	112
	Sydney	400	204	87
EU	Hamburg	50	1447	225
Non-EU North Europe	Hamburg	0	305	na
South America	Buenos Aires	100	242	85

na - Not Applicable

Source: TOEPFER International, 1992

Some malt-importing regions also have production capacity. These regions are allowed to import malting barley for conversion into malt (given domestic plant capacities), or import malt directly.

Malt Demand

Malt demand specifications for North America are as outlined in Johnson and Wilson (1994). Beer manufacturers have different malt preferences, which are imposed as constraints, i.e., minimum and maximum percentages by type. Beer production is weighted by market shares of major beer companies in individual regions, resulting in regional demand constraints for each type of malt. In the U.S., each barrel of beer uses 24 lbs of malt, while in Canada, each barrel uses 36 lbs. North American beer production (and, hence malt demand) is based on data from 1993.

Each import demand region identified in the model includes several countries. These were defined to consist of countries that differ in terms of crucial variables, such as level of beer production, malt required to produce a barrel of beer, existence of malting capacity, tariff levels, and preference for bulk and/or container shipments.

Beer-producing countries were identified and categorized into 20 demand regions, based on geographical considerations and import port locations. The ports, corresponding regions, and the countries with malting capacities are presented in Table 3.4. Malt demand is based on estimated 1990 beer production (Wesolowski, 1995) for these regions. Estimates for individual countries were aggregated by regions. The identified regions include selected countries in the corresponding geographical area. A country is excluded from the respective regions if beer production in that country is negligible, if it has no malting capacity, if the country is an exporter of malt, or if the country has not imported malt during 1988 through 1990. Some significant beer-producing countries, such as Japan, China, and the Philippines, were treated separately.

TABLE 3.4. MALTING BARLEY AND MALT IMPORTING REGIONS

Region	Countries	Port	Countries with Malting Capacity
N. Africa	Algeria, Morocco, Tunisia.	Algiers	
W. Asia	Iraq, Israel, Jordan, Lebanon, Syria.	Bahrain	Iraq
C. America	Belize,Costa Rica,El Salvador, Guatemala,Honduras,Nicaragua, Panama.	Balboa	
S. Africa	Botswana,Lesotho,Malawi,South Africa, Zambia,Zimbabwe.	Cape Town	South Africa, Zimbabwe
E. Asia	HongKong,Korea,R.,Taiwan.	Hong Kong	Korea,R.,Taiwan
Caribbean	Bahamas,Barbados,Cuba,Dominican, Grenada,Haiti, Martinique,Puerto Rico,St.Kitts,St.Lucia,Trinidad and Tobago.	Kingston	
W. Africa	Angola,Benin,Burkina Faso,Burundi, Cameroon,Cape Verde, Central African Rep.,Chad,Congo,Gabon,Ghana,Guinea Bissau, Liberia,Mali,Niger,Nigeria, Rwanda, Sao Tome., Senegal, Sierra Leone, Togo,Zaire.	Lagos	
Philippines	Philippines	Manila	
E. Africa	Kenya,Madagascar,Mauritius, Mozambique, Reunion, Seychelles, Tanzania,Uganda.	Mobassa	Kenya,Tanzania
N.S. America	Colombia,Guyana,Suriname,Venezuela.	Puerto la Cruz	Colombia
S. Europe	Malta,Romania,Yugoslavia.	Piraeus	Romania,Yugoslavia
E.S. America	Brazil,Paraguay.	Recife	Brazil
China	China	Shanghai	China
S.E. Asia	Indonesia,Malaysia,Nepal,Singapore,Sri Lanka,Thailand,Viet Nam.	Singapore	Thailand
non EU N.Europe	Austria,Hungary,Iceland,Norway, Sweden,Switzerland.	Stockholm	Austria,Hungary,Sweden
Oceania	Fiji,New Caledonia,New Zealand,Papua New Guinea.	Suva	New Zealand
Japan	Japan	Tokyo	Japan
W.S. America	Bolivia,Peru.	Valparaiso	Bolivia, Peru
	Russia	Vladivostok	Russia
	Russia	Odessa	Russia

Beer Production, Malt Requirement, and Malt-use Intensity

Beer production in 1990 was used to derive total malt and malt equivalent malting barley requirements for each country. Malt use intensity (pounds per barrel of malt used) for each country was obtained from Wesolowski (1995). Since beer production may vary across countries in a region, a weighted average of malt use intensity was computed for each region. Malt-use intensities for individual countries in a region were weighted by their share of regional beer production. Regional malt use intensity, beer production (1990), and malting capacity are shown in Table 3.5. Data for China, Japan, Philippines, and Russia represent actual production. China uses the least malt per barrel while the regional aggregate malt use intensity of southeastern Europe is the highest. Among importing regions, China, Japan, and eastern South America (Brazil and Paraguay) have the greatest beer production. Bahrain (Iraq, Israel, Jordan, Lebanon, and Syria) has the least beer production among all the regions in the study. China has the highest malting capacity among importing regions, while North Africa, Central America, Caribbean, West Africa, the Philippines, and northern South America have none.

North American Transportation and Logistics

Shipping and handling costs for barley and malt within North America are described in Johnson and Wilson (1995a). Barley shipments are by truck or rail. Handling costs are added to the transport costs, depending on the movement configuration. Barley movements are allowed to move from Canada to the U.S. directly by truck, thereby incurring a U.S. elevator charge, or via the Canadian marketing system, thereby incurring a Canadian elevator charge. Malt shipments are all by rail or truck.

Canadian shipments of barley and malt to export positions in Vancouver and Thunder Bay qualify for a rail subsidy. The U.S. has three points for offshore exports of malting barley (Portland, Oregon; Duluth, Minnesota; and Mobile, Alabama) and two collection points for malt (Portland and Mobile).

International Logistics

Calculation of ocean freight costs for malt and malting barley are presented in this section. Cost data for deep draft ocean vessels are published by the U.S. Army Corps of Engineers (ACE). Cost estimates for bulk movements of barley and malt and container movements of malt were estimated using a spreadsheet model. The method was to select ports and obtain estimates of distances between them, determine vessel and shipment sizes by trade corridor, and calculate costs.

Port Selection

For model simplification, one port was selected for each importing region[11] (Table 3.6). Port selection criteria included capability to receive containers and bulk traffic, location within the region, and availability of distance data. Port selections were shared with industry representatives who confirmed that malt or barley moved through these locations.

[11]An exception was Russia. In the trade model, flows to Russia are via either Odessa or Vladivostok, depending on shipment origin. Shipments to Russia from Australia, Portland, and Vancouver are via Vladivostok, while other shipments are via Odessa.

TABLE 3.5. MALT USE INTENSITY, BEER PRODUCTION, AND MALTING CAPACITIES IN MALT DEMAND REGIONS

Port	Region	Beer Production 1990 (000 hectolitres)	Malt Use (lb/barrel)	Malt Plant Capacity (000 mt)
Algiers	N. Africa	1,329	34	0
Bahrain	Middle East	781	37	18
Balboa	Central America	4,199	31	0
Cape Town	Southern Africa	22,962	30	201
Hong Kong	East Asia	6,182	39	256
Kingston	Caribbean	4,980	36	0
Lagos	West Africa	19,364	29	0
Manila	Philippines	12,783	25	0
Mobassa	East Africa	4,590	43	70
Puerto la Cruz	N.S. America	24,527	25	0
Piraeus	Southeastern Europe	22,848	51	417
Recife	E.S. America	50,335	27	261
Shanghai	China	59,654	18	670
Singapore	Southeastern. Asia	5,550	41	18
Stockholm	non-EC Europe	26,413	38	322
Suva	Oceania	3,936	32	60
Tokyo	Japan	55,925	32	201
Valparaiso	W.S. America	5,267	30	68
Vladivostok	Russia	2,579	33	250
Odessa	Russia	2,579	33	250

Source: Pollack and Pool, 1993 provided Beer Production and Malt Plant Capacities. Malt Use Intensity is obtained from Weslowski (1995)

TABLE 3.6. DEMAND REGIONS, LOCATION OF PORTS, AND AVERAGE LEVEL 1991-1993 IMPORTS

		Average Level of Imports (tmt)		
Port of Entry	Region	Barley	Bulk Malt	Container Malt
Algiers, Algeria	North Africa	0	0	3
Cape Town	Southern Africa	0	58	18
Lagos, Nigeria	West Africa	0	157	76
Mombassa, Kenya	East Africa	0	0	28
Balboa, Panama	Central America	0	0	59
Kingston, Jamaica	Caribbean	0	20	88
Puerto la Cruz, Venezuela	Northern South America	110	237	3
Recife, Brazil	Eastern South America	112	465	13
Valparaiso, Chile	Western South America	78	0	40
Bahrain, Bahrain	West Asia	0	0	19
Hong Kong	East Asia	0	0	484
Manila	Philippines	0	0	182
Shanghai	China	833	0	17
Singapore	Southeast Asia	0	0	67
Tokyo	Japan	1,367	0	727
Vladivostok	Russia	0	55	0
Odessa	Russia	0	55	0
Piraeus, Greece	Southern Europe	568	0	62
Stockholm, Sweden	Non EU North Europe	233	286	184
Suva, Fiji	Oceania	0	0	15

Malting barley is shipped in bulk, and a typical payload is 10,000 mt. Malt is shipped either in bulk or containers. Countries were designated as receivers of bulk and/or container shipments, based on 1989-91 trade levels and discussions with industry officials. In general, small-quantity importers are assumed to receive malt only in containers. Excluding North American and EU countries, 48 of the 159 countries in the data set received no malt, while 102 countries imported less than 50,000 mt of malt annually. Unless otherwise informed by industry officials, countries receiving more than 50,000 tons annually were assumed to receive malt in bulk. The two important exceptions to the bulk/container decision rule are Japan and the Phillippines, which both receive large volumes of malt imports by container. Assumed shipment sizes for bulk and container malt are 5,000 and 1,000 mt, respectively. Six regions receive both bulk and container malt, 12 regions receive only containers, and Russia receives only bulk (Table 3.7).

TABLE 3.7. DEMAND REGIONS, LOCATION OF PORTS, AND ASSUMED PAYLOAD

Assumed Port of Entry	Region	Assumed Payload (tmt)		
		Barley	Bulk Malt	Container Malt
Algiers, Algeria	North Africa	na	na	1
Cape Town	Southern Africa	na	5	1
Lagos, Nigeria	West Africa	na	5	1
Mombassa, Kenya	East Africa	na	0	1
Balboa, Panama	Central America	na	0	1
Kingston, Jamaica	Caribbean	na	5	1
Puerto la Cruz, Venezuela	Northern South America	10	5	1
Recife, Brazil	Eastern South America	10	5	1
Valparaiso, Chile	Western South America	10	0	1
Bahrain, Bahrain	West Asia	0	0	1
Hong Kong	East Asia	0	0	1
Manila	Philippines	0	0	5
Shanghai	China	10	0	1
Singapore	Southeast Asia	na	na	1
Tokyo	Japan	10	na	5
Vladivostok	Russia	na	5	na
Odessa	Russia	na	5	na
Piraeus, Greece	Southern Europe	10	na	1
Stockholm, Sweden	Non EU North Europe	10	5	2
Suva, Fiji	Oceania	na	na	1

na: Not Applicable

Nine ports for the five principal exporting regions were identified in discussions with industry officials. Export points are Fremantle and Sydney, Australia; Buenos Aires, Argentina; Hamburg, Germany; Thunder Bay and Vancouver, Canada; and Duluth, Minnesota; Portland, Oregon; and Mobile, Alabama.

Cost Calculation

Point-to-point cost estimates require information about three factors: distance, payload, and unit costs. Distances in nautical miles between export and import points were found in *Ports of the World* and *Lloyd's Maritime Atlas.* Flows to Russia were allocated to two ports, Vladivostok and Odessa, depending on shipment origin.

Unit costs are taken from ACE cost estimates for deep draft vessels.[12] ACE estimates are published for U.S. and foreign flag tankers, dry bulk, container, and general cargo deep draft vessels. Our work uses ACE data for foreign flag dry bulk and containers. The ACE data include assumptions about vessel size and speed (Table 3.8). For example, deadweight tons and cubic capacity of ships are reported for bulk vessels. For container ships, the data include deadweight tons, cubic capacity, and capacity of 20-foot equivalent units (TEUs).[13]

TABLE 3.8. ASSUMED CHARACTERISTICS OF BULK CARGO AND CONTAINERSHIPS FOR BARLEY AND MALT

Ship Characteristics	Dry Bulk	Containership
Deadweight tons	15,000	12,000
Capacity	690,000 cubic feet	600 TEUs
Length	478 feet	482 feet
Beam	67 feet	73 feet
Draft	27.6 feet	26.7 feet
Speed	14 MPH	17 MPH

SOURCE: Dept. of the Army, *FY 1993 Planning Guidance.*

The bushels per ship were determined as:

$$\text{Bushels/ship} = \frac{\text{ship cubic capacity}}{\text{1.24 cubic feet/bushel}}$$

For barley, the shipment size is the minimum of a vessel's weight limit and its cubic capacity. The following condition was used to capture this feature:

$$\text{If} \quad \left[\frac{\text{bushels per ship}}{\text{bushels per mt}}\right] > \text{DWT},$$

$$\text{then} \quad [\text{mt barley per ship}] = \left[\frac{\text{bushels per ship}}{\text{45.9 bu per ton}}\right];$$

$$\text{otherwise} \quad [\text{mt barley per ship}] = \text{DWT}.$$

[12]The Army Corp of Engineers (ACE) data are taken from the *FY 1993 Planning Guidance.* This report is available from George Antle, Dept. of the Army, Water Resources Support Center, 7701 Telegraph Rd., Casey Bldg, Alexandria, VA 22310-3868.

[13]Standard containers are 20 or 40 feet long. They may also be regular or high cubic capacity. Thus, a 600 TEU containership could haul 600 20-ft containers, 300 40-ft containers, or some combination of both.

The equation for bulk malt is identical, except that bushels per ship is divided by 68.9. Barley and malt never reach the weight capacity, regardless of vessel size. For example, a 15,000 deadweight ton ship can haul only 12,075 MT of barley and only 8,050 MT of malt.

Annual capital cost is based on a 20-year useful life and an interest rate of 8.25 percent. Fixed annual operating costs include wages and benefits, store and supplies, maintenance and repairs, insurance, administration, and other costs. The annual fixed operating cost and capital cost are summed to obtain total annual fixed costs. A total daily fixed cost is obtained assuming 350 days of operation per year. Daily fuel costs are reported at sea and in port. Since we are concerned with point-to-point movements, we only consider at-sea fuel costs. Daily at-sea fuel costs are added to total daily fixed costs to obtain total daily costs. These costs were used to derive an hourly total cost. Given the ACE cost per hour, payload assumptions, vessel speeds, and the distance matrix, point-to-point costs were calculated (Table 3.9).

TABLE 3.9. SUMMARY OF ARMY CORP OF ENGINEERS OCEAN FREIGHT COST DATA

Cost Item	Bulk Carrier	Containership
	(in US Dollars)	
Annual Capital Cost	1,885,359	2,127,410
Wages, Benefits, Subsistence	569,765	896,253
Stores and Supplies	143,206	195,255
Maintenance and Repair	330,857	196,899
Insurance	122,232	192,802
Other	152,674	105,382
Administration	131,873	396,648
Fixed Annual Operating Cost	1,450,607	1,983,239
Total Annual Fixed Costs	3,335,966	4,110,649
Total Daily Fixed Costs	9,531	11,745
Daily Fuel Costs (at sea)	2,567	3,167
Total Daily Costs (at sea)	12,098	14,912
Hourly Total Costs (at sea)	504	621

SOURCE: Dept. of the Army, *FY 1993 Planning Guidance.*

Trade Policies

The model includes export subsidies provided by the U.S., EU, and importer tariffs. Different subsidy levels apply to different EEP markets. Base-case bonus levels, shown in Table 3.10, are derived from regional weighted averages for 1988 to 1990. Quantity limits also apply to these subsidized shipments. Average bonuses were computed for each country receiving EEP shipments, using the ratio of annual initiatives to total initiatives as weights. Average annual initiatives were also computed. If more than one country belonging to a region was subsidized, the regional weighted average bonuses were computed. The ratio of average initiatives to total regional average initiatives were used as weights. Subsidized shipments to a region were constrained to be less than the total of average initiatives. The model does not allow subsidized shipments of U.S. malting barley in the base case.[14] These results are shown in Table 3.10.

TABLE 3.10. US EEP BONUSES AND INITIATIVES FOR MALT EXPORTS (Average 1990-93)

Region	Port	Malt Bonus ($/mt)	Volume (000 mt)
North Africa	Algiers	140	3.3
Central America	Balboa	96	4.8
Caribbean	Kingston	44	19.5
West Africa	Lagos	104	50.2
Philippines	Manila	106	19.6
N.S. America	Puerto la Cruz	79	17.7
E.S. America	Recife	83	8.2

EU's malt exports are eligible for refunds under the restitution scheme. The difference between the world price and internal market price is made up by refund payments to the exporters. Refunds may vary according to the destinations. Regulation 1124/77 divides major destinations of malt exports into eight zones. However, the logic behind varying refunds for different destinations is the varying freight rate, not to retaliate against export competitor strategies.

Export restitutions apply to shipments of malting barley and malt. Under the base case, the barley restitution is $125/mt, and the malt restitution is $167/mt (1.3 times the level for barley). The barley restitution is obtained by converting the monthly average for each year into U.S. dollars at an exchange rate prevailing in that year and then averaging for 1989/90 through 1991/92.

Different *ad valorem* tariffs apply to barley and to malt. Regional aggregate tariffs were obtained using a weighting scheme. Tariff rates were converted into percentages for each country. When information was missing for individual countries, zero tariffs were assumed. Each country's tariff was weighted by its average share in regional imports. The average was computed for the period 1988 through 1990. Regional percentage tariffs used in the base model are presented in Table 3.11.

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[14]EEP was extended to malting barley beginning in 1992, but no bids have been accepted under the program (personal communication from Dr. James Warden of USDA).

TABLE 3.11. REGIONAL WEIGHTED AVERAGE IMPORT Ad Valorem TARIFFS FOR MALTING BARLEY AND MALT

Region	Barley	Malt
	------------------%	------------------
North Africa	0	0
Middle East	0	0
Cen. America	0	0
Southern Africa	0	0
East Asia	17	17
Caribbean	0	0
West Africa	0	0
Philippines	20	30
East Africa	0	36
South Europe	23	7
Northern S. America	15	23
Eastern S. America	24	29
China	3	35
South Asia	0	5
Non-EU Europe	10	10
Oceania	0	0
Japan	10	20
Southern S. America	22	33
Russia	0	26

Data Sources

Data on U.S. area planted and harvested and yields were taken from the USDA/NASS. For Canada, the same data were obtained from Agriculture Canada sources. Data on barley quality were developed from *Know Your Barley Varieties* (American Malting Barley Association) and Barley Briefs (Malting Barley Research Institute) for the U.S. and Canada, respectively. Grade factor data in the U.S. were from state-level quality reports, and Canadian acceptance rates were from Carter (1993a).

Data for the U.S. brewing industry are from Brewers Almanac 1992, published by the Beer Institute (Washington, DC) and Brewers' Digest: 1991 Buyers Guide and Brewery Directory; data for Canada are from the 1992 statistical bulletin of the Brewers Association of Canada (Ottawa). U.S. beer production capacities at the state level were derived from the Brewer Almanac and Anheuser-Busch capacities from an Anheuser-Busch pamphlet. U.S. and Canadian malt plant locations, ownership, and capacities are from Canadian Wheat Board (1992).

Transport and handling costs are from several sources. U.S. rail rates were taken from Burlington Northern and CP/Soo Line Tariffs in the 1991 Waybill Data. Canadian rates were taken from CP and CN Rail tariffs. Trucking costs and formulas and handling costs were from industry sources in each country.

Information for the malting barley and malt availability and an export restitution mechanism in EU are obtained from Gauger and TOEPFER reports on barley and malt. Barley subsidies were obtained from World Grain Statistics published by the International Wheat Council. Availabilities of malting barley and malt for exports from Australia were obtained from Commodity Statistical Bulletin published by Australian Bureau of Agricultural and Rural Economics (ABARE). Availabilities in Austria, Czechoslovakia, Poland, and South America (Argentina, Chile, and Uruguay) were obtained from Pollack and Pool estimates.

Comparison of Cost Elements in Base Model

Many cost elements affect international competitiveness in the world malt and malting barley market. Before presenting the results from the linear programing model, this section makes some point-to-point comparisons of cost elements for key movements. The emphasis is on the individual cost elements in buying malting barley from major supply regions and shipping and handling costs associated with the movement to the indicated importing region.

Elements used in the base case are shown for this comparison. The value of feed barley, introduced as the opportunity cost of malting barley, was taken to be the nearest supply region (with adequate supplies and least shipping cost to the port). All other cost elements are the values from the base case. Results are shown in Tables 3.12 and 3.13 for malting barley and malt shipments, respectively. The regions chosen for illustration are some of the major world markets for malt and malting barley.

One major component of cost in the analysis is the value of feed barley. As illustrated, this value is relatively high for Hamburg (reflecting the effect of the CAP), Fremantle, and Portland. The latter reflect the value of the West Coast feed grains in the U.S. In contrast, it is relatively low for shipment through Canadian ports. The higher cost of domestic shipping in Canada reflects the effect of higher handling costs relative to those in the U.S.

For malting barley, Buenos Aires would be most efficient in serving Brazil, followed by Thunder Bay and Duluth. Thunder Bay has a cost advantage relative to Duluth due to lower values of feed barley. Vancouver would be most efficient in serving China and Japan, in both cases followed by Sydney and Buenos Aires. In both cases, shipments from Portland are relatively high, in part due to the high value of feed barley in that region.

Similar values for malt are shown in Table 3.13, including the effects of EEP and the EU export restitutions. Mobile is the lowest cost origin for Brazil followed by Hamburg. These would be high cost origins without subsidies. Absent subsidies for Brazil, the lowest cost origin is Buenos Aires, followed by Vancouver. For China, Vancouver and Sydney would be the lowest cost malt origin, followed by Hamburg (with restitution). Similar rankings exist with Japan. The last column also illustrates the effect of import tariffs on relative malt values. Price differentials are exacerbated by the application of *ad valorem* tariffs.

TABLE 3.12. COST ELEMENTS FOR MALTING BARLEY SHIPMENTS TO SELECTED MARKETS ($/MT OF MALTING BARLEY)

Ports	Feed Barley	Interior Transport and Handling	International Shipping	Subsidy	C&F Price	Price + Import Tariff
Importing Country: Brazil						
Portland	94	18	21		133	140
Duluth	68	18	16		102	107
Vancouver	58	25	22		105	111
Thunder Bay	59	24	16		99	104
Fremantle	112		24		136	143
Sydney	87		26		113	118
Buenos Aires	85		7		92	96
Hamburg	225		13	-125	113	119
Importing Country: China						
Portland	94	18	16		128	132
Duluth	68	18	39		125	128
Vancouver	58	25	15		99	102
Thunder Bay	59	24	39		122	126
Fremantle	112		13		125	128
Sydney	87		14		101	104
Buenos Aires	85		33		118	122
Hamburg	225		32	-125	132	136
Importing Country: Japan						
Portland	94	18	13		125	138
Duluth	68	18	36		122	134
Vancouver	58	25	13		96	106
Thunder Bay	59	24	36		119	131
Fremantle	112		13		125	138
Sydney	87		13		100	110
Buenos Aires	85		32		117	128
Hamburg	225		35	-125	135	148

TABLE 3.13: COST ELEMENTES FOR MALT SHIPMENTS TO SELECTED MARKETS ($/MT OF MALT)

Ports	Feed Barley**	Interior Transport and Handling	International Shipping	Subsidy	C&F Price*	Price + Import Tariff
Importing Country: Brazil						
Portland	113	48	37	-83	211	232
Mobile	93	43	22	-83	181	199
Vancouver	77	26	39		237	261
Thunder Bay	77	50	29		251	276
Fremantle	149		43		288	317
Sydney	116		46		258	284
Buenos Aires	113		12		221	243
Hamburg	300		24	-167	253	278
Importing Country: China						
Portland	113	48	25		285	385
Mobile	93	43	28		295	398
Vancouver	77	26	27		226	305
Thunder Bay	77	50	69		292	394
Fremantle	149		22		267	360
Sydney	116		25		237	320
Buenos Aires	113		59		268	362
Hamburg	300		57	-167	286	386
Importing Country: Japan						
Portland	113	48	40		298	343
Mobile	93	43	85		327	376
Vancouver	77	26	40		238	274
Thunder Bay	77	50	64		287	330
Fremantle	149		42		287	330
Sydney	116		41		253	291
Buenos Aires	113		56		265	305
Hamburg	300		61	-167	290	334

*Includes an assumed marginal processing cost of $96 across all origins.
**Feed Barley prices represent cost of barley required to produce one MT of malt, i.e., 1.33*price of a MT of feed barley. Feed barley prices are referenced at production regions in NA while they are referenced at ports for regions outside of NA.

A comparison of values in these tables shows cost differences between importing malt and importing malting barley. For example, the total cost of importing barley into Brazil, regardless of origin, is substantially less than the cost of importing malt. This is largely due to the effect of the tariff differential, which more than offsets the export subsidy on malt from the U.S. and EU. Similar conclusions can be made with respect to China and Japan.

IV. EMPIRICAL RESULTS

The model was used to analyze spatial competition in the malting barley and malt sector and to analyze the effects of change on this industry. Base case results are presented along with a detailed explanation of trade flows and relevant marginal values. Three additional sets of simulations were then run and compared to the base case. First, a set of scenarios concerns aggregate trade policies. Simulations were conducted on the effects of CAP reforms and changes in U.S. and EU export subsidies and import tariffs. Second, a set of simulations analyzed effects of some important changes in the world beer market. Finally, some logistical requirements important to this industry were analyzed.

Base Case Results

This section presents base case simulation results, focusing primarily on offshore trade in malting barley and malt. Results are reported for aggregate exports and imports, optimal source-destination trade flows, and marginal values of crucial constraints.

Aggregate Exports and Market Shares

Total malting barley exports, aggregated by type, amount to 30 percent of the total malt requirements of importing regions (Table 4.1). Two-rowed (2R) varieties dominate world market, both in malting barley and malt. Six-rowed (6R) varieties represent 19 percent of world malting barley exports, but less than 2 percent of world malt exports.

Exports of 2R malting barley are dominated by Canada (49 percent) and Australia (39 percent) (Table 4.1). Remaining 2R malting barley exports are divided between South America (8 percent) and the EU (4 percent). The United States accounts for 97 percent of all 6R malting barley exports.

Exports of 2R malt from the EU represent 54 percent of the world total (Table 4.1). Other exporters of 2R malt include Australia (16 percent), eastern Europe (11 percent), South America (9 percent), Canada (8 percent), and the United States (3 percent). All 6R malt shipments are from the United States.

Malting barley and malt imports, by region and type, are shown in Table 4.2. China accounts for 42 percent of world imports of 2R malting barley. Other importers of 2R malting barley include Japan (15 percent), eastern South America (11 percent), northern South America (11 percent), east Africa (7 percent), Russia (7 percent), and western South America (6 percent). The leading importer of 6R malting barley is eastern South America (67 percent), followed by Japan (25 percent) and northern South America (8 percent).

TABLE 4.1. BASE MODEL: EXPORTS AND MARKET SHARES, BY SOURCE AND BARLEY/MALT TYPE

		Malting Barley		Malt	
Exporting Country	Port	6RW	2RW	6RW	2RW
		----	---- 000 mt	----	----
USA	Portland	65 (0.22)	0	4 (0.09)	50 (0.02)
	Duluth	226 (0.75)	0	0	0
	Mobile	0	0	39 (0.91)	16 (0.01)
Canada	Thunder Bay	0	282 (0.22)	0	0
	Vancouver	10 (0.03)	348 (0.27)	0	211 (0.08)
Australia	Fremantle	0	103 (0.08)	0	204 (0.08)
	Sydney	0	400 (0.31)	0	204 (0.08)
European Union	Hamburg	0	50 (0.04)	0	1447 (0.54)
S. America	Buenos Aires	0	100 (0.08)	0	242 (0.09)
Eastern Europe	Hamburg	0	0	0	305 (0.11)
Total		301	1283	43	2679

*Figures in paranthesis represent individual ports' shares of total exports of indicated commodity.

Every region included in the study imports 2R malt, except for China, western South America, and Russia (Table 4.2). Japan is the largest importer of 2R malt, accounting for 19 percent of the world total. Other large import markets for 2R malt are southern and northern (non-EU) Europe, eastern South America, southern Africa, and west Africa. Importers of 6R malt include northern South America (42 percent), eastern South America (19 percent), the Philippines (18 percent), the Caribbean (13 percent), and Central America (9 percent).

Trade Flows

The model identifies optimal flows by type of malting barley and malt (Tables 4.3 and 4.4). Results reflect the mode of transportation for malt, (i.e., bulk or container shipping), and whether the shipment is subsidized or non-subsidized.

China imports 434 thousand metric tons (tmt) of 2R malting barley from Australia, and 111 tmt from Canada (Tables 4.3 and 4.4). China is the major market for Australian malting barley, accounting for 86 percent of Australian exports. Eastern South America (Brazil and Paraguay) imports 202 tmt of 6R malting barley from the

TABLE 4.2. BASE MODEL: MALTING BARLEY AND MALT IMPORTS AND SHARES BY REGIONS AND TYPE

		Malting Barley		Malt	
Region	Port	6RW	2RW	6RW	2RW
		-000 mt			
North Africa	Algiers	0	0	0	18 (0.006)
West Asia	Bahrain	0	0	0	11 (0.004)
Central America	Balboa	0	0	4 (0.09)	46 (0.02)
Southern Africa	Cape Town	0	0	0	265 (0.10)
East Asia	Hong Kong	0	0	0	92 (0.03)
Caribbean	Kingston	0	0	6 (0.13)	64 (0.02)
West Africa	Lagos	0	0	0	219 (0.08)
Philippines	Manila	0	0	8 (0.18)	118 (0.04)
East Africa	Mobassa	0	93 (0.07)	0	5 (0.002)
South Europe	Piraeus	0	0	0	452 (0.17)
Northern South America	Puerto la Cruz	24 (0.08)	136 (0.11)	18 (0.41)	102 (0.04)
Eastern South America	Recife	202 (0.67)	146 (0.11)	8 (0.19)	262 (0.10)
China	Shanghai	0	545 (0.42)	0	0
South East Asia	Singapore	0	0	0	88 (0.03)
Non-EU North Europe	Stockholm	0	0	0	387 (0.14)
Oceania	Suva	0	0	0	49 (0.02)
Japan	Tokyo	75 (0.25)	193 (0.15)	0	498 (0.19)
Western South America	Valparaiso	0	82 (0.06)	0	0
Russia	Vladivostok	0	44 (0.03)	0	0
	Odessa	0	44 (0.03)	0	0
Total		301	1283	43	2679

Shares in Parantheses.

TABLE 4.3. BASE MODEL: OPTIMAL OFFSHORE MALTING BARLEY TRADE FLOWS

Importers	Type	Exporters					Total
		United States	European Union*	Canada	Australia	South America	
		000 mt					
East Africa (Mobassa)	2RW		6		69	18	93
Northern South America (Puerto la Cruz)	6RW	24					24
	2RW			136			136
Eastern South America (Recife)	6RW	202					202
	2RW			146			146
China (Shanghai)	2RW			111	434		545
Japan (Tokyo)	6RW	65		10			75
	2RW			193			193
Western South America (Valparaiso)	2RW					82	82
Russia (Odessa and Vladivostok)	2RW		44	44			88
TOTAL	6RW	291		10			301
	2RW		50	630	503	100	1283

* Subsidized shipments.

United States, and 146 tmt of 2R malting barley from Canada. Japan is Canada's largest market for malting barley, importing 193 tmt, or 31 percent of total Canadian exports. Canada also exports 2R malting barley to northern South America and Russia. Malting barley shipments from the EU are largely to Russia, while most exports from South America (Argentina, Chile, and Uruguay) are to adjacent countries.

Malt exports from the United States are mostly to South America, Central America, the Caribbean, the Philippines, and North and West Africa, all of which are under EEP. The EU exports malt to North and West Africa, Central and South America, the Caribbean, and surrounding Non-EU countries. All shipments originating from the EU are subsidized. Other European countries (Austria, Czechoslovakia, and Poland) export to Japan, West Asia, and East Africa. South America exports to southern and west Africa. Canada exports 2R malt to Japan and the Philippines while Australia exports malt to southern Africa, east Asia, southeast Asia, Oceania, and Japan.

All exporters were allowed to export malt in bulk or containers. However, only six importing regions (southern Africa, west Africa, northern and western South America, non-EU northern Europe, and Caribbean countries) were allowed to import malt in bulk. Bulk shipments from the United States go to western Africa and northern South America. Australia exports malt in bulk to southern Africa while shipments to eastern Asia, southeastern Asia, Oceania, and Japan were by containers. The EU shipped more than one-third of their malt in bulk, the rest in containers. Most of the bulk shipments from the EU are to non-EU northern Europe and northern South America, two of the major bulk malt importers. Canada and eastern Europe export malt exclusively by containers to Japan and the Philippines. Overall, 34 percent of 2R malt was shipped in bulk, the rest in containers.

TABLE 4.4. BASE MODEL: OPTIMAL OFFSHORE MALT FLOWS

Importers (Port)	Type	United States Subsidized Bulk	United States Subsidized Cont	European Union Subsidized Bulk	European Union Subsidized Cont	Canada Non-Subsidized Cont	Australia Non-Subsidized Bulk	Australia Non-Subsidized Cont	E. Europe Non-Subsidized Cont	Latin America Non-Subsidized Bulk	Latin America Non-Subsidized Cont	Total
		------	------	------	------	------	000 mt	------	------	------	------	------
NORTH AFRICA (Algiers)	2RW		3		14							17
WEST ASIA (Bahrain)	2RW								11			11
CENTRAL AMERICA (Balboa)	6RW		4									4
	2RW		1		46							47
SOUTH AFRICA (Capetown)	2RW						73			126	66	265
EAST ASIA (Hong Kong)	2RW							92				92
CARIBBEAN (Kingston)	6RW		6									6
	2RW			14	50							64
WEST AFRICA (Lagos)	2RW	50		102	16						50	218
PHILIPPINES (Manila)	6RW		8									8
	2RW		12			106						118
EAST AFRICA (Mobassa)	2RW								6			6
SOUTH EUROPE (Piraeus)	2RW				452							452
NORTHERN SOUTH AMERICA (P.l.cruz)	6RW	18										18
	2RW			102								102
EASTERN SOUTH AMERICA (Recife)	6RW		8									8
	2RW			14	249							263
SOUTH EAST ASIA (Singapore)	2RW							88				88
NON-EU NORTH EUROPE (Stockholm)	2RW			271	116							387
OCEANIA (Suva)	2RW							49				49
JAPAN (Tokyo)	6RW					105		106	288			499
TOTAL	6RW	18	25									43
	2RW	50	16	504	943	211	73	335	305	126	116	2679

Given EEP subsidies, the United States enjoys an advantage in exporting bulk malt to northern South America, as indicated by the magnitude of 6R bulk malt shipments. Other markets where the United States enjoys a cost advantage are western Africa and northern South America by bulk, and the Phillippines, eastern South America, Caribbean and Central American countries by container.

Marginal Values: Malting Barley and Malt Supplies

Table 4.5 presents quantities of malting barley and malt supply, by type, at export points and their marginal values.[15] Constraints are specified differently for North American ports, and hence the marginal values are not directly comparable to those for other regions.[16] For North American ports, marginal values reflect costs of barley acquisition, domestic transport, and processing (for malt) before export. Thus, they are equivalent (ignoring signs) to North American port prices for malting barley and malt. For other export regions, the marginal values represent the net cost savings that would be realized, *ceteris paribus*, if an additional ton were available for export. For example, if an additional ton of 2R malt were available for export from Hamburg, total costs decrease by $82. This reflects the displacement of a higher-cost supplier by EU malt in some import market.

The zero marginal values for 2R malting barley indicate surplus availability at Fremantle, Australia (Table 4.5). North America also has additional capacity to export malting barley.[17] However, availability is fully utilized in Sydney, Hamburg, and Buenos Aires. Marginal values are generally higher (in absolute terms) for 2R malting barley than for 6R at export ports.

Comparing marginal values for malt, 2R malt is more highly valued than 6R at most North American export ports (Tables 4.5). Thunder Bay is an exception. However, the reverse is true in EU, eastern Europe, and Australia. Although these regions do not produce 6R malt (or malting barley), the marginal values suggest there would be cost advantages in doing so. It must be emphasized that these interpretations apply "at the margin," rather than for "large" changes in parameter values. Implicit price premiums for different types of malt (i.e., 2R at U.S. export ports, 6R elsewhere) are likely due to the requirements of specific malt importers. If these markets (especially for 6R) are small or easily saturated, then premiums might not survive even modest changes in supply conditions. That is, the results may be heavily dependent on assumptions about quantities and types of malt available for export.

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[15]Information regarding the malting barley availability for exports from Non-EU Europe was not available. Also, Duluth does not export either type of malt; therefore, these flows were not allowed in the model.

[16]For North American export ports, supplies are not predetermined, but endogenous. Marginal values are associated with material-flow constraints; these ensure that outflows (exports to offshore markets) are no greater than inflows (shipments received from domestic production regions). In contrast, constraints for exporting regions outside of North America specify that the sum of outflows cannot exceed a fixed quantity (i.e., malting barley or malt available for export).

[17]Although not apparent from values shown in Table 4.5, there is surplus capacity in North American barley production regions.

TABLE 4.5. MARGINAL VALUES: AVAILABILITIES ($/MT) OF MALTING BARLEY AND MALT IN EXPORT COLLECTION POINTS

			Malting Barley		Malt	
Exporter	Port	Type	Availability	Marginal*	Availability	Marginal
			-------------------------------- 000 mt	-----------	-----------	-----------
Australia	Fremantle	6RW	0	0	0	-52
		2RW	400	0	204	-31
	Sydney	6RW	0	-24	0	-68
		2RW	400	-25	204	-54
EU	Hamburg	6RW	0	-3	0	-99
		2RW	50	-3	1447	-82
South America	Buneos Aires	6RW	0	-15	0	-63
		2RW	100	-19	242	-63
Eastern Europe	Hamburg		**		0	-100
			**		305	-78
USA	Portland	6RW	na	-112	na	-256
		2RW	na	-113	na	-285
	Mobile	6RW	na	-107	na	-271
		2RW	na	-119	na	-310
	Duluth	6RW	na	-96	**	
		2RW	na	-111	**	
Canada	Thunder Bay	6RW	na	-96	na	-283
		2RW	na	-111	na	-275
	Vancouver	6RW	na	-112	na	-273
		2RW	na	-113	na	-274

na: Not Applicable
* marginal values for N. American ports have different interpretation (see text)
** No malting barley shipments from Eastern Europe and no malt shipments from Duluth allowed.

Marginal Values: Malt Plant Capacities

Table 4.6 shows North American malt plant capacities, optimal levels of capacity utilization, and marginal values. The marginal value represents the change in objective function (‘000 dollars) value for a unit ('000 mt) increase in malt plant capacity at a given location. For example, given that the Minneapolis plants would operate at full capacity in this analysis, an additional mt of capacity would be worth $11. In contrast, there is surplus capacity at Wisconsin, and an additional unit of capacity there would be worth zero.

Within North America, Wisconsin plants had the largest unused capacity (Table 4.6). Results suggest the value of additional capacity would be greatest at Idaho Falls followed by Spirtwood, Winnipeg, Alix, and Calgary. These plants have the greatest incentive to expand, based on transportation costs and other model parameters.

TABLE 4.6. MARGINAL VALUES: MALT PLANT CAPACITIES IN NORTH AMERICA

	Utilization	Capacity	Marginal
	------------------- 000 mt -----------------------		
Spiritwood	347	347	-25
Minneapolis	562	562	-11
Winona	155	155	-10
Wisconsin	498	1143	0
Chicago	137	137	-8
Buffolo	51	51	-13
Pocatello	130	130	-9
Idaho Falls	162	162	-26
Vancouver	178	250	0
Los Angeles	91	91	-22
Alix	80	80	-24
Calgary	206	206	-24
Biggar	166	166	-22
Thunder Bay	185	185	-22
Winnepeg	113	113	-25
Mexico	349	460	0

Table 4.7 shows marginal values for malt plant capacities in foreign demand regions. For most importing regions, it is more efficient to import malt than malting barley. This is suggested by underutilized malt plant capacities in western Asia, southern Africa, eastern Asia, and southeastern Asia, Non-EU northern Europe, and southern Europe. Although China and western South America import malting barley, they do not exhaust existing malt plant capacities.[18] Four regions have zero capacity. Only one of these, the Philippines, has a nonzero marginal value, indicating that local malt production would be cost-effective. Five demand regions produce malt at full capacity. East Africa has the largest marginal value in absolute terms. Besides east Africa and the Phillipines, other regions at full capacity are eastern South America, northern South America, and Japan.

Marginal Values: Limits on U.S. Malt EEP

Regions receiving EEP subsidies are shown in Table 4.8 along with EEP quantity limits and their marginal values.[19] Shipments to all these regions are constrained by the quantity limits, excepting flows to

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[18]The result for China is somewhat surprising given that considerable capacity expansion is now underway or planned. There are two alternative explanations. First, the model may underestimate beer consumption or the malt required per barrel in China. Second, Chinese capacity expansion may be due to anticipated growth in beer consumption and therefore malt demand.

[19]Quantity limits are obtained from annual historical shipments to these countries from the United States and do not refer to individual EEP initiatives.

TABLE 4.7. MARGINAL VALUES: MALT PLANT CAPACITIES IN FOREIGN DEMAND REGIONS

		Malt Plant Capacities		
Region	Port	Utilization	Capacity	Marginal
		(tmt)	(tmt)	$/mt
North Africa	Algiers	0	0	0
West Asia	Bahrain	0	18	0
Central America	Balboa	0	0	0
Southern Africa	Cape Town	0	201	0
East Asia	Hong Kong	0	256	0
Caribbean	Kingston	0	0	0
West Africa	Lagos	0	0	0
Philippines	Manila	0	0	-9
East Africa	Mobassa	70	70	-40
Southern Europe	Piraeus	0	417	0
Northern South America	Puerto la Cruz	120	120	-2
Eastern South America	Recife	261	261	-7
China	Shanghai	409	670	0
South East Asia	Singapore	0	18	0
Non-EU north Europe	Stockholm	0	322	0
Oceania	Suva	0	60	0
Japan	Tokyo	201	201	-4
Western South America	Valparaiso	61	68	0
Russia	Vladivostok	33	250	0
	Odessa	33	250	0

the Caribbean. Marginal values indicate how the objective function value would change if an additional unit of malt under EEP were allocated to a region. Thus, for example, the reduction in total costs would be greatest for eastern South America (Brazil and Paraguay) and least for the Caribbean. In the latter case, shipments were less than the EEP allocation, so a larger allocation (with no change in bonus level) would not expand U.S. exports.

It is instructive to compare marginal values with EEP bonus levels.[20] Both vary across importing regions (Table 4.8). For most regions, the bonus level exceeds the marginal value in absolute terms. In these cases, additional purchases of U.S. malt under EEP would displace (2R) malt imports from other sources that are otherwise cost-competitive. Reductions in total cost (the objective function) are less than the value of the EEP subsidy borne by U.S. taxpayers.

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[20]While marginal values are associated with a global criterion (total costs of satisfying malt requirements), bonus levels represent costs borne by U.S. taxpayers for each ton of malt exported under EEP.

TABLE 4.8. OPTIMAL LEVELS, LIMITS, AND MARGINAL VALUES OF U.S. MALT EXPORT ENHANCEMENT PROGRAM

Region	Port	Level	Upper	Marginal(M)	Bonus (B)	B-M
		(tmt)	(tmt)	----------------$/mt-	-------------------	
North Africa	Algiers	3.3	3.3	-50	40	90
Central America	Balboa	4.81	4.81	-35	96	61
Caribbean	Kingston	5.558	19.5	0	44	44
West Africa	Lagos	50.15	50.15	-35	104	69
Philippines	Manila	19.6	19.6	-69	106	37
Northern South America	Puerto la Cruz	17.67	17.67	-91	79	-12
Eastern South America	Recife	8.2	8.2	-98	83	-15

However, in two regions, northern and eastern South America, the marginal value exceeds the bonus level (Table 4.8). These regions import 6R malting barley from the United States in the base case. A larger EEP allocation would induce them to import less 6R malting barley and more 6R malt. Impacts on shipping and tariffs are such that, at the margin, reductions in total cost exceed the value of EEP subsidies provided to these regions.

Trade and Agricultural Policy Simulation

Simulations were conducted to evaluate effects of possible changes in trade policy variables. Exporter shares of individual markets are shown for each simulation. Figures 4.1 and 4.2 illustrate the market shares for malting barley and malt, respectively.[21]

CAP Reform: Reducing EU Malt Availability for Exports

EU area planted to barley has been declining and is expected to decline due as internal support programs are phased out. This is expected to have an impact on the levels of malt production and, in turn, on export surplus. In the base model, EU malt export availability is exogenous, based on estimates of area planted, selection for malting, and domestic malt use. To simulate the effects of changes in government support (and reduced barley planting), we reduce the availability of EU malt for export.

The average area under barley in EU during 1989-91 was 12.3 million hectares, declining to 10.6 million hectares in 92-94, a decrease of 13.5 percent. The decrease in production was even more pronounced, from an annual average of 51 mmt in 1989-91 to 43 mmt in 1992-94, a decrease of 16.8 percent. The decrease in area and production had a major effect on feed consumption. Average feed consumption decreased from 31 to 27 million mt (12.7 percent). Consumption other than feed declined by 0.6 mmt. Considering that nonfeed consumption is primarily for malt use, the decline of 0.6 mmt translates into a decrease in malt production of 0.4 million mt.

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[21]Nominal values for flows for each of these simulations are shown in Appendix Table A2.6.

Given the dominant position of the EU, these changes could be expected to have fairly dramatic effects on the distribution of malt in the world market. Simulations conducted in this section were done to identify impacts of reduced EU malt availability on world trade flows. The most important objective is to identify in which regions the EU loses market share to other exporters.

The base case level of malt exports was 1.447 million mt. This was reduced to 1.0 million mt to illustrate the effects of supply reductions.

Most of the change occurs in the malt sector, although there are some changes in malting barley flows. Australian malting barley exports would increase by almost 200 tmt, although not all of the availability is exhausted. Shipments of 2R malting barley from Canada would increase by more than 150 tmt. Increased shipments from Thunder Bay account for most of this change. Shipments of 6R malting barley from Duluth would decrease, and are offset by higher 6R malt exports from Mobile.[22]

The effect of decreases in EU malt export availability has important implications for malt trade. EU malt shipments to Central America are reduced and replaced by shipments from Eastern European countries. EU also lose a considerable share of the Caribbean market to the United States. Other markets that EU loses are western and eastern Africa and eastern (Brazil and Paraguay) and northern (Colombia and Venezuela) South America. The east African market is captured by Australia while EU shipments to west Africa are replaced by South American countries. U.S. shipments to northern South America increase by 38 percent, while malting barley shipments from Canada and malting barley and malt shipments from South American countries replace EU shipments to eastern (Brazil and Paraguay) South America.

East Asia would switch from importing malt to malting barley, with Canadian malting barley exports replacing Australian malt exports. In southern Africa, Australia and eastern Europe replace malt supplies from South America. Similarly, Australia would replace Canadian malting barley shipments to China. Also, Canadian malting barley exports would replace South American malting barley exports to western South America, and Australian malting barley exports would replace Canadian malting barley exports to Russia.

Reductions in EU malt supply would increase the share of Canadian malting barley in all of South America. U.S. exports of malting barley would not be affected (Figures 4.1 and 4.2). More drastic changes occur in malt market shares. The United States would gain shares in northern and eastern South America, Canada would gain in Japan, and Australia would gain in southern Africa.

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[22]Under alternative simulation scenarios, the availability at offshore locations other than North America is kept at constant levels. Therefore, the changes (absolute gains in market share) are manifested mainly in the cases of Canada and the United States. The gain for Australia is due to an underutilized supply of malting barley. Stronger statements cannot be made regarding gains in market share, since the malt supplies (available for export) in Australia, Non-EU Europe, and Latin America are kept at baseline levels. In this sense the discussion on marginal values of export availability constraints in the following paragraphs are more revealing.

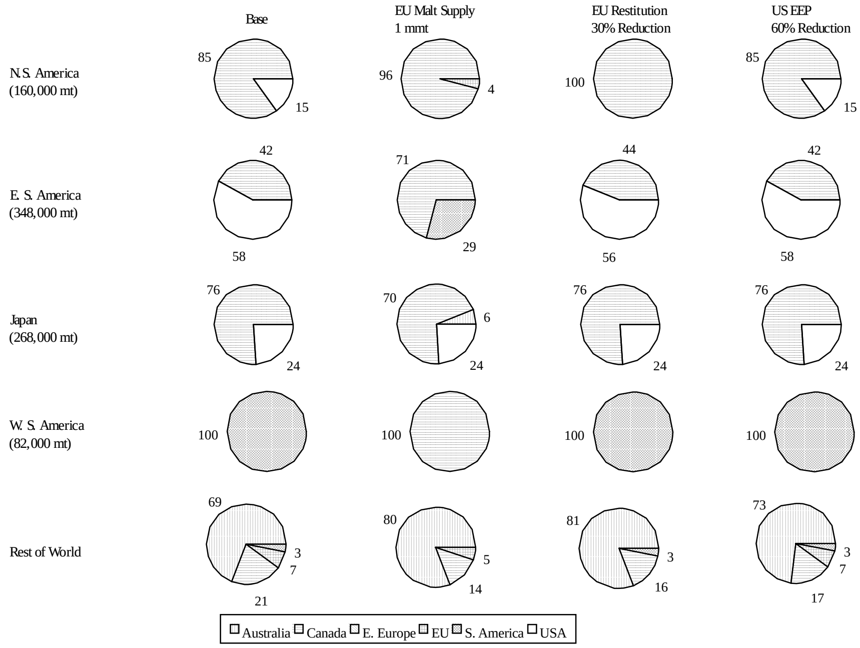

Figure 4.1. Exporter Market Shares in Selected Malting Barley Importing Regions Under Base Case and Different EU and U.S. Policies

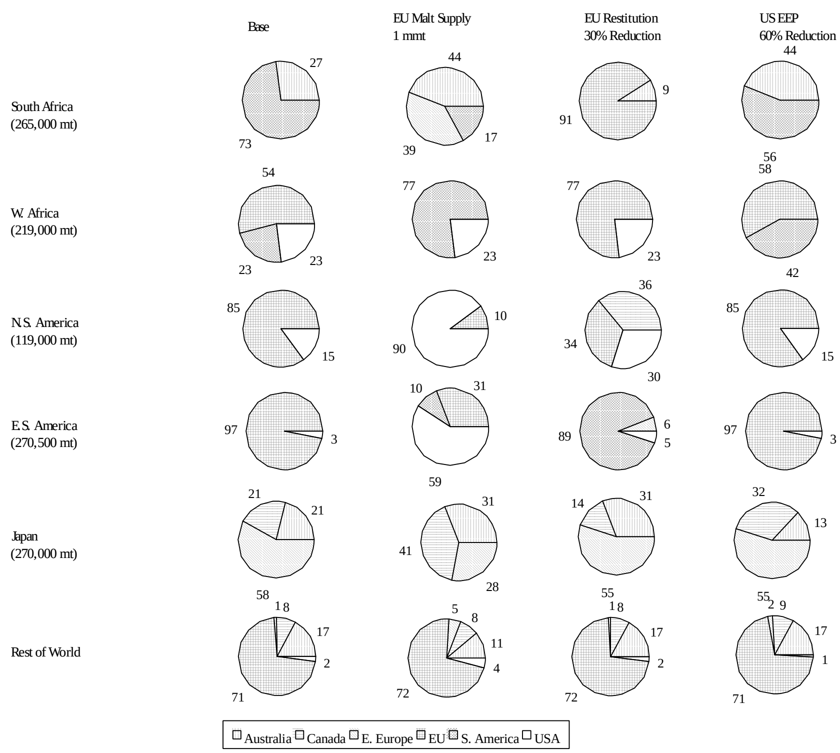

Figure 4.2. Exporter Market Shares in Selected Malt Importing Regions Under Base Case and Different EU and U.S. Policies

Changes in EU malt export supply affect marginal values of malting barley supply to a small extent (Table 4.9).[23] The largest increase in barley values ($11/mt) is observed at the North American ports of Mobile, Duluth, and Thunder Bay. Changes in marginal values of malt are more extreme. With EU malt export availability set at 1 million mt, the value of 2R malt at Thunder Bay increases by 34 $/mt. Large increases in malt values (especially 2R) are also observed in other export regions. In Hamburg, an additional ton of 2R malt would be worth $24 more than in the base case. Changes in 2R malt values are comparatively small at U.S. ports. Values of 6R malt also increase by $13/mt in Portland and Mobile.

Based on the marginal values for malt supplies, it appears that Canada would be most favored by the decrease in EU malt availability (Table 4.9). Australia and South America would also stand to gain, should they have an exportable surplus.

Reduced EU availability of malt exports increases the marginal values of malt plant capacities in east Africa, the Philippines, northern South America (Columbia and Venezuela), eastern South America (Brazil and Paraguay), and Japan (Table 4.10). These regions would be under greater pressure to import malting barley and process it locally. The change in marginal values is largest in east Africa..

East Asia, a region with surplus malting capacity in the base case, begins to import more malting barley as a result of reduced EU malt availability (Table A2.6). The Philippines would have greater incentive to build malting capacity (Table 4.10). Likewise, there would be greater incentive for capacity expansion in northern South America (Columbia and Venezuela), eastern South America (Brazil and Paraguay), and Japan.

EU Malt Export Restitution

Recently, budgetary pressures and trade negotiations have led the EU to reduce its export subsidies. The effects of reductions in EU subsidies on other exporters are of central interest here. Reductions in export restitutions on malt and malting barley would be expected to reduce the competitiveness of EU malt. Simulations in this section quantify the potential impacts of reduced EU restitutions on trade flows and exporter market shares.

Specific details regarding the phasing out of these trade policy measures are not available. Hence, simulations were conducted with various restitution values, ranging from 0.7 to 0.95 times the base-case levels ($167/mt for malt, $125/mt for malting barley). Results are shown for a 30 percent reduction in restitution (Table 4.9). The composition of imports, in terms of malting barley and malt, was unchanged for restitution decreases of less than 30 percent.

Figures 4.1 and 4.2 show how exporter market shares change, relative to the base case, in selected import markets. Detailed results are reported in Table A2.6.[24] Russia would import more malt and less

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[23]The interpretation of changes in marginal values needs to be clarified. The optimization problem minimizes total costs of transportation and processing. Thus, marginal values pertaining to the export availabilities and malt plant capacities are negative, indicating a reduction in total costs when constraints are relaxed. Changes in the marginal values are calculated as:

[MV in alternative simulation] − [MV in base case].

If this difference is negative, export supply (or malt capacity) at a particular location has become more valuable relative to the base case.

[24]Table A2.6 reports changes in exporter market shares for malt and malting barley combined (in malt equivalent), by importing region. The reported percentages are changes in exporter shares relative to the base case. For each importing region, the changes (malt and malting barley combined) sum to zero.

TABLE 4.9. CHANGES IN MARGINAL VALUES OF MALTING BARLEY AND MALT AVAILABILITIES FROM BASE CASE FOR ALTERNATIVE TRADE POLICIES

			EU Malt Availability Set at 1 mmt		EU Refund Reduced by 30%		US EEP Reduced by 60%	
Exporting Region	Port	Type	M. Barley	Malt	M. Barley	Malt	M. Barley	Malt
			$/mt					
Australia	Fremantle	6RW	0	-1	0	-1	0	-1
		2RW	0	-23	0	0	0	-1
	Sydney	6RW	-1	-6	0	0	0	-1
		2RW	0	-20	0	0	0	0
EU	Hamburg	6RW	-3	-6	0	53	0	-1
		2RW	-3	-24	0	59	0	-2
S. America	Buenos Aires	6RW	-6	-23	0	0	3	-1
		2RW	-10	-23	0	-6	0	-2
Eastern Europe	Hamburg	6RW	..	2	..	0	..	0
		2RW	..	-20	..	0	..	0
USA	Portland	6RW	-8	-13	0	0	0	4
		2RW	-9	-9	0	0	0	9
	Mobile	6RW	-9	-13	0	0	4	5
		2RW	-11	-2	0	0	0	13
	Duluth	6RW	-9	..	0	..	4	..
		2RW	-11	..	0	..	0	..
Canada	Thunder Bay	6RW	-9	8	0	0	4	5
		2RW	-11	-34	0	-9	0	-2
	Vancouver	6RW	-8	-20	0	0	0	0
		2RW	-8	-20	0	0	0	0

TABLE 4.10. CHANGES IN MARGINAL VALUES OF MALT PLANT CAPACITIES IN FOREIGN DEMAND REGIONS: ALTERNATIVE TRADE POLICIES

Importing Regions	Ports	Change in Marginal Values from Base Case ($/mt)		
		EU Malt Export Availability Reduced to 1 mmt	EU Export Refund Reduced by 30%	US EEP Reduced by 60%
Philippines	Manila	-10	-1	-1
East Africa	Mobassa	-20	-1	-1
N.S. America	Puerto la Cruz	-9	-6	-2
E.S. America	Recife	-9	-8	-2
Japan	Tokyo	-10	-1	-1

malting barley, but in no other region are there shifts in the composition of trade (Table A2.6). Eastern South America switches its malt imports from the EU to South American producing countries (Figure 4.2). The EU also loses malt market share in northern South America (to Canada and the United States), while gaining a larger share of malt markets in western and southern Africa.

Curiously, the reduction in EU export restitutions leads to displacement of U.S. malting barley in northern South America (by Canada). Otherwise, changes in malting barley flows are negligible (Figure 4.2), as are changes in marginal values associated with malting barley supplies (Table 4.9). Malt values (2R) at Hamburg decline by $59 relative to the base case, while small increases are observed in Thunder Bay, Buenos Aires, and Fremantle.[25] No changes are observed in malt values at U.S. export ports.

Reduced export restitutions would improve marginal values of malt plant capacities in importing locations (Table 4.10). Most notable are changes in eastern South America, followed by northern South America, east Africa, the Philippines, and Japan.

U.S. Malt EEP

The United States has attempted to expand exports of malt since 1986 and malting barley since 1992 through the Export Enhancement Program. However, sales of malting barley were not made under EEP until 1995. Hence, simulations were restricted to varying the malt EEP bonuses ($/mt), which vary across regions. Rather than conducting separate simulations for individual regions (which would lead to an enormous volume of output), we reduced EEP bonuses to all regions simultaneously.

Bonuses decrease by varying amounts for purposes of sensitivity analysis. Results for U.S. malt exports are summarized in Figure 4.3. The base case assumed a weighted average EEP bonus of U.S.$ 93/mt. In alternative simulations, bonuses are reduced by 10 to 80 percent in all regions. The United States exports 110 tmt of malt in the base case. As expected, U.S. exports decline as the bonus is reduced. Results may be particularly sensitive to bonus reductions in the 30 to 40 percent range, with U.S. malt export volumes falling from 100 to 40 tmt.

[25]Because EU malt qualifies for a lower export subsidy (relative to the base case), it is less valuable in the context of the model's objective of global cost minimization. From an importer perspective, EU malt is more expensive.

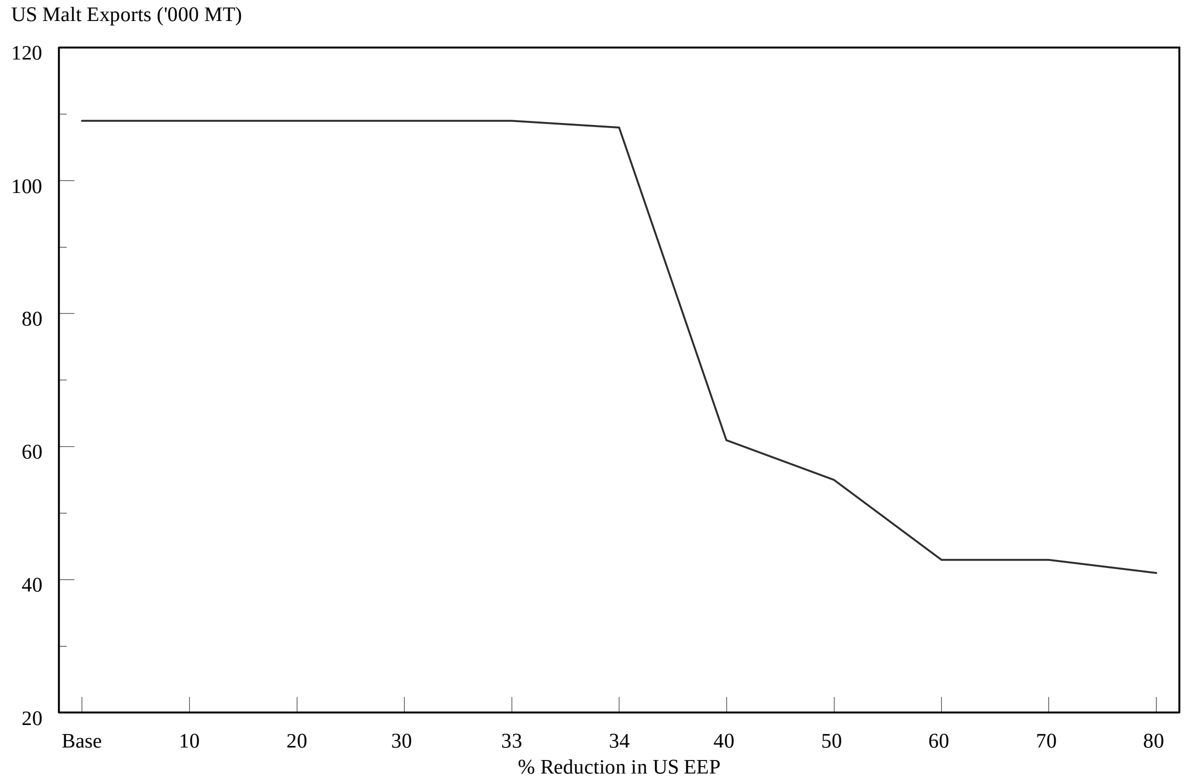

Figure 4.3. Reductions in U.S. EEP Bonus and U.S. Malt Exports

U.S. exports and world trade patterns remained more or less identical for reductions in EEP of 60 percent and higher. In the following discussion, results for a 60-percent bonus reduction are compared to the base case.

Exporter shares of malting barley markets are largely unchanged (Figure 4.1). However, the reduction in EEP reduces U.S. 2R malt shipments by more than one-half relative to the base case. Malt shipments from Portland are completely eliminated. The United States exports less malt to north Africa, Central America, west Africa, and the Philippines. U.S. malt is replaced by EU malt in north Africa, by EU and South American malt in west Africa, and by EU and Canadian malt in the Philippines.

Marginal values for supplies of malting barley and malt at export ports are not changed substantially outside North America (Table 4.9). The value of 6R malting barley declines $4/mt in Mobile, Duluth, and Thunder Bay. The impact on malt values is largest in Mobile, the port that handles most EEP shipments in the base case. The value of 2R malt declines by $13/mt in Mobile and $9/mt in Portland; smaller declines are observed for 6R malt in North American ports. Outside of North America, malt values increase by $1-2/mt because of lower EEP bonuses.

Reductions in U.S. EEP slightly affect the marginal values of malt plant capacities in east Africa, Japan, northern and eastern South America, and the Philippines (Table 4.10). Changes are in the range of $1-2/mt.

EEP Strategies: Malt vs. Malting Barley

An important issue in the administration of EEP is whether program initiatives should cover both malting barley and malt, or malt alone. EEP initiatives have usually targeted malt, rather than malting barley. Sales of malting barley under the program have been negligible. However, this is at the discretion of U.S. program administrators. Allocations across commodities (and countries) can be changed as need arises, and bonuses vary with market conditions. For perspective, the EU export restitution mechanism is less flexible. EU restitutions for malt are in a fixed proportion (1.3) to those for barley, and export licenses for malt are issued annually.

To illustrate the effects of alternative EEP allocations, two sets of simulations were conducted. In the first, EEP subsidies apply only to U.S. malting barley exports, and in the second, they apply only to U.S. malt exports. The EEP budget is fixed at U.S.$10 million in both cases.[26] For simplicity, bonus levels for malting barley or malt are assumed to apply equally to all importing regions.

For malting barley, bonus levels were varied by $5 increments between U.S.$10/mt and $50/mt. Corresponding quantity limits were obtained by dividing total EEP expenditures ($10 million) by the bonus level. Thus, quantity limits ranged from 1.0 to 0.2 million mt. Both the bonus level (in the objective function) and the quantity limit (a model constraint) were varied in model simulations.

Net revenue was computed as the difference between U.S. export sale revenue (export volumes multiplied by marginal values at U.S. ports) and the value of EEP subsidies. Results for different EEP bonus levels are shown in Figure 4.4. For comparison, total net export revenue (from both malting barley and malt) is divided into components. Changes in EEP bonuses for malting barley also affect the value of U.S. malt exports through their impact on domestic availability (and hence, malting barley prices). Thus, an increase in the EEP bonus for malting barley is shown to raise the value of U.S. malt exports. This reflects the requirements of some importers for 6R malt supplied by the United States.

Quantity limits were binding in all simulations except at the $10 bonus level. The maximum net export revenue of $67 million (malting barley and malt combined) was observed at a bonus level of $15/mt on malting barley. Shipments at this bonus level were made to eastern, northern, and western South America and Japan. As the bonus level increases, smaller quantities qualify for subsidies (to maintain the $10 million spending cap). At the highest bonus level of U.S.$50/mt, all shipments were to eastern South America.

These results suggest that if EEP were only given for malting barley, a bonus level of approximately $15/mt would maximize net revenue from exports of U.S. malting barley and malt combined. Given the $10 million cap on EEP expenditures, net revenue is maximized by selling a large volume at a relatively low bonus level.

Comparable simulations were conducted for U.S. malt exports. Adjustments were made to malt bonus levels and quantity limits, and the $10 million spending cap was retained. Bonus levels ranged from $13.33 to $66.67 per mt. Corresponding malt quantity limits ranged from 750 tmt to 150 tmt. Nine simulations were conducted, with the malt EEP bonus changing in increments of $6.67/mt, and net revenue associated with each bonus level was computed.[27] The bonus levels and corresponding net export revenue are shown in Fig. 4.4.

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[26]The maximum expenditure on malt has been U.S.$10 million since the inception of the program.

[27]One ton of malt is equivalent to 1.33 tons of malting barley. The range of malt bonus levels and the quantity limits are consistent with those for malting barley.

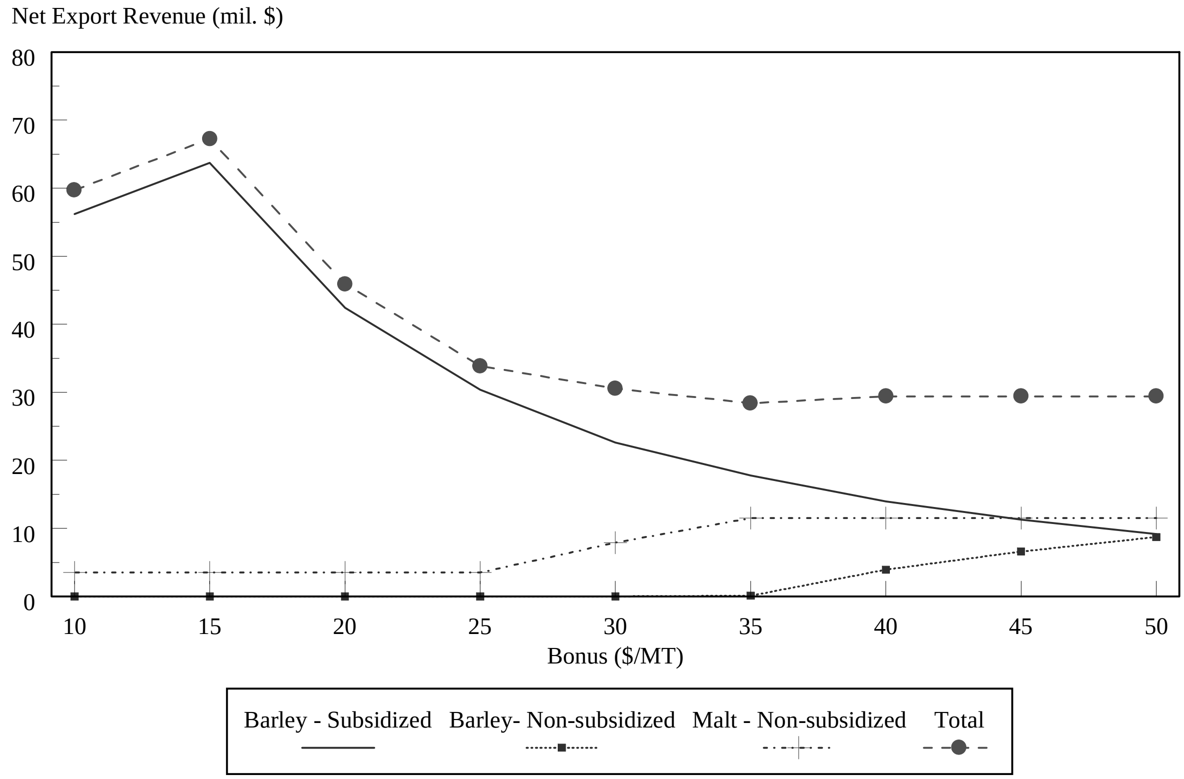

Figure 4.4. Impact of Malting Barley EEP Bonus on U.S. Net Export Revenue

A maximum total net revenue (malt and malting barley combined) of $116 million was observed at a malt bonus level of U.S.$ 20/ mt.[28] At that bonus level, U.S. malt shipments were made to Central America, the Caribbean, Russia, Japan, and the Philippines. The quantity limit constraint was not binding for bonus levels below $20. At a bonus level of $66.67/mt, total net revenue would decline to a minimum of $46 million.

A comparison of Figures 4.4 and 4.5 suggests that with an EEP budget of $10 million, U.S. net export revenue would be greater by allocating the entire budget to malt. Differences between malt and malting barley (in terms of responsiveness to EEP) are related to the variety preferences of importers and competitive conditions vis-a-vis other exporters. For malting barley, the United States confronts Canada, a relatively low cost supplier, in most markets. In the case of malt, the EU is a major competitor, but can be displaced in selected markets that accept both 2R and 6R varieties. The results also indicated that a lower bonus level covering a larger volume would generate greater net revenue than a combination of higher bonus and smaller volume (Figure 4.5).

[28]These bonuses are less than those in the base model; however, in these simulations, all malt import regions are eligible for U.S. export subsidies. The model determines the optimal regional distribution of EEP shipments.

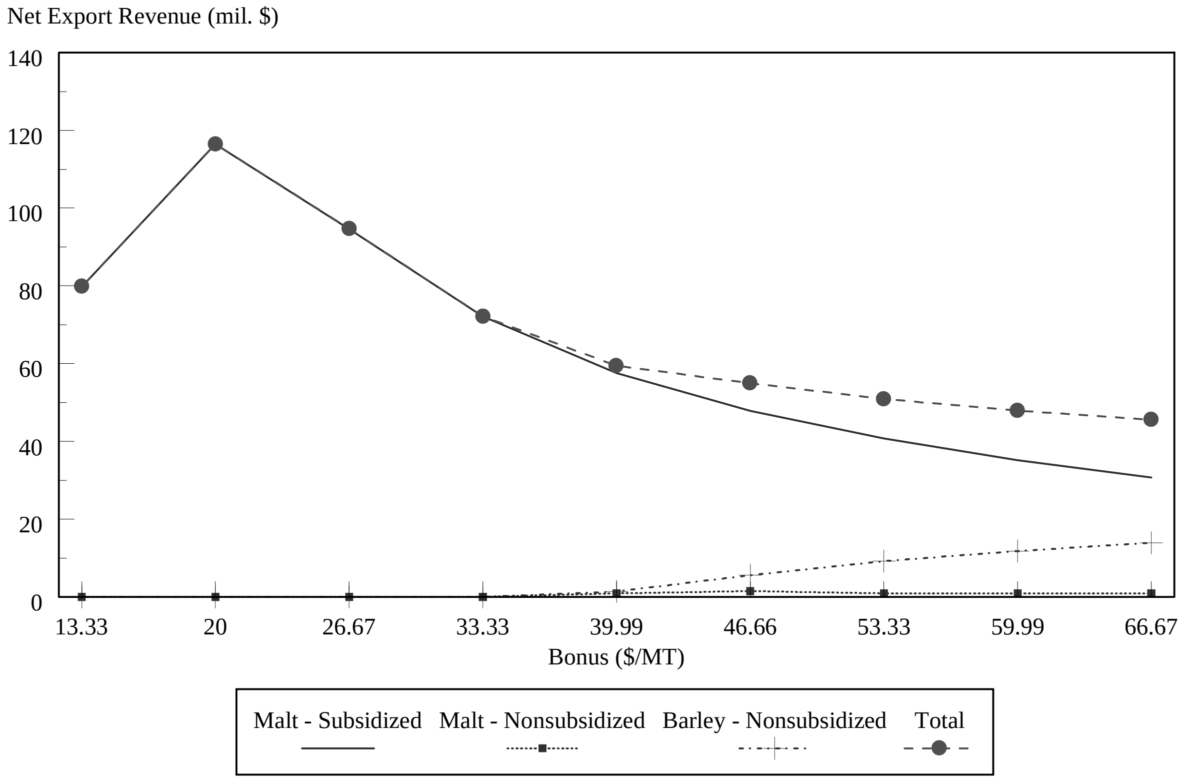

Figure 4.5. Impact of Malt EEP Bonus on U.S. Net Export Revenue

Importing Countries' Tariffs

Tariffs are an important component of the overall cost of importing malting barley and malt. Differences in the tariff rates applied to malting barley and malt can determine the composition of trade. In many countries with indigenous malt plant capacity, higher tariffs are applied on malt imports than on malting barley. Important examples are China, Brazil, and Japan. In such regions, elimination of tariffs on both malt and malting barley would tend to favor more malt imports. Changes in tariffs would also have secondary effects in other import markets due to reallocations of global supplies and processing.

To assess the impacts of importer tariffs, two simulations were conducted. In the first, tariffs on malting barley and malt are eliminated worldwide. In the second, China equalizes its tariff treatment of malting barley and malt, but tariffs in other importing regions remain unchanged. Results of both simulations can be compared to the base case in Figures 4.6 and 4.7 and Appendix Table A2.7.

Global Elimination of Import Tariffs

Malting barley and malt trade composition would change as a result of importer tariff elimination. Malting barley imports declined by more than 100 tmt. Some major importers would switch from importing malting barley to malt. However, east Asia would switch from importing malt to malting barley. Russia would fulfill part of its malt requirement with malt instead of malting barley.

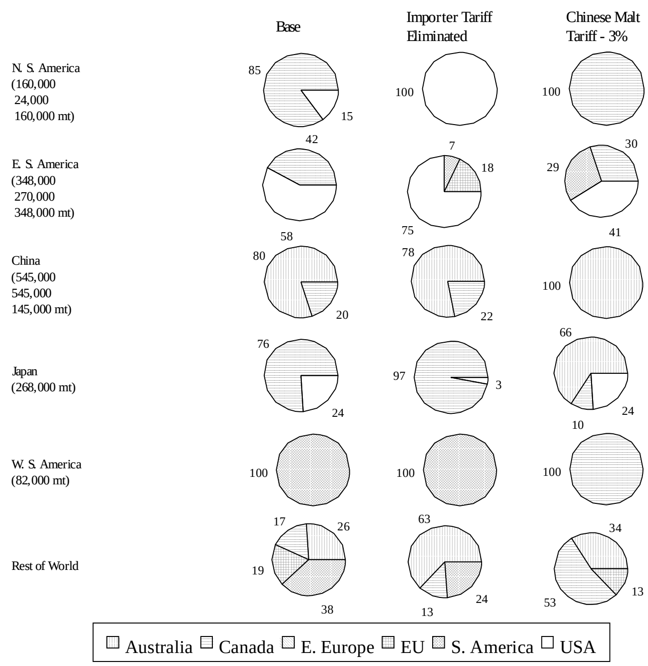

Figure 4.6. Exporter Market Shares in Selected Malting Barley Importing Regions nder Base Case and Different Importer Tariff Regimes

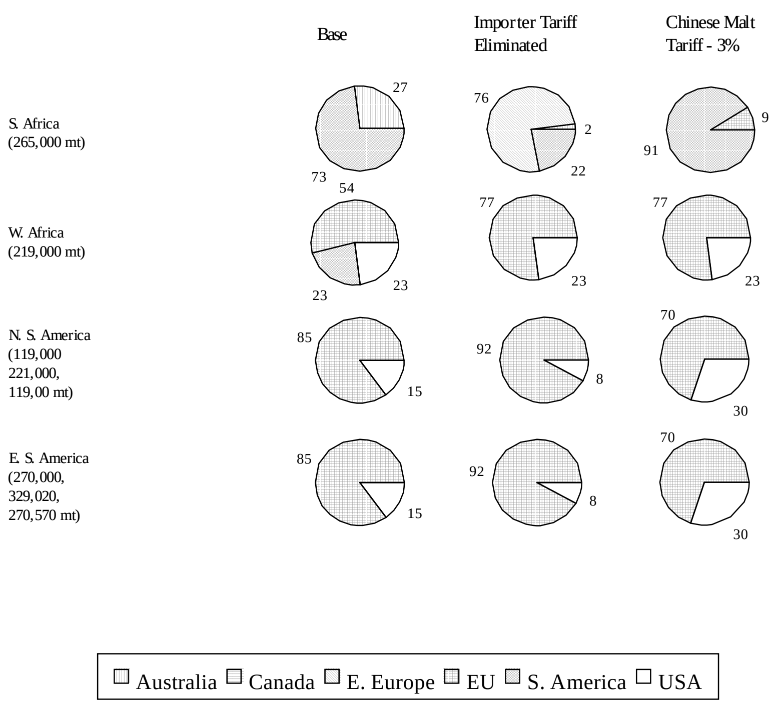

Figure 4.7. Exporter Market Shares in Selected Malt Importing Regions Under ase Case and Different Importer Tariff Regimes

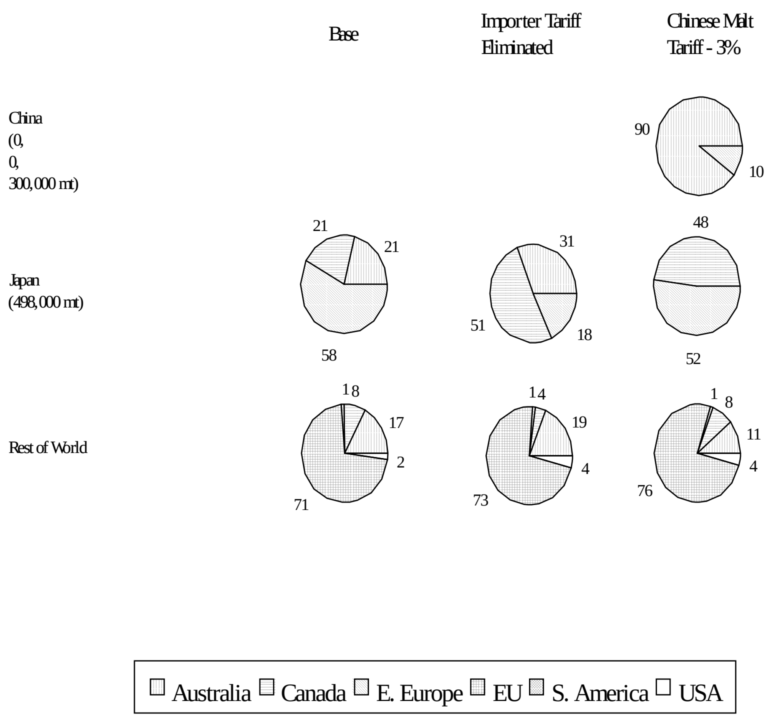

Figure 4.7. (Continued)

Figure 4.6 shows market shares of exporters in selected malting barley importing regions. Global tariff elimination would result in an 85 percent reduction in malting barley imports in northern South America. Imports of Canadian barley are eliminated, while imports of U.S. barley are unchanged. In eastern South America, malting barley imports are reduced by 22 percent, with imports from South America and the EU displacing Canadian barley. In China, malting barley imports are nearly identical to the base case, while in Japan, the United States loses market share to Canada.

With global tariff elimination, marginal values of malting barley and malt supplies differ considerably from the base case (Table 4.11). Marginal values for malting barley decline at North American ports, but gain in the EU and South America. Marginal values for Australian barley remain close to base case levels. Malt values increase in all regions outside North America, especially for 2R varieties. At North American ports, 2R malt values decrease by small amounts.

The change in the composition of imports affects the marginal value of malting capacity, as shown in Table 4.12. Tariff elimination would have the most effect in east Africa, where the marginal value of capacity declines by U.S.$39/mt. In northern and eastern South America, tariff elimination induces a rise in malt imports (and reduction of malting barley imports), causing malting capacity to lose value. On the other hand, the value of malting capacity increases in Japan, Central America, and the Caribbean. China continues to have excess malting capacity, as in the base case.

TABLE 4.11. CHANGES IN MARGINAL VALUES OF MALTING BARLEY AND MALT AVAILABILITIES FROM BASE CASE FOR ALTERNATIVE LEVELS OF IMPORTER TRADE POLICIES (US$/MT)

			Change in Marginal Value from Base Case			
			Importer Tariff Eliminated		Equal Tariff for M.Barley and Malt in China	
Eporting Country	Port	Type	M. Barley	Malt	M. Barley	Malt
Australia	Fremantle	6RW	0	-16	0	1
		2RW	0	-34	0	-21
	Sydney	6RW	-1	-25	7	-7
		2RW	1	-36	8	-21
EU	Hamburg	6RW	-1	-14	0	4
		2RW	-5	-31	0	-13
S. America	Buenos Aires	6RW	-4	-19	4	4
		2RW	-11	-34	-2	-18
Eastern Europe	Hamburg	6RW	..	-14	..	3
		2RW	..	-32	..	-19
USA	Portland	6RW	0	-1	-1	-5
		2RW	2	2	-4	-5
	Mobile	6RW	6	2	-4	-5
		2RW	3	0	-4	0
	Duluth	6RW	2	..	-4	..
		2RW	4	..	-4	..
Canada	Thunder Bay	6RW	2	2	-4	6
		2RW	4	3	-4	-13
	Vancouver	6RW	0	-4	0	-19
		2RW	3	1	0	-19

TABLE 4.12. CHANGES IN MARGINAL VALUES OF MALT PLANT CAPACITIES IN FOREIGN DEMAND REGIONS FOR ALTERNATIVE LEVELS OF IMPORTER TRADE POLICY VARIABLES (US$/MT)

		Change in Marginal Value from Base Case	
Importing Regions	Ports	Importer Tariff Eliminated	Chinese Tariff Equated for Malting Barley and Malt
Central America	Balboa	-2	0
Caribbean	Kingston	-2	0
Philippines	Manila	9	-19
East Africa	Mobassa	39	-19
N.S. America	Puerto la Cruz	2	-9
E.S. America	Recife	7	-9
Japan	Tokyo	-1	-19

Chinese Malt Import Tariff

China is of special interest as one of the world's most rapidly-growing beer markets. China's tariff on malting barley imports is 3 percent while that on malt is 35 percent. This favors local processing of malting barley. Because of the emerging importance of China in world malt trade, separate simulations were conducted to assess the effects of changes in Chinese tariffs.

In these simulations, China's tariff on malt was reduced while that on barley was held constant. The malt tariff was reduced by increments until malting barley and malt tariffs were equalized at 3 percent *ad valorem*. Results indicated no changes in trade flows until the malt import tariff was reduced below 20 percent (Figure 4.8). Thereafter, Chinese malting barley imports decline while malt imports increase. With tariff rates equalized at 3 percent, malting barley imports are reduced to 145 tmt, from 545 tmt in the base case. Malt imports rise to 300 tmt, from zero in the base case. As shown in Figure 4.8, a tariff rate of 15 percent is sufficient to eliminate malt imports; thus, China's current tariff of 35 percent appears to be higher than necessary.[29]

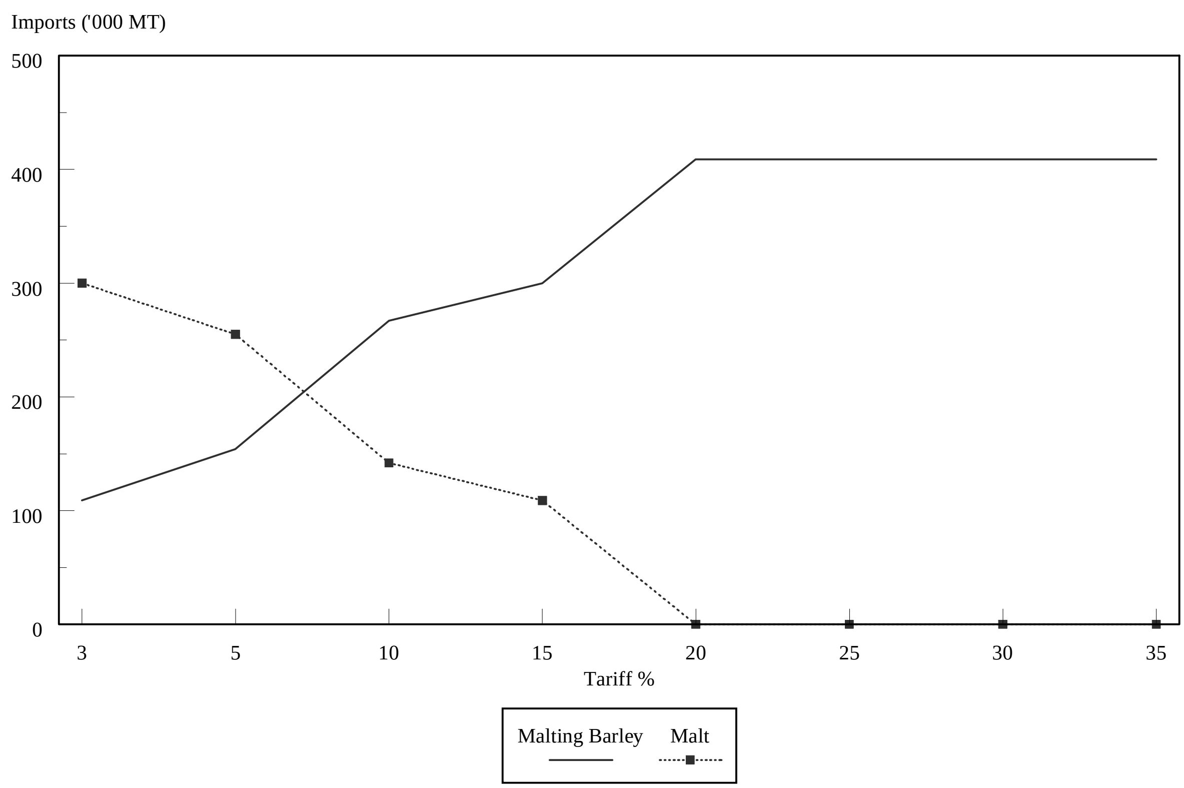

Figure 4.8. Changes in Malting Barley (in Malt Equivalent) and Malt Import Levels for Varying Chinese Malt Import Tariff

[29]Unless costs of malting or barley acquisition in China are higher than assumed in the base case.

Changes in market shares are shown in Figures 4.6 and 4.7. In the base case, all Chinese malt requirements are met via local processing. Equalizing the tariffs would result in 73 percent of requirements being met through malt imports. Australia would export less malting barley to China, but gain a 90 percent share of China's malt imports. Eastern Europe would supply the remaining 10 percent of malt imports. Canada would lose its malting barley exports to China.

Reductions in China's malt import tariff would have repercussions for trade patterns in other regions. The United States would export less malting barley to northern and eastern South America, and more malt (Figures 4.6 and 4.7). Likewise, Canada would export less malting barley but more malt to Japan. East Asia (Hong Kong, Korea, Taiwan) switches from importing malt (from Canada) to importing malting barley (from Australia). Other changes in trade patterns are summarized in Appendix Table A2.7.

The marginal value of malting barley would decrease in Sydney, while increasing at most North American ports because of Chinese malt tariff reductions (Table 4.11). Malt gains value at most export locations. The value of 2R malt increases by $21/mt in Fremantle and Sydney. Values of 2R and 6R malt increase by $19/mt in Vancouver, and by $5/mt in Portland.

Because of malt tariff reductions, China would use less than half its malt plant capacity. However, because of changes in relative prices, other regions would have greater incentive to import malting barley for local processing. The marginal value of malt plant capacity in these regions would increase considerably from base case levels (Table 4.12). Gains are greatest in east Africa and Japan, followed by eastern and northern South America. The Philippines would have greater incentive to develop new malting capacity.

Changes in Beer Market and Malt Type Preferences

Growth in Beer Market by 2000

Beer consumption is positively influenced by income in consuming countries, and many developing countries are experiencing high income growth. China and Mexico are often cited as high growth markets. Wesolowski (1995) analyzed beer consumption in the world and projected levels for beer production for 2000. The projected beer production levels were translated into malt import requirements. Implied changes in malt requirements between 1992 and 2000 are shown in Table 4.13. Positive changes are projected in some regions and negative changes in others. Major growth is expected in eastern South America (Brazil), Japan, and southeast Asia. Beer production is expected to decline in east Africa, Oceania, and western South America.

Simulations were conducted to analyze the impact of projected increases in beer production. With existing supplies of malting barley, it is impossible to satisfy projected levels of malt demand for the year 2000. Accordingly, adjustments were made to the malt requirements of importing regions.[30] Malt requirements are allowed to grow by 48 percent of the amounts shown in Table 4.13. Results of this scenario are compared to the base case in Figures 4.9 and 4.10.

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[30]Adjustments were made as follows. For each region, malt requirements were set equal to the base-case level plus a fraction of the change to 2000 (tmt) reported in Table 4.13. Through experimentation, it was determined that fractions above .48 led to infeasible solutions. Thus, requirements of importing regions are set equal to the base case level plus .48 times the projected change to 2000.

TABLE 4.13. CHANGES IN MALT REQUIREMENTS IN (000MT.) IN FOREIGN DEMAND REGIONS FROM BASE LEVEL TO PROJECTED BEER PRODUCTION IN YEAR 2000

Import Region	Difference	% Change	Import Region	Difference	% Change
North Africa	0	0.28	Northern South America	111	46
West Asia	2	17	Eastern South America	523	98
Central America	1	3	China	45	11
Southern Africa	80	30	South East Asia	90	102
East Asia	-56	-61	non-EU North Europe	-45	-12
Caribbean	-39	-56	Oceania	-32	-64
West Asia	194	89	Japan	211	30
Philippines	36	29	Western South America	-34	-56
East Africa	-15	-20	Russia	0	0
Southern Europe	80	18	Russia	0	0
			Total	1153	29

Source: Computed from Weslowski (1995)

Of all importing regions, eastern South America is projected to have the largest increase in total malt requirement. This is largely satisfied by imports of U.S. malt (Figure 4.10). At the same time, the United States is displaced as a supplier of malting barley to eastern South America by Canada and South America (Figure 4.9). The United States also gains a larger share of the malt market in northern South America. Increased U.S. malt exports are facilitated by excess malting capacity, particularly in Wisconsin.

In Japan, Canada and Australia gain malt market share at the expense of Eastern Europe. Canadian malting barley exports replace Australian malt exports to east Asia. A decline in beer consumption is projected for the Caribbean, resulting in reduced malt import requirements. This affects Caribbean imports from the EU. West Africa imports its growing malt requirement from the EU and South America while Canada captures the growing Filipino malt import market. Growth in southern European beer consumption favors malt exports from the EU.

Corresponding changes in marginal values are shown in Table 4.14. Increases in values of malting barley are greatest at U.S. ports and Thunder Bay. Changes in values of 2R malt are almost identical at all ports outside the United States. The maximum gains were in EU (Hamburg) and South America (Buenos Aries) of U.S.$27/mt. At U.S. ports, increases in malt values range from $3-12/mt.

With increased malt utilization, the value of malting capacity increases (Table 4.15). The marginal value of malting capacity increases most drastically in East Africa. Values also increase in other regions where malting capacities were binding in the base case: Japan, eastern and northern South America, and the Philippines.

Malt Type Preferences of Importers

Beer is produced with malt prepared from three types of barley: 2R, 6R white, and 6R blue. World beer production has traditionally used 2R barley malt. In contrast, many North American brewers have a clear

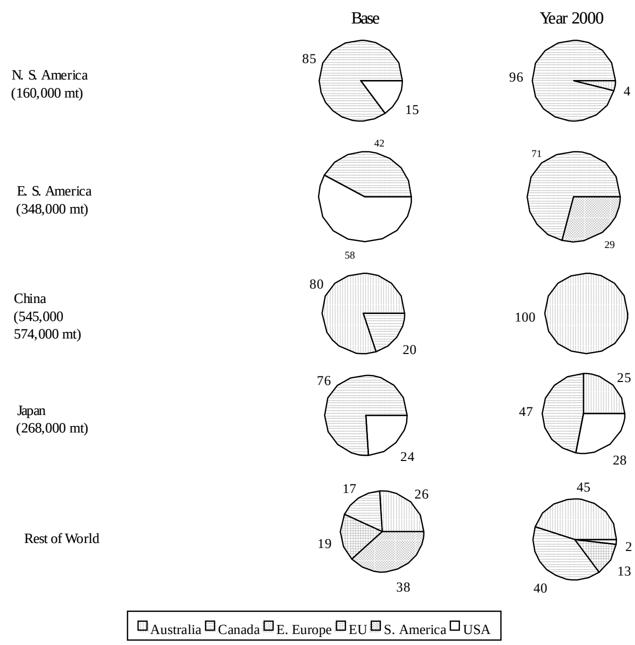

Figure 4.9. Exporter Market Shares in Selected Malting Barley Importing Regions Under Base Case and Beer Production Levels Projected for 2000

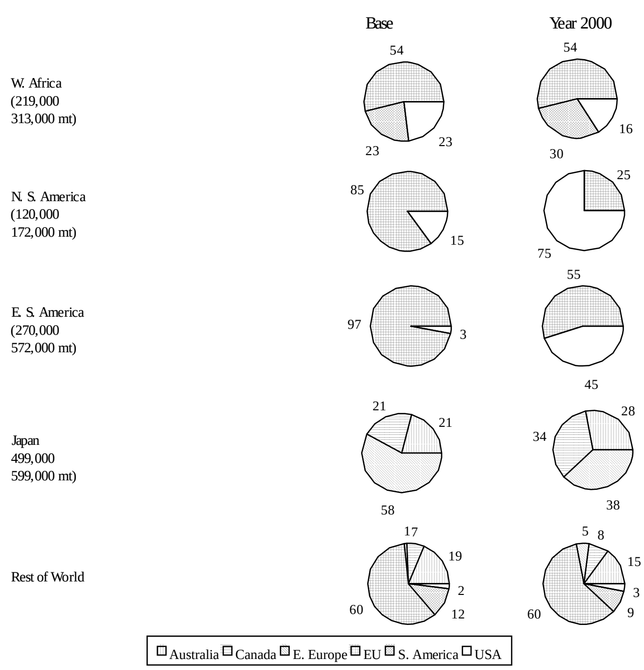

Figure 4.10. Exporter Market Shares in Selected Malt Importing Regions Under Base Case and Beer Production Levels Projected for 2000

TABLE 4.14. CHANGES IN MARGINAL VALUES OF MALTING BARLEY AND MALT AVAILABILITIES FROM BASE CASE FOR DIFFERENT LEVELS OF BEER CONSUMPTION IN IMPORTING REGIONS (US$/MT)

			Change in Marginal Value from Base Case					
			20%		40%		48%	
Exporting Region	Port	Type	M. Barley	Malt	M. Barley	Malt	M. Barley	Malt
Australia	Fremantle	6RW	-9	-14	0	-1	-1	-5
		2RW	0	-12	0	-22	0	-27
	Sydney	6RW	-3	-27	-1	-7	-3	-12
		2RW	0	-11	0	-22	0	-26
EU	Hamburg	6RW	-2	5	-3	-6	-3	-9
		2RW	-6	-13	-3	-23	-3	-27
S. America	Buenos Aires	6RW	-2	-7	-4	-2	-5	-7
		2RW	-1	-12	-10	-22	-10	-27
E. Europe	Hamburg	6RW	..	-2	..	0	..	-5
		2RW	..	-11	..	-22	..	-26
USA	Portland	6RW	-1	-5	-7	-15	-8	-20
		2RW	-2	-4	-10	-9	-9	-12
	Mobile	6RW	2	-5	-11	-15	-12	-20
		2RW	-3	0	-11	0	-11	-3
	Duluth	6RW	-4	..	-11	..	-12	..
		2RW	-3	..	-11	..	-11	..
Canada	Thunder Bay	6RW	-4	5	-11	-15	-12	-19
		2RW	-3	-13	-11	-34	-11	-27
	Vancouver	6RW	-1	-11	-7	-22	-8	-26
		2RW	-1	-11	-8	-22	-8	-26

TABLE 4.15. CHANGES IN MARGINAL VALUES OF MALT PLANT CAPACITIES IN FOREIGN DEMAND REGIONS FOR ALTERNATIVE LEVELS OF BEER CONSUMPTION LEVELS (US$/MT)

		Change in Marginal Values from Base Case		
Importing Regions	Ports	20%	40%	48%
Philippines	Manila	-10	-12	-16
East Africa	Mobassa	-11	-40	-40
N.S. America	Puerto la Cruz	-9	-9	-12
E.S. America	Recife	-9	-9	-12
Japan	Tokyo	-10	-12	-16

(-) indicates a gain in marginal values, (+) indicates a loss.

preference for 6R white malt.[31] Six-rowed barley is grown mainly in North America. From the standpoint of export market development, it is important to understand the implications of variety preferences, and possible changes in preferences, for malt and malting barley trade flows.

In the base case, the importers' preference for 2R and 6R white malting barley and malt types were included in the form of restrictions. Upper and lower bounds on shipments of malting barley and malt were imposed, based on information from the industry and historical shipments. The regions that were allowed shipments of 6R white barley and malt in the base case were the Caribbean (5-8 percent), Central America (4-8 percent), the Philippines(2-6 percent), northern South America (4-15 percent), eastern South America (0-30 percent), and Japan (2-8 percent). These are the regions that have imported malt and/or malting barley from North American sources in the past. The percentages in the parentheses correspond to minimum and maximum malt shipments to these regions from the United States.

A simulation was conducted with these restrictions relaxed, so that every region could import either 2R or 6R varieties (malting barley or malt) without limit. In this scenario, perfect substitutability is assumed between different types of malting barley and malt.

Total 6R malting barley imports increased from 301 tmt in the base case to 477 tmt with importers' specifications unrestricted. Imports of 2R malting barley declined by about 177 tmt. Eastern and northern South America would import more 6R malting barley while Japan would increase imports of 2R malting barley. Malting barley flows to remaining destinations would remain at base case levels (Table 4.16).

Both types of malting barley exports from the United States would increase, while malting barley exports from Canada would decrease from base levels. Only the United States recorded an increase in 6R malt exports when importer preferences were relaxed. Japan would switch to importing 2R malting barley, and shipments would originate in Canada, replacing 6R malting barley from the United States and Canada. Eastern and northern South America would switch from importing 250 tmt of 2R malting barley from Canada to 6R malting barley from the United States. There would also be minor changes in the source of 2R malt imports into eastern and southern Africa, and Japan. China and western South America's 2R malting barley source would also be altered.

The United States would export more 6R malt to north Africa, Central America, the Philippines, the Caribbean, and west Africa. In all cases except the Caribbean, 2R shipments from the United States would be replaced by 6R shipments. In the case of the Caribbean, 2R malt imports from the EU would be replaced by 6R malt imports from the United States. These indicate that North American exporters have a cost advantage in exporting 6R malting barley and/or malt.

The switch from 2R to 6R in the case of North Africa, Central America, west Africa, and the Philippines does not change the export source. However, the switch in the case of the Caribbean and eastern and northern South America is beneficial to the United States, with U.S. 6R replacing 2R shipments from EU and 6R shipments from Canada, respectively.

Overall, results of this sceanrio suggest that the United States gains, and the EU loses. If importers are willing to switch freely between 2R and 6R malt, the United States has a cost advantage in shipping malt to the Caribbean and eastern and northern South America. In those cases, trade is diverted from the EU and Canada.

[31] 6R blue brewing is limited to North American countries.

TABLE 4.16. CHANGES IN TRADE FLOWS, BY TYPE, WHEN 6R AND 2R ARE PERFECTLY SUBSTITUTIBLE ('000 MT)

		Changes in Trade Flows						
		USA		EU	Canada		Australia	South Amer.
Importing Regions	Ports	6RW	2RW	2RW	6RW	2RW	2RW	2RW
North Africa (Algiers)	Malt	3	-3					
Central America (Balboa)	Malt	1	-1					
Southern Africa (Cape Town)	Malt						-14	14
Caribbean (Kingston)	Malt	14		-14				
West Africa (Lagos)	Malt	50	-50	14				-14
Philippines (Manila)	Malt	12	-12					
East Africa (Mobassa)	M. Barley						-69	69
N.S. America (Puerto la Cruz)	M. Barley	136				-136		
E.S. America (Recife)	M. Barley	116				-116		
China (Shanghai)	M. Barley					34	-34	
Japan (Tokyo)	M. Barley	-65			-10	75		
	Malt					-14	14	
W.S. America (Valparaiso)	M. Barley		40			29		-69
Total	M. Barley	187	40		-10	-114	-103	0
	Malt	80	-66	0		-14	0	0

Marginal values of 2R malting barley and malt decrease relative to the base case (Table 4.17). However, the value of 6R malting barley increases at most locations. Within North America, the largest gains in 6R barley values ($13/mt) occur in Duluth and Thunder Bay (Table 4.17). Values of 6R malt increase by $19/mt in Portland and $18/mt in Mobile. Relaxation of importers' preferences (by type) would leave the marginal values of malt plant capacities substantially unchanged.

TABLE 4.17. CHANGES IN MARGINAL VALUES OF MALTING BARLEY AND MALT AVAILABILITIES WHEN 6R AND 2R ARE PERFECTLY SUBSTITUTIBLE (US$/MT)

			Change in Marginal Values from Base Case	
Exporting Region	Port	Type	M. Barley	Malt
Australia	Fremantle	6RW	-5	-20
		2RW	0	3
	Sydney	6RW	-1	-21
		2RW	2	3
EU	Hamburg	6RW	-9	-20
		2RW	1	3
S. America	Buenos Aires	6RW	-21	-42
		2RW	1	3
Eastern Europe	Hamburg	6RW	..	-20
		2RW	..	3
USA	Portland	6RW	0	-19
		2RW	1	10
	Mobile	6RW	-11	-18
		2RW	1	14
	Duluth	6RW	-13	..
		2RW	2	..
Canada	Thunder Bay	6RW	-13	12
		2RW	2	3
	Vancouver	6RW	1	-3
		2RW	2	3

Importer Logistical Issues: Bulk vs. Container Shipments of Malt

The analytical model allowed malt shipments in two forms, bulk and container. Malt has been traditionally shipped in bulk by the EU, the major player in world malt trade. Bulk shipping is generally cost effectiv. However, the import marketing channels in most countries would have to change to accommodate bulk malt shipments. One objective of the study was to assess how flows would be affected if importers shifted their logistics to accept bulk shipments.

In the base case, bulk shipments were allowed to a group of importing regions that met two criteria: 1) their malt imports were large enough to justify bulk shipments, and 2) these regions had the necessary port facilities for receiving malt in bulk. The regions that met these criteria were south Africa, the Caribbean, west Africa, eastern South America, northern South America, non-EU north Europe, and Russia. Shipments to remaining import regions were allowed in containers only. Also, as in the base case, all exporters were allowed to export malt both in bulk and in containers.

To assess the implications of these restrictions, an alternative scenario was developed in which all importing regions were allowed to accept bulk shipments of malt. With restrictions removed, the form of shipment (bulk vs. container) to each importing region is determined by relative shipping costs. These favor bulk shipment. Indeed, for every source-destination pair in the model, bulk shipping costs are lower than container shipping costs.

A limit to this scenario is that the decision to import by container or in bulk reflects many other transport mode selection criteria. For example, shipments by container might offer better protection from weather and pilferage than shipment in bulk. The preference for container shipments probably also reflects operating practices of malting plants around the world.

Allowing bulk shipments to all importing regions would not change the value of malting barley and malt imports of any region. Imports of malting barley and malt, by type, remain at base case levels for all world regions. Among exporters, malting barley exports from Canada would decline while those from Australia would increase.

In every importing region, container shipments of malt would be replaced by bulk shipments (Table 4.18). North Africa would switch from container to bulk malt imports from the United States and the EU. Similarly, west Asia, Central America, east Asia, the Caribbean, west Africa, the Philippines, east Africa, southern Europe, eastern South America, southeast Asia, non-EU north Europe, and Oceania would all switch from container to bulk imports, but from the same sources as in the base case. Switching from container to bulk would result in Japan's importing more malt from Australia, and less from eastern Europe. Southern Africa would import malt from eastern Europe instead of Australia.

The marginal values of 2R malting barley are unchanged at all ports (Table 4.19). Values of 6R malting barley show little change at North American ports, but increase elsewhere. Changes in malt values are largest for 6R malt. The value of 6R malt in Portland increases by $19/mt. Curiously, the value of 2R malt declines at some export locations (by $9/mt in Mobile).

Generally, malting capacity in importing regions would be less valuable if restrictions on bulk shipments were removed (Table 4.20). Marginal values of malt plant capacities decline in east Africa, eastern South America, Japan, and the Philippines. The value of plant capacity in northern South America shows a minor increase.

TABLE 4.18. CHANGES IN MALT TRADE FLOWS FROM BASE CASE WITH RELAXED RESTRITCTIONS ON BULK MALT SHIPMENTS (‘000MT)

		Exporters					
		Malt Shipments to All Importers Allowed in Bulk					
Importing Region	Mode	US	EU	Canada	Australia	E.Europe	S. Amer.
North America (Algiers)	Bulk	3	14				
	Cont.	-3	-14				
West Asia (Bahrain)	Bulk					11	
	Cont.					-11	
Central America (Balboa)	Bulk	5	45				
	Cont.	-5	-45				
S. Africa (Cape Town)	Bulk				-49	49	66
	Cont.						-66
East Asia (Hong Kong)	Bulk				92		
	Cont.				-92		
Caribbean (Kingston)	Bulk	6	50				
	Cont.	-6	-50				
West Africa (Lagos)	Bulk		16				50
	Cont.		-16				-50
Philippines (Manila)	Bulk	20		106			
	Cont.	-20		-106			
East Africa (Mobassa)	Bulk					5	
	Cont.					-5	
S. Europe (Piraeus)	Bulk		452				
	Cont.		-452				
E.S. America (Recife)	Bulk	8	249				
	Cont.	-8	-249				
S.E. Asia (Singapore)	Bulk				88		
	Cont.				-88		
Non-EU North Europe (Stockholm)	Bulk		116				
	Cont.		-116				
Oceania (Suva)	Bulk				49		
	Cont.				-49		
Japan (Tokyo)	Bulk			104	155	239	
	Cont.			-104	-106	-288	
Total	Bulk	42	942	210	384	304	116
	Cont.	-42	-942	-210	-384	-304	-116

TABLE 4.19. CHANGES IN MARGINAL VALUES OF MALTING BARLEY AND MALT AVAILABILITIES FOR VARIATIONS IN IMPORTERS PREFERENCES IN MODE OF SHIPMENT

			Bulk Shipments Unconstrained	
Exporter	Port	Type	M. Barley	Malt
Australia	Fremantle	6RW	-1	-14
		2RW	0	1
	Sydney	6RW	-7	-33
		2RW	0	0
EU	Hamburg	6RW	-1	-9
		2RW	0	0
S. America	Buenos Aires	6RW	-5	-16
		2RW	0	1
E. Europe	Hamburg	6RW	..	-8
		2RW	..	3
USA	Portland	6RW	0	-19
		2RW	0	0
	Mobile	6RW	1	0
		2RW	0	9
	Duluth	6RW	0	..
		2RW	0	..
Canada	Thunder Bay	6RW	0	0
		2RW	0	0
	Vancouver	6RW	0	0
		2RW	0	0

TABLE 4.20. CHANGES IN MARGINAL VALUES OF MALT PLANT CAPACITIES IN FOREIGN DEMAND REGIONS FOR CHANGES IN IMPORTERS' PREFERENCE FOR MODE OF MALT SHIPMENT ($MT)

Importing Regions	Ports	Change in Marginal Values
Philippines	Manila	5
East Africa	Mobassa	3
N.S. America	Puerto la Cruz	-0.28
E.S. America	Recife	3
Japan	Tokyo	3

V. SUMMARY AND CONCLUSIONS

Several important changes are affecting world trade and competition in malt and malting barley. First, changes in agricultural policies in several important malting barley-producing countries around the world have reduced barley production. Second, several trade policies are under pressure for change. Of particular interest is the potential for reductions in EU restitutions, EEP, and changes in import tariffs on malt and malting barley. Finally, this is an industry in which there is negligible growth in traditional markets, which by themselves are very large. However, growth rates in the world market are greater, and some are particularly rapid. Taken together, pressure is giving rise to changes in trade flows and competitiveness between producing and exporting regions.

The purpose of this report was to analyze effects of these various changes on the malting barley and malt sector. To do so, a linear programming model was constructed of the world malt and malting barley sector. All major producing countries and regions were included, as well as all importing countries and North American domestic demand regions. Shipping activities allowed for trade in either malt (in bulk or container) or malting barley. Using this model, a base case was identified; and simulations were conducted to evaluate the effects of major changes.

Summary of Major Findings

1. *Market Growth in Beer*: A statistical analysis was conducted to document growth rates in beer production and malt import demand. Results indicated the United States is the largest beer producer, but growth is stagnant with an average of 0.5 percent growth per year. Of 124 countries, 34 had negative growth rates, while most of the remainder were positive. Countries with the largest growth rates in beer production were Brazil, Japan, China, and the Philippines. The fastest growing malt import markets are Colombia, China, Zaire, the Philippines, and Brazil. Negative growth for beer is observed in Nigeria, FSU, and Portugal.

2. *Import Tariff Differentials*: A survey was conducted to document the form and level of tariff applied to both malting barley and malt. Of particular importance to this industry is the differentials in tariffs between malt and malting barley. This difference is especially important in China, Brazil, and Japan. Tariffs in these countries favor local processing and distort the location of processing and trade worldwide.

3. *Base Case Results*: The analytical model established a set of results based upon conditions reflective of the world barley and malt situation in the early 1990s. Results from this base model identified optimal flows of malt and malting barley. Important results from this are summarized, effects of other assumptions were simulated, and results are identified relative to the base case.

   <u>Barley Type</u>: 2R malting barley dominates world trade of barley with about 4 times as much volume as 6R malting barley.

   <u>Malt versus Malting Barley</u>: Imports of malting barley account for about 30 percent of the total malt requirements of all importing regions. The remainder is fulfilled as malt imports. This suggests that underlying efficiencies favor malt trade as opposed to trade in malting barley. This effect is also reflected in shadow prices for malt plant capacities. In particular, our results suggest surplus capacity in Wisconsin and in numerous importing regions. In contrast, malting locations that should be

operating at capacity and which would have the greatest value of expansion include plants in the U.S. Midwest and the Canadian prairies.

Subsidized versus non-subsidized malt: Under base case assumptions, all U.S. and EU malt exports are subsidized through their respective programs.

U.S. targeted markets: The results can be used to identify those markets in which particular exporting countries have a competitive advantage in serving. These should be interpreted as target markets for export expansion. For U.S. malting barley, these include northern and eastern South America, and east Africa markets for 6R malting barley and totaling 290,000 mt in the base case. The markets for malt in which the United States should have the greatest advantage in serving are numerous small regions concentrated in South America, the Caribbean, the Philippines, primarily for 6R, and west Africa for 2R.

4. *Reductions in EU Malt Supplies:* EU malt supplies for export have been declining since 1985. In the base case, EU malt supplies were 1.4 mmt; and in this simulation, this was reduced to 1.0 mmt. The effect of this is for numerous changes in flows to and from other countries, both in malt and malting barley. Most interesting is that this magnitude of reduction in EU malt supplies would result in increased exports of 2R malting barley from both Australia and Canada. There would only be a slight change in U.S. exports. The United States and Canada would gain in the Caribbean and South American markets.

5. *Changes in EU Restitutions and EEP*: Export subsidies from the EU and the United States have been an important feature of the world trade in malt and malting barley. Both countries have used subsidies primarily on malt, with malting barley receiving relatively smaller shares. Simulations were conducted to evaluate the effect of changes in volume exported under these mechanisms.

EU Restitutions: Results indicated that a 30 percent reduction in malt restitutions would not reduce shipments from the EU, although it would alter some flows. The EU would still export all the available malt supplies. The EU would lose market share in South America, which would be captured mostly by Canada and the United States Australia would lose market share in south Africa, but gain share in east Africa, China, and Japan.

U.S. EEP. A 60 percent reduction in U.S. EEP on malt would reduce U.S. exports by more than 60,000 mt. The change would reduce the U.S. malt exports to 43,000 mt. Exports to African importing regions would be affected most. The markets in which the United States would remain competitive with this reduction would be Central America, the Caribbean, and northern and eastern South America. Results suggest that the United States would be much better off with a policy of using EEP for malt exports in contrast to exports of malting barley, assuming the policy is used discretely on either malt or malting barley. This conclusion is affected by numerous variables including relative logistical costs, and the composition of importers and competitors in the malting barley versus malt market.

6. *Changes in Importer Tariffs*: Elimination of tariffs by importers on malting barley and malt would primarily benefit exporting regions outside of North America. 2R malting barley supplies in South America and the EU would become more valuable while that in North America would decrease. This implies that most of the decline in tariffs would take place in regions that imported from regions outside North America. These results suggest that tariff elimination would primarily affect trade flows from supply regions outside North America to importers versus North America to importers. The

marginal value of malt plant capacity in east Africa would decline the most followed by eastern and northern South American regions.

7. *Chinese Import Tariffs*: Tariffs on malting barley and malt imported into China are 3 percent and 35 percent, respectively. The effects of this are to offset logistical advantages of shipping malt to China, and induce processing within China. This is in contrast to the vast majority of the rest of the world's trade.

   A simulation was conducted to determine the effects of changing this differential (holding the malting barley tariff fixed and reducing the malt tariff). Results show the shift in import composition as the malt tariff is reduced. With malt tariffs below 20 percent, malt imports increase. With malt tariffs equal to those on malting barley, the composition of imports shifts and comprises 300,000 mt malt and 101,000 mt malting barley. This is in contrast to malt imports being nil with tariffs greater than 20 percent.

   The primary beneficiaries of the current regime of tariffs are Australia and Canada, each of which exports significant volumes of malting barley to China. Thus, any change in the tariff regime would affect the composition of exports from these countries.

8. *Beer Production Growth*: Growth rates for beer production outside North America are large relative to those within North America and are relative to the growth (or lack thereof) of malting barley production in the principal producing regions. The model was simulated to identify changes in flows that would be expected to correspond to beer production levels projected to the year 2000.

   Given the existing composition of supplies, the results suggest that only 48 percent of the projected increase in demand could be met. Beyond that, the model was infeasible. The primary changes in flows would be for an increase in 6R malt exports from the United States. The United States would gain in the Caribbean, South America, and Japan; the EU would gain in southern Europe and eastern South America, but would lose in Central America, the Caribbean, west Africa. Canadian exports to east Asia, the Philippines, South America, and Japan would increase, but malting barley exports to China would decrease. Australia, having excess malting barley production, would gain substantially.

9. *6R versus 2R*: The results show that importer's preference for type of malting barley and malt is a crucial variable that determines the composition of imports. Traditionally, the vast majority of imports have been 2R with only a few importers having experience in 6R varieties. The base case reflected these patterns.

   Allowing importers to substitute freely between 2R and 6R will increase 6R malting barley and malt exports by more than 200,000 mt (malt equivalents). Brazil, Colombia, and Venezuela would be the prospective and cost-efficient markets for 6R malting barley and malt, while Japan would import more 2R malting barley. The change in preferences would alter malting barley and malt flows from the United States, Canada, and Australia. The United States would export more 6R malting barley and malt, affecting 2R malting barley exports from Australia and Canada and malt exports from Canada.

10. *Logistics*: Importers receive malt in either bulk or container. The latter are more prevalent, but bulk shipment costs are generally less. However, not all importing regions have facilities to import malt in bulk. A simulation allowing all importers the capability to receive malt in bulk resulted in complete elimination of malt shipments in container vessels, implying that every possible source-destination

unit cost of container shipments is greater than corresponding bulk shipment costs. This change would not alter the level of malting barley and malt exports, by type, from different sources at base case levels.

Conclusions and Discussion

While there are numerous developments affecting the malting barley and malt sector, there are three which appear to be particularly important challenges to the industry. First, the growth markets are in non-traditional regions, and the growth rates of demand exceed those of supply. Area planted in all of the major traditional producing regions has been contracting. Results from this study suggest that only a portion of the anticipated demand growth can be met with existing supplies. This suggests that either yields have to increase or area planted in traditional or non-traditional regions will have to increase to fulfill demand growth. The second major development is that reductions in the subsidy regimes will have important impacts on flows in the world market. It is noteworthy that U.S. malt exports are very sensitive to changes in the EEP program, partially in contrast to EU restitution. Third, the tariff regime in several importing countries has the effect of distorting the composition of trade from what would otherwise be optimal. In general, this favors malting barley shipments relative to malt.

Growth rates in these markets present opportunities for both export of malting barley and malt, an important value-added activity. However, these markets have been dominated by the EU in malt and Canada and Australia in malting barley. The United States has not been a major player in either the malt or malting barley export market in recent decades. Results from this study can be used to identify major constraints to further expansion of trade from the United States. One is the relatively high opportunity cost of malting barley in the United States which is measured as the value of feed barley in this study. These are not high relative to all competitors, but are compared to Canada. A second constraint is the export availability of 6R (2R is surplus in the United States). Though at present not all markets readily accept 6R as a substitute for 2R, some do. These are important niche markets that the United States should have the advantage in serving. However, supply is exhausted, suggesting this limits the ability of penetrating these markets. The third constraint is related to the import tariff regime of malt and malting barley. These have two offsetting effects: discouraging malt trade and encouraging malting barley exports.

Both public policies and private strategies will affect the evolution of trade in this sector. In the case of the United States there are several very important public policy issues. One is that some acreage set-aside policies (notably the CRP in the case of barley) have reduced area planted, in turn reducing the availability of exportable supplies. Second, is it more efficient (effective) to expand exports of malt or malting barley? Our results indicate that generally, the United States would have the greatest advantage in using subsidies on malt exports. The third is the identification of targeted markets. Though the EEP has been extensively available in this sector, it has rarely been fully subscribed. Results from this study identify countries that could be interpreted as those the United States would have the greatest advantage in penetrating. Finally, though much of the thrust of international trade issues has focused on export subsidies, these results demonstrate that existence of tariff differentials on malt versus malting barley has an important effect on the composition of trade and location of processing. In future trade discussions, these should warrant further attention, particularly in this sector.

There are also some important issues for the formulation of private strategies in this sector. The results clearly demonstrate that, in most cases, processing plants located closer to the point of production have strategic advantages. This is a long-term trend particularly apparent in North America. The import tariff regime discussed has the effect of distorting expansion decisions. From an investment perspective, this no doubt instills an important source of uncertainty for the industry as firms evaluate expansion plans. Finally, shipper preferences for containers instead of bulk shipments limit the ability of the U.S. to take advantage of shipping efficiencies.

Finally, while the United States has an advantage in producing 6R, not all buyers will readily substitute it for 2R. The largest growth in beer production and, subsequently, in malt imports are expected to come from Latin American and Asian countries and Mexico. North America (and Australia) have location advantages in serving these markets. The continued use of 2R instead of 6R malt suggests there are important switching costs that prevent brewers from using U.S. 6R malt. Attempts are underway to educate consumers in these regions regarding North American malt, particularly, 6R barley malt. In practice, this could be viewed as a technical change in an ingredient used in the brewery process.   Consequently, educational and promotional programs should be an essential ingredient to export expansion.

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Appendix I

Mathematical Specification of the Analytical Model

Appendix I

Mathematical Specification of the Analytical Model

The objective function is specified as :

$$
\begin{aligned}
\text{MIN } W = & \sum_{p}\sum_{m}\sum_{t} Y0_{pmt}[FP_p + TY0_{pm}] + \sum_{p_u}\sum_{i_u}\sum_{t} Y1_{p_u i_u t}[FP_{p_u} + TY1_{p_u i_u}] + \\
& \sum_{p_c}\sum_{i_c}\sum_{t} Y1_{p_c i_c t}[FP_{p_c} + TY1_{p_c i_c}] + \sum_{m}\sum_{b}\sum_{t} Z0_{mbt}[MPC_m + TZ0_{mb}] + \\
& \sum_{m_u}\sum_{j_u}\sum_{t} Z1_{m_u j_u t}[TZ1_{m_u j_u}] + \sum_{m_c}\sum_{j_c}\sum_{t} Z1_{m_c j_c t}[TZ1_{m_c j_c}] + \\
& \sum_{i}\sum_{k}\sum_{t} Y2R_{ikt} * [\tau_k * (FP_i + TY2_{ik}) + MPC_k] + \\
& \sum_{i_s}\sum_{k}\sum_{t} Y2S_{i_s kt} * [\tau_k * (FP_{i_s} + TY2_{i_s k} - SUBB_k) + MPC_k] + \\
& \sum_{j}\sum_{k}\sum_{t} Z2R_{jkt} * [\delta_k * (TZ2B_{jk})] + \sum_{j_s}\sum_{k}\sum_{t} Z2S_{j_s kt} * [\delta_k * (TZ2B_{j_s k} - SUBM_k)] + \\
& \sum_{j}\sum_{k}\sum_{t} Z3R_{jkt} * [\delta_k * (MPC_j + TZ3C_{jk})] + \\
& \sum_{j_s}\sum_{k}\sum_{t} Z3S_{j_s kt} * [\delta_k * (MPC_{j_s} + TZ3C_{j_s k} - SUBM_k)]
\end{aligned}
$$

W: Objective function value,
Y0: Malting barley flows from North American Production regions to NA malt plants,
Y1: Malting barley flows form NA production regions to NA offshore ports,
Y2R: Non-subsidized malting barley shipments from ports to import demand regions,
Y2S: Subsidized malting barley shipments from ports to import demand regions,
Z0: Malt shipments from NA malt plants to NA breweries,
Z1: Malt shipments from NA malt plants to NA export locations,
Z2R: Non-subsidized bulk malt shipments from U.S. export locations to import demand regions,
Z2S: Subsidized bulk malt shipments from U..S. export locations to import demand regions,
Z3R: Non-subsidized container malt shipments from export locations to import demand regions,
Z3S: Subsidized container malt shipments from export locations to import demand regions,
τ: Tariff on malting barley charged by the importing regions,
δ: Tariff on malt charged by the importing regions,
SUBB: Subsidy on malting barley provided by the exporting region,
SUBM: Subsidy on malt provided by the exporting region,
p: NA malting barley production regions,
m: NA malt plant locations,
t: malting barley and malt types,

b: NA breweries,
i: Malting barley export locations,
j: Malt export locations,
k: Malting barley and malt import locations,
subscripts u, and c on p, m, i, and j refer to subsets of locations in the United States, Canada, and subscript s on i, and j refer to export locations that allow subsidized malting barley and malt shipments,
FP: Feed price in $/mt in the subscripted exporting region,
MPC: Malt production cost in the subscripted region,
TY0: Malting barley shipping cost from production region to malt plant locations,
TY1: Malting barley shipping cost from production region to exporting locations,
TY2: Malting barley shipping cost from export to importing locations,
TZ0: Malt shipping cost from malt plants to breweries,
TZ1: Malt shipping cost from malt plants to export locations,
TZ2B: Bulk malt shipping cost from export to import locations,
TZ3C: Container malt shipping cost from export to import locations.

Appendix II

Statistical Tables

TABLE A2.1 AUSTRALIAN MALTING BARLEY AND MALT EXPORTS: 86-87 TO 93-94 (‘000mt)

Malting Barley	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94
Europe	30	150	66	48	32			
South America								
Brazil	122		95		32	89	24	
Chile	32	11	48	37	10	20	10	
Colombia	22			47	13	25	26	
Ecuador			8	21	5	10	12	
Peru	45	17	33	48	52	38	49	
Uruguay	32							
Asia								
China	190	30	99	469	713	385	400	
Japan	20	35	10	15		24	101	
Korea, Rep.			34	30	48	62	45	
Taiwan	93	33	76	81	63	51	59	
Other	3	8	12	33	43	67	135	
Total	589	283	495	830	1010	771	860	
Malt								
Brazil	16	6	43	25	11	21	7	10
Japan	175	82	146	148	154	135	135	119
Total	356	161	369	404	359	342	301	291

Source: Commodity Statistical Bulletin, ABARE, 1994

TABLE A2.2 EU AND REST OF THE WORLD MALT EXPORT COMPARISONS: 1979-89

	World		European Union			Rest of the World		
Year	Total	Value	Total	Value	Share	Total	Value	Share
	(000t)	US$/t	(000t)	US$/t		(000t)	(US$/t)	
1979	2598	257	1550	275	60	1048	232	40
1980	2644	293	1524	331	58	1120	251	42
1981	2906	301	1777	310	61	1129	290	39
1982	2811	298	1774	312	63	1037	273	37
1983	2966	273	1919	280	65	1047	260	35
1984	2681	272	1736	279	65	945	260	35
1985	2701	245	1814	249	67	887	238	33
1986	2728	249	1853	265	68	874	215	32
1987	3069	249	2001	273	65	1068	205	35
1988	3255	280	2109	304	65	1146	235	35
1989	3361	330	2173	345	65	1189	303	35

Source: Pollack and Pool, 1991

TABLE A2.3 AVERAGE MALT EXPORTS, SHARES, AND COMPOUND GROWTH RATES BY COUNTRY (1979-92)

Exporter	Volume	Share	CGR*	T-Values
EU	1,969,373	0.64	0.035	23.63
Australia	329,474	0.11	0.016	3.34
Czechoslovakia	227,722	0.07	0.017	5.44
Canada	210,764	0.07	-0.003	-0.52
U.S.A.	63,499	0.02	0.158	29.52
Uruguay	53,939	0.02	0.071	16.06
Finland	38,598	0.01	-0.007	-1.3
Chile	36,905	0.01	-0.009	-0.34
Argentina	30,752	0.01	0.156	7.63
Turkey	29,044	0.01	0.099	2.17
Germany D.R.**	28,891	0.01	0.016	2.17
Sweden	14,731	0.005	-0.06	-4.16
Zimbabwe	11,527	0.004	0.003	0.21
Poland	11,300	0.004	-0.19	-3.49
New Zealand	9,898	0.003	0.032	0.85
Austria	5,795	0.002	0.117	3.04
Hungary	1,699	0.001	0.151	2.27
Kenya	318	0.0001	-0.022	-0.35
Total	3,068,038		0.029	15.67

*Compound growth rate.

**For the period 1979-89 only.

TABLE A2.4 AVERAGE BEER PRODUCTION (000 HL), SHARES, AND COMPOUND GROWTH RATES: 1979-89

Country	AVG/79-89	AVG Share	CGR*	T-VALUE
U S A	227789	0.231	0.005	8.12
Germany F.R.	93266	0.095	0.0004	0.2
U.K.	61213	0.062	-0.01	-7.47
U S S R.	59974	0.061	-0.02	-5.55
Japan	50158	0.051	0.028	16.04
Brazil	35724	0.036	0.082	20.42
Mexico	29543	0.03	0.033	9.9
China	27373	0.028	0.308	43.5
Germany D.R.	24418	0.025	0.003	1.27
Czechoslovakia	23390	0.024	-0.01	-5.42
Spain	23028	0.023	0.035	18.75
Canada	22645	0.023	0.005	6.63
France	21221	0.022	-0.012	-10.01
Australia	19168	0.019	0.0001	-5.74
Netherlands	16152	0.016	-0.01	-0.73
Colombia	14493	0.015	0.052	27.87
Belgium	13958	0.014	0.0001	-1.76
South Africa	13281	0.013	0.105	16.41
Yugoslavia	11751	0.012	0.0001	-0.7
Venezuela	11504	0.012	0.009	1.22
Poland	11140	0.011	0.012	5.56
Romania	11045	0.011	0.02	4.78
Italy	10005	0.01	0.025	11.2
Philippines	9194	0.009	0.067	5.71
Hungary	8464	0.009	0.026	19.29
Austria	8441	0.009	0.019	13.06
Denmark	8416	0.009	0.006	5.46
Nigeria	8121	0.008	-0.011	-1.62
Korea	7743	0.008	0.065	10.66
Bulgaria	6029	0.006	0.029	4.98
Peru	5715	0.006	0.03	2.72
Ireland	5492	0.006	-0.019	-20.71
Portugal	4331	0.004	0.068	5.19
Switzerland	4155	0.004	0.0001	-0.34
Argentina	4044	0.004	0.124	8.84
Cameroon	3925	0.004	0.078	6.96
New Zealand	3860	0.004	0.009	8.13
Sweden	3852	0.004	0.019	2.72
Zaire	3281	0.003	0.039	7.4
Taiwan	3180	0.003	0.059	18.67
Finland	3140	0.003	0.04	10.08
Greece	3110	0.003	0.054	20.44
Kenya	2805	0.003	0.063	17.35
Cuba	2767	0.003	0.047	7.08
Turkey	2517	0.003	0.0001	-0.28
Ecuador	2284	0.002	-0.039	-2.94

TABLE A2.4 (CONTINUED)

Country	AVG/79-89	AVG Share	CGR*	T-VALUE
Chile	2076	0.002	0.052	5.18
Norway	2032	0.002	0.016	5.67
Vietnam	1764	0.002	0.039	6.21
India	1571	0.002	0.041	3.2
Ivory Coast	1390	0.001	-0.01	-1.03
Rwanda/Burundi	1371	0.001	0.048	9.58
Thailand	1311	0.001	0.002	0.08
Malaysia/S.Pore	1278	0.001	-0.06	-4.42
Hong Kong	1205	0.001	0.076	8.01
Zimbabwe	1202	0.001	0.064	3.59
Bolivia	1099	0.001	-0.028	-1.22
Dominican Rep.	1023	0.001	0.051	5.3
Zambia	940	0.001	-0.029	-2.68
Paraguay	924	0.001	0.038	2.03
Panama	905	0.001	0.04	2.55
Gabon	806	0.001	0.042	3.4
Indonesia	762	0.001	0.038	7.62
Ethiopia	760	0.001	0.038	3.31
Congo	735	0.001	0.03	2.27
Tanzania	730	0.001	-0.046	-4.45
Guatemala	730	0.001	0.035	1.8
Jamaica	711	0.001	0.068	4.54
Luxembourg	695	0.001	-0.015	-2.62
Costa Rica	643	0.001	0.046	6.83
Angola	616	0.001	0.0001	-0.03
Algeria	613	0.001	-0.021	-1.37
Uruguay	583	0.001	0.0001	-0.04
Honduras	541	0.001	0.051	5.63
Iraq	535	0.001	-0.02	-1.36
El Salvador	508	0.001	0.075	4.52
New Guinea	503	0.001	0.001	0.18
Puerto Rico	497	0.001	-0.073	-2.43
Israel	493	0.0005	0.0001	-0.06
Burkina Faso	490	0.0005	0.003	0.51
Nicaragua	461	0.0005	-0.037	-2.48
Egypt	431	0.0004	0.003	0.31
Morocco	417	0.0004	0.027	2.48
Togo	414	0.0004	0.009	0.75
Ghana	397	0.0004	0.087	2.24
Mozambique	379	0.0004	-0.094	-7.3
Tunisia	355	0.0004	0.008	0.65
Namibia	350	0.0004	0.067	7.49
Trinidad	337	0.0003	0.049	2.15
Benin	326	0.0003	-0.056	-5.07
Mauritius/R.Union	285	0.0003	0.038	5.23
Rep.Cen.Africa	248	0.0003	0.051	7

TABLE A2.4 (CONTINUED)

Country	AVG/79-89	AVG Share	CGR*	T-VALUE
Senegal	244	0.0002	-0.091	-4.53
Madagascar	240	0.0002	-0.01	-0.45
Cyprus	240	0.0002	0.055	12.92
Fiji	169	0.0002	0.001	0.04
Liberia	137	0.0001	-0.03	-2.21
Dutch Antilles	133	0.0001	0.035	3.26
Malta	133	0.0001	0.039	4.33
Guyana	131	0.0001	0.001	0.02
Surinam	130	0.0001	-0.019	-1.95
Chad	119	0.0001	-0.01	-0.72
Uganda	118	0.0001	0.012	0.37
Lebanon	118	0.0001	-0.029	-0.82
Malawi	107	0.0001	-1	-0.0001
Tahiti	107	0.0001	0.017	0.95
Albania	100	neg.	0.045	1.7
Martinique	97	neg.	neg.	-0.17
Niger	88	0.0001	0.033	6.47
Syria	87	0.0001	0.014	2.57
Fr.Polynesia	81	neg.	-0.065	-1.83
Barbados	79	neg.	0.065	3.6
Sri Lanka	74	0.0001	-0.017	-1.23
Sierre Leone	66	0.0001	-0.124	-3.74
Jordan	63	neg.	-0.091	-4.16
Iran	56	0.0001	0.027	0.39
New Caledonia	50	0.0001	0.057	4.97
Samoa	47	neg.	0.044	1.47
Seychelles	46	neg.	0.009	0.93
Iceland	41	neg.	0.066	5.42
Myanmar	40	neg.	0.042	4.17
Guinea Bissau	35	neg.	-0.098	-1.57
Haiti	30	neg.	0.229	5.29
Pakistan	8	neg.	0.062	2.37
Total	986752	1	0.018	31.51

*Compound growth rate.
neg: Negligible

TABLE A2.5 AVERAGE MALT IMPORTS, AND COMPOUND GROWTH RATES: 1979-89

Importer	Average-80/84	Average-85/89	Difference	CGR*	T-value
Japan	544163.60	549604.20	5440.6	0.013	2.91
Germany F.R.	221510.20	301853.00	80342.8	0.071	20.67
Brazil	178136.20	272299.20	94163	0.057	6
Venezuela	172710.40	173272.20	561.8	0.021	3.63
Netherlands	149635.00	154412.40	4777.4	0.019	3.84
Philippines	105937.80	126260.00	20322.2	0.058	5.89
Belgium	75946.60	98113.60	22167	0.085	10.65
Switzerland	81675.20	89079.80	7404.6	0.011	2.78
Cameroon	53758.20	80381.20	26623	0.064	6.68
Nigeria	133661.20	79602.20	-54059	-0.167	-5.01
U.K.	38815.40	78427.00	39611.6	0.098	7.79
Italy	70205.40	77969.20	7763.8	0.014	3.23
U.S.S.R.	245127.40	65200.40	-179927	-0.854	-7.5
South Africa	68911.80	61467.40	-7444.4	0.009	0.59
Colombia	21410.40	50762.60	29352.2	1.001	neg.
Zaire	26587.80	46500.00	19912.2	0.103	14.46
Cuba	35904.20	43889.60	7985.4	0.046	16.2
Norway	23313.20	35691.00	12377.8	0.08	26.18
Peru	28954.80	32353.00	3398.2	0.025	0.8
U.S.A.	45049.20	31269.60	-13779.6	-0.107	-9.76
France	16477.20	22262.80	5785.6	0.136	9.93
Spain	11424.00	22019.40	10595.4	0.077	6.1
Hungary	0.00	20139.40	20139.4	0.63	5.7
Malaysia	20642.80	19312.60	-1330.2	-0.001	-0.19
Ivory Coast	19180.00	17759.40	-1420.6	-0.012	-0.88
Hongkong	14531.60	17405.20	2873.6	0.05	5.53
Thailand	24532.20	17373.00	-7159.2	-0.035	-2.68
Singapore	15146.80	16977.00	1830.2	0.038	10.2
Dominican	14508.80	16233.20	1724.4	0.041	1.5
Greece	10888.60	14730.00	3841.4	0.074	3.03
Gabon	11807.60	14031.60	2224	0.035	6.14
Panama	8607.00	12887.60	4280.6	0.087	9.56
Bolivia	12911.60	12846.00	-65.6	0.087	5.12
Guatemala	7622.80	12581.00	4958.2	0.028	0.74
Jamaica	10080.80	11442.80	1362	0.034	5.7
Portugal	6728.20	11298.80	4570.6	-0.061	-0.51
China	5281.00	11139.00	5858	0.27	2.4
Indonesia	10581.20	10852.20	271	0.024	3.95
Congo	8197.20	9704.80	1507.6	0.04	1.44
Vietnam	2160.00	9600.00	7440	0.227	4.07
Paraguay	7815.20	9416.40	1601.2	0.065	2.82
Burundi	7862.20	8975.40	1113.2	0.028	5.51
Costa Rica	6071.80	8734.00	2662.2	0.049	7.39
Sweden	4629.40	8042.00	3412.6	0.051	3.02
Rwanda	5896.60	7692.00	1795.4	0.055	2.76
Israel	6228.40	7660.00	1431.6	0.047	8.3
Denmark	1442.20	7635.40	6193.2	0.367	4.34
Iraq	5067.40	7408.60	2341.2	0.049	1.28
Ghana	6240.00	7228.80	988.8	0.012	0.4

TABLE A2.5. (CONTINUED)

Importer	Average-80/84	Average-85/89	Difference	CGR*	T-value
Togo	5359.20	7001.00	1641.8	0.032	1.23
Korea	12982.40	6908.40	-6074	-0.167	-2.67
Honduras	5530.20	6268.40	738.2	0.033	4.08
Trinidad	6038.40	6121.20	82.8	0.017	2.4
Puerto Rico	6704.00	6092.40	-611.6	-1	neg.
El Salvador	3543.20	5765.20	2222	0.067	2.19
Austria	1751.40	5525.40	3774	0.123	2.04
Papua N.G.	4231.60	5434.20	1202.6	0.046	3.07
Yugoslavia	0.00	5388.60	5388.6	0.698	2.58
Ireland	726.80	5360.80	4634	0.305	6.73
Zambia	6979.40	4936.40	-2043	-0.077	-3.62
Angola	6240.00	4734.40	-1505.6	0.008	0.22
Burkina Faso	7871.20	4159.40	-3711.8	-0.078	-4.1
Rep. Cen. Africa	2562.60	4140.60	1578	0.064	7.11
Botswana	3485.00	3877.20	392.2	0.008	0.62
Morocco	1760.00	3497.60	1737.6	0.148	1.32
Jordan	910.80	3483.40	2572.6	0.074	0.45
Mauritius	2282.20	3478.80	1196.6	0.085	7.05
Romania	3100.00	3400.00	300	-0.015	-0.74
Cyprus	2562.00	3303.20	741.2	0.05	10.14
Nicaragua	5959.20	3180.20	-2779	-0.052	-2.48
Madagascar	2751.60	2977.40	225.8	0.006	0.36
Algeria	3419.60	2956.40	-463.2	-0.046	-1.61
Benin	3385.60	2940.40	-445.2	-0.022	-1.22
Fiji	2461.00	2115.00	-346	-0.024	-2.63
Tanzania	4913.40	1900.00	-3013.4	-0.23	-4.7
Malta	1654.60	1869.20	214.6	0.032	4.1
French Polynesia	1552.20	1860.00	307.8	0.033	3.02
Senegal	2157.80	1847.80	-310	-0.043	-2.17
Malawi	1695.40	1840.60	145.2	0.005	0.24
Mozambique	5640.00	1781.40	-3858.6	-0.152	-2.35
Liberia	2196.60	1750.80	-445.8	-0.044	-1.61
Ethiopia	7378.40	1650.20	-5728.2	-0.967	-30.57
Uganda	1900.00	1600.00	-300	0.016	0.22
Lebanon	1040.00	1500.00	460	0.02	0.71
Reunion	1280.40	1415.60	135.2	0.034	1.78
Syria	1289.20	1386.80	97.6	-0.003	-0.12
Barbados	1368.00	1376.40	8.4	0.023	1.85
Martinique	1350.20	1357.80	7.6	0.001	0.33
Chad	1500.00	1300.00	-200	-0.03	-0.9
Tunisia	1401.60	1200.00	-201.6	0.007	0.18
Niger	1068.20	1030.00	-38.2	-0.018	-2.36
Sri Lanka	988.20	1023.80	35.6	-0.029	-0.73
Guyana	1265.20	1020.00	-245.2	-0.125	-2.2
New Caledonia	764.00	936.40	172.4	0.068	3.43
St. Lucia	673.20	837.20	164	0.005	0.15
Seychelles	773.80	804.20	30.4	-0.021	-0.94
Surinam	1537.20	750.00	-787.2	-0.08	-4.03
Samoa	408.40	724.00	315.6	0.155	4.54

TABLE A2.5. (CONTINUED)

Importer	Average-80/84	Average-85/89	Difference	CGR*	T-value
Iceland	566.80	703.20	136.4	0.035	2.38
Sierra Leone	1229.20	655.80	-573.4	-0.12	-6.45
Germany D.R.	1780.00	600.00	-1180	0.076	0.7
Belize	450.20	484.40	34.2	0.077	2.06
Myanmar	470.00	430.00	-40	-0.02	-0.43
New Zealand	1142.20	413.40	-728.8	-0.004	-0.03
Guinea Bissau	533.20	382.40	-150.8	-0.045	-1.23
Haiti	287.60	374.00	86.4	0.052	1.51
Faeroe Islands	331.00	373.20	42.2	0.042	3.12
Grenada	316.20	371.00	54.8	0.027	2.07
St. Kitts	227.80	297.40	69.6	0.057	2.35
Guinea	292.80	232.00	-60.8	-0.326	-2.23
Saudi Arabia	186.00	197.60	11.6	0.047	0.59
Australia	576.20	160.00	-416.2	-0.042	-0.6
Total	2760759.20	2973278.60	212519.4	0.019	9.35

*Compound growth rate.

TABLE A2.6. TRADE FLOW CHANGES FROM BASE CASE (PERCENTAGES) UNDER DIFFERENT TRADE POLICIES

		Exporting Regions																	
		EU Malt Export Availability Reduced to 1 mmt.						EU Malt Export Refunds Reduced by 30 Percent						US EEP Reduced by 60 Percent					
Importing Regions		USA	EU	Can.	Aus.	E. Euro	S. Amer.	USA	EU	Can.	Aus.	E. Euro	S. Amer.	USA	EU	Can	Aus	E. Euro	S Amer
North Africa (Algiers)	Malt													-19	19				
Cen. America (Balboa)	Malt		-90			90								-2	-21			23	
South. Africa (Cape Town)	Malt				16	39	-55		91		-19		-72				16		-16
East Asia (Hong Kong)	M. Barley			100															
	Malt				-100														
Caribbean (Kingston)	Malt	20	-20																
West Africa (Lagos)	Malt		-54				54		23				-23	-23	3				20
Philippines (Manila)	Malt													-10		10			
East Africa (Mobassa)	M. Barley		-6		24		-18		-6		6								
N.S. America (Puerto la Cruz)	M. Barley	-8	2	6				-8		8									
	Malt	38	-38					8	-26	18									
E.S. America (Recife)	M. Barley	-28		14			14	-1		1									
	Malt	28	-34				6	1	-49			3	46						
China	M. Barley			-20	20					-8	8								
Japan (Tokyo)	M. Barley			-2	2														
	Malt			14	7	-21				-5	7	-2				8	-6	-2	

TABLE A2.6. (CONTINUED)

Importing Regions		Exporting Regions: EU Malt Export Availability Reduced to 1 mmt.						EU Malt Export Refunds Reduced by 30 Percent						US EEP Reduced by 60 Percent					
		USA	EU	Can.	Aus.	E. Euro	S. Amer.	USA	EU	Can.	Aus.	E. Euro	S. Amer.	USA	EU	Can	Aus	E. Euro	S Amer
W.S. America (Valparaiso)	M. Barley			75			-75												
Russia (Odessa and Vladivostok)	M. Barley			-100	100				-100										
	Malt								100										

TABLE A2.7. CHANGES IN TRADE FLOWS FROM BASE CASE FOR ALTERNATIVE IMPORTER TRADE POLICIES (PERCENTAGES)

		Exporters											
		Reductions in Importer Tariffs						Equaling Chinese Malting Barley and Malt Import Tariff					
Importing Regions		USA	EU	Canada	Australia	E. Europe	S.America	USA	EU	Canada	Australia	Eastern	S. America
Cen. America (Balboa)	Malt		-90	90									
Southern Africa (Cape Town)	Malt				-26	76	-50		9		-27		19
East Asia (Hong Kong)	M. Barley				100					100			
	Malt				-100						-100		
Caribbean (Kingston)	Malt	20	-20					20	-20				
West Africa (Lagos)	Malt		23				-23		23				-23
Philippines (Manila)	Malt			-84	84								
East Africa (Mobassa)	M. Barley		-6		24		-18				18		-18
	Malt				7	-7							
N.S. America (Puerto la Cruz)	M. Barley			-42				-8		8			
	Malt		42					8	-8				
E.S.America (Recife)	M. Barley		7	-21			3	-8		-6			14
	Malt		-23				34	8	-8				
China (Shanghai)	M. Barley			2	-2					-20	-53		
	Malt										66	7	
Japan (Tokyo)	M. Barley	-6		6						-19	19		
	Malt			21	7	-28				19	-15	-4	
W.S. America (Valparaiso)	M. Barley									100			-100
Russia (Odessa and Vladivostok)	M. Barley		-100							-100	100		
	Malt		100										

TABLE A2.8 CHANGES IN MALTING BARLEY AND MALT TRADE FLOWS FROM BASE CASE FOR ALTERNATIVE BEER CONSUMPTION LEVELS IN IMPORTING REGIONS ('000 MT)

		Exporters																	
		1990 Beer Consumption Levels + 20 % of Difference Between Year 2000 and 1990 Beer Consumption Levels						1990 Beer Consumption Levels + 40 % of Difference Between Year 2000 and 1990 Beer Consumption Levels						1990 Beer Consumption Levels + 48 % of Difference Between Year 2000 and 1990 Beer Consumption Levels					
Importing Region	Type	US	EU	Canada	Austr	E.Eur	S.L.A	US	EU	Canada	Austr.	E.Eur	S.L.A	US	EU	Canada	Austr.	E.Eur	S.L.A
Central America (Balboa)	Malt		-45			46			-2			3			1				
Southern Africa (Cape Town)	Malt				25	63	-71				7	64	-39				18	65	-44
East Asia (Hong Kong)	M. Barley			108						93						87			
	Malt				-92						-92						-92		
Caribbean (Kingston)	Malt	11	-20					14	-30					14	-33				
West Africa (Lagos)	Malt		-32				71		39				39		44				50
Philippines (Manila)	Malt			7						15							18		
East Africa (Mobassa)	M. Barley				18		-18				24		-18				22		-18
	Malt					-3						-5						-5	
Southern Europe (Piraeus)	Malt		16						32						39				
N.S. America (Puerto la Cruz)	M. Barley	-24		24				-24	6	18				-24	6	18			
	Malt	19						85	-41					111	-59				
E.S. America (Recife)	M. Barley	22		-50			27	-169		69			100	-202		102			100
	Malt	15	91					189	20					227	25				
China (Shanghai)	M. Barley			-111	123					-111	135					-111	140		

TABLE A2.8. (CONTINUED)

Importing Region	Type	Exporters: 1990 Beer Consumption Levels + 20 % of Difference Between Year 2000 and 1990 Beer Consumption Levels						1990 Beer Consumption Levels + 40 % of Difference Between Year 2000 and 1990 Beer Consumption Levels						1990 Beer Consumption Levels + 48 % of Difference Between Year 2000 and 1990 Beer Consumption Levels					
		US	EU	Canada	Austr	E.Eur	S.L.A	US	EU	Canada	Austr.	E.Eur	S.L.A	US	EU	Canada	Austr.	E.Eur	S.L.A
S.E. Asia (Singapore)	M. Barley																24		
	Malt				18						36						25		
Non-EU N. Europe (Stockholm)	Malt		-9						-18						-21				
Oceania (Suva)	Malt				-6						-13						-15		
Japan (Tokyo)	M. Barley	4		-4				9		-9				11		-78	67		
	Malt				93	55	-106			86	62	-63				97	64	-60	
W.S. America (Valparaiso)	M. Barley						-9			63			-82	6		54			-82
Russia (Odessa and Vladivostok)	M. Barley									-44	44					-44	44		

TABLE A2.8. (CONTINUED)

TABLE A2.8. (CONTINUED)

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