AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Policy Implications for U.S. Agriculture of Changes in Demand for Food

Helen H. Jensen and James A. Chalfant
Editors

Proceedings of the S-216 Southern Regional Research Committee Symposium
Washington, D.C.
October 7-8, 1991

Sponsored by:
The Economic Research Service, U.S. Department of Agriculture
and
The Farm Foundation

Center for Agricultural and Rural Development
Iowa State University
578 Heady Hall
Ames, Iowa 50011-1070

1994

U.S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY
RECEIVED
APR 15
ORDER UNIT
ACQUISITIONS BRANCH

Meat Demand Elasticities and Trade Potentials: A Prospectus

Barry W. Bobst and Michael R. Reed

When submitting the idea for this paper, we had in mind entitling it "Meat Demand Elasticities and Trade Potentials," with the word "Prospectus" tacked on to indicate that the document was a prospectus for the paper. When the title got printed this way, we thought, "Oh, oh, we are going to have to change this." But the more we thought about it, the more appropriate the title seemed. Work on international food demand is in a very early stage of development, and any results should be considered tentative and a prospectus for more polished work to come. The title is, therefore, appropriate, because the results we have to report really should be considered tentative and very much open to future improvements.

The results we wish to discuss are part of a study, performed under cooperative agreement with USDA's Economic Research Service (ERS), that is specifically policy oriented. The issue is, what would happen to the demand and supply for meats in the world if trade liberalization were to reduce livestock production subsidies and restrictions on meat imports? Trade liberalization would free up prices to adjust meat trade flows, the outcomes of which depend, of course, on demand and supply price elasticities. Trade liberalization works on both the demand and supply sides of markets, but our interest here is focused on the demand side. If markets are opened up, consumers in countries that had restricted imports should have access to meats at lower prices, while consumers in exporting countries might well face rising prices. Magnitudes of these changes obviously depend on the magnitudes of the elasticities. Our object was to estimate these elasticities for a coherent set of world regions on a common dataset to provide a global scope and comparability to meat trade analysis.

The Demand Model

A Rotterdam demand model was chosen, primarily because of the nature of the data. With prices and incomes reported in many different currencies, only percentage changes in quantities, prices, and incomes are comparable across countries and regions. The log-change formulation of the Rotterdam model therefore made it a natural choice. Expositions of the Rotterdam model are readily accessible (Theil 1976, 1-22; Johnson, Hassan, and Green 1984, 68-72), so only a few highlights of it will be repeated here. Assuming that block independence of preferences for meats holds globally, we can express the demand for meat i of a country in region k as a function of (a) the demand for the meats group in region k and (b) its own and competing meat prices. In terms of log changes, the demand function for a given meat among n meats in the group is expressed as follows:

$$w_{ikt}\Delta(lnq_{ikt}) = U_{ik}\Delta(lnQ_{gkt}) + \sum_{j=1}^{n} \pi_{ij}\Delta(lnp_{jkg}) + \epsilon_{ikt},$$

$$i,j = 1,2,\ldots,i\epsilon g, \qquad (1)$$

where, for meat i, in region k, in period t
w_{ikt} = average budget share during period t
$\Delta(\ln q_{ikt})$ = log change in quantity demanded in period t

$\Delta(\ln Q_{gkt})$ = log change in consumption of all meats in group g
$\Delta(\ln p_{jkt})$ = log change in price of meat j in period t.
The relative price version of the Rotterdam model was used, with meat prices and total meat expenditures expressed in relative terms by deflating nominal prices in local currencies by local consumer price indexes before conversion to log changes.

The Rotterdam model under the preference independence assumption places several restrictions on the parameters. The parameters U_{ik} in the model are interpreted as the log change in individual meats with respect to a log change in total consumption in region k. As such, it follows that

$$\Sigma U_{ik} = 1 \qquad (2)$$

Since demand is unaffected by prices outside the group,

$$\Sigma \pi_{ijk} = 0 \qquad (3)$$

for each meat. Slutsky symmetry also requires that

$$\pi_{ijk} = \pi_{jik} \qquad (4)$$

It should be noted that these restrictions are applied to demand functions for regions rather than for individual countries. Income elasticities are calculated from the parameters as follows:

$$\eta_{ik} = U_{ik}/\overline{W}_{ik} \qquad (5)$$

where $\overline{W}_{ik}$ = mean expenditure weight for meat i in region k. Marshallian price elasticities of demand are calculated from price coefficients as follows:

$$e_{ijk} = \pi_{ijk} - \eta_{ik}\overline{W}_{jk}, \qquad i = 1,2,j...,n \qquad (6)$$

Regions

Twelve regions were identified for the purposes of this study; the composition of these is shown in Table 1. These regions were delineated on the basis of geographic, political, and economic considerations, some of which have changed in the three years since the study was planned. German reunification is the most notable example of change, and the inclusion of Eastern Europe with the USSR has been thrown open to question. On the other hand, after 1992 the European Community (EC) will presumably be even more cohesive a grouping than it was in our study. Only the United States and Canada were treated as single-nation regions. At the other extreme (excluding the Rest of the World), Oceania consists of 16 different entities. How this disparity was handled is discussed later.

Data

Annual data from all countries for the years 1961 to 1987 for beef, pork, poultry (chickens and turkeys), and, for some regions, fish, were used in the analysis. Types of data and sources are listed in Table 2.

Beef was divided into fed and nonfed categories. It was assumed that only the United States, Japan, and South Korea are significant producers of grain-fed beef. Since Japan and South Korea do not export beef, it was further assumed that (1) all U.S. beef exports were of fed beef and (2) that imports from the United States were the sole source of fed beef in all regions except Japan and South Korea.

Data were incomplete for many countries, particularly those in the lesser-developed regions. Missing data were handled by excluding observations, so that the analyses reflect available data. To the extent that data are missing because of civil wars and other kinds of internal upheavals, the analyses are weighted toward the more settled countries within regions.

Estimation

Log changes in meat quantities demanded in each country were measured by log changes in domestic output plus net trade. For poultry these were calculated from weighted averages of chicken and turkey. Under our assumption about fed beef, we measured consumption of this meat by imports from the United States in all but Japan and South Korea. Some regions, such as Oceania, recorded no beef imports from the United States. In most others, the role played by fed

Table 1. World meat demand and supply regions

(1)	United States
(2)	Canada
(3)	European Community: excludes the former German Democratic Republic
(4)	Other Western Europe: includes Yugoslavia but excludes Turkey
(5)	USSR and Eastern Europe: includes the former German Democratic Republic
(6)	Japan and South Korea
(7)	Pacific Rim: includes Taiwan, Hong Kong, ASEAN, and Indochinese nations
(8)	China/East Asia: includes China (but excludes Taiwan), Mongolia, and North Korea
(9)	Oceania: includes Australia, New Zealand, and Pacific island nations
(10)	Argentina and Brazil
(11)	Other South America: excludes Central America and West Indies nations
(12)	Rest of World: wherever data were available

Table 2. Descriptions of data and data sources[a]

Item	Source
Meat quantities: domestic output plus net trade	*FAO Yearbook-Production* and *FAO-Yearbook-Trade;* USDA Livestock and Meat Statistics
Prices: domestic livestock prices	*FAO Yearbook-Production*
Meats trade	*FAO Yearbook-Trade,* For. Agr. Trade of the U.S.
Private consumption expenditures	*International Finance Statistics*
Population, consumer price indexes	*International Finance Statistics*

[a]All data except individual countries' consumer price indexes are contained in the database of USDA-ERS Automated Research Information for Economic Studies.

beef in consumer expenditure patterns is not clear. Is it integrated into local at-home consumption, or is it marketed primarily through the hotel-restaurant channel, possibly mostly to U.S. tourists? Having no answer to this question, we estimated demand systems with and without fed beef for several regions. Fed beef was excluded from the demand system for Oceania and other regions having no beef imports from the United States.

The price situation was even more complicated. Since retail meat prices were unavailable in most countries, log changes in prices were measured by log changes in livestock prices deflated by local consumer price

indexes. Except in Japan and South Korea, log changes in cattle prices were taken as measures of nonfed beef prices. In Japan and South Korea, fed beef prices were represented by farm-level beef cattle prices, and nonfed beef was represented by dividing the value of nonfed beef consumption by the quantity produced. In other regions, fed beef prices were represented by unit values of U.S. beef exports. Poultry prices in all countries were represented by weighted averages of farm-level chicken and turkey prices. Because of these data limitations, we had to calculate meat expenditures from farm-level prices and quantities, so that the demand functions estimated were actually farm-level derived demands. However, unless price transmission between farm and retail levels is severely nonproportional, price elasticities in the Rotterdam model are unaffected by the market level at which they are measured. Total meat expenditures, total meat expenditures as a proportion of income (actually, total private consumption expenditure), and subsequent calculations were also performed on a farm-level basis.

Data for each region were organized as a time series of cross-sections of the individual countries within the region. Regional expenditure weights were calculated by population-weighing the individual countries' expenditure proportions. Thus, in the regression analyses, individual countries' observations were scaled in proportion to their share of regional populations. Thus, for example, Luxembourg is proportionately less important than France in determining demand parameters for the EC.

Because of the instrumental nature of much of the price data, the various parameter restrictions inherent in the Rotterdam model were imposed as estimation constraints. While in principle these restrictions can be used to deduce the price and expenditure share parameters of one commodity in a group from empirical estimates for the other commodities, this did not seem feasible here. Accordingly, the restrictions described in Eqs. (2), (3), and (4) were imposed as constraints on parameter estimates.

Parameter Estimates in Selected Regions

Canada, the European Community, other western Europe, Japan, and South Korea, and the Pacific Rim are current or potential markets for U.S. meat exports and are the regions discussed here. Price and income elasticity estimates for these regions are shown in Table 3. To assure comparability across regions, only fed and nonfed beef, pork, and poultry are included in the meats group, even though fish are known to be important in some regions, notably Japan and South Korea. Elasticities are set at zero for all parameters whose t-ratios are less than one. As stated earlier, these elasticity estimates should be considered as tentative and subject to refinements. This is especially the case for the estimates of fed beef demand.

Demand estimates for fed beef for Canada, the EC, and other western Europe are obviously suspect. No one believes that the income elasticity for fed beef in Canada is 0, 36 in the EC, nor –7 in the other western Europe region. We present these results as a form of cautionary tale to future analysts: U.S. export prices do not provide a reliable basis for estimating fed beef demand. Just what should be used in place of them is not at all clear. In the meantime, the elasticity estimates excluding fed beef look like the more reliable set, so our applications discussion is based on them.

Effect of Price Cuts in Trade Liberalization

Meat trade liberalization would affect prices differently in different regions, depending upon the degree of protection being reduced, upon supply price elasticities, as well as upon the price elasticities of demand discussed here. However, as a first approximation, the effect of across-the-board cuts in meat prices on quantities of meats demanded within regions can be evaluated by summing their price elasticities for each meat. That is, for a given region k,

$$\%\Delta Q_{ik} = EP_{ijk}\,(\%\Delta P_{jk}) = \eta_{ik}\Sigma W_{jk} \qquad (7)$$

where EP_k is the matrix of own- and cross-price elasticities of demand. Since the sum of own-price and substitution effects within the meat demand system for each country is equal to zero, these sums are also

Table 3. Meat price and income elasticity estimates for selected regions

Region	Fed Beef	Nonfed Beef	Pork	Poultry	Income
Fed Beef Demand					
Canada	–1.840	0.757	1.038	0	0
EC[a]	–1.027	3.182	0	0	–7.583
OWE	–0.64	0	–1.898	0	36.776
J-SK	–0.472	0.051	0.324	0.074	0.793
Nonfed Beef, with Fed Beef					
Canada	0.008	–0.075	0.041	0.019	0.278
EC	0.002	–0.061	0.069	–0.029	0.393
OWE	0	–0.130	0.106	0	0.830
J-SK	1.041	–1.08	0	0	8.759
Nonfed Beef, excluding Fed Beef					
Canada		–0.067	0.048	0.02	0.098
EC		–0.130	0.081	0.033	0.302
OWE		–0.111	0	0.083	0.624
PCRIM		–0.206	0.084	0	1.408
Pork, with Fed Beef					
Canada	0.027	0.1	–0.166	0.039	0
EC	0	0.083	–0.113	0.015	0.326
OWE	–0.002	0.125	–0.095	–0.009	–0.424
J-SK	0.283	0	–0.215	–0.079	0.31
Pork, excluding Fed Beef					
Canada		0.096	–0.16	0.046	0.723
EC		0.104	–0.104	0	0
OWE		0	–0.027	0.015	0
PCRIM		0.026	–0.11	0	1.461
Poultry, with Fed Beef					
Canada	0	0.04	0.04	–0.119	1.53
EC	0	–0.07	0.064	0	–0.769
OWE	0	0	–0.043	0.056	0.289
J-SK	0.134	0	–0.134	0	–0.868
Poultry, excluding Fed Beef					
Canada		0.047	0.057	–0.128	0.97
EC		0.107	0	–0.126	0.549
OWE		0.267	0.048	–0.315	0
PCRIM		0	0	–0.014	–0.823

[a]Region abbreviations: EC: European Community, OWE: Other Western Europe, J-SK: Japan and South Korea, PCRIM: Pacific Rim.

equal to the sum of expenditure-weighted income elasticities for each meat. These quantity effects are presented in Table 4, together with estimates of producer and consumer subsidy equivalents developed by Roningen and Dixit (1989) for several of the regions discussed here. While these subsidy equivalents are not direct measurements of equilibrium-level price distortions, their values should give some rough notion of how large the distortions are and, therefore, what latitude there may be for such across-the-board price cuts as are postulated here. It can be seen that the latitude is substantial for the EC, for other western Europe, and for Japan. In Canada, however, there is little room to cut prices by reducing subsidies. Subsidy equivalents are not available for the Pacific Rim region.

The relationship between price changes and expenditure-weighted income elasticities best explains why the quantity effects shown in Table 4 are all very small. Since meat demands appear to be inelastic with respect to income, and meat expenditures are small percentages of income, the quantity effects of an across-the-board price reduction are understandably small. They are positive, however, for most meats in most regions. The only exceptions are for poultry in the Other Western Europe region and in Japan and South Korea, where the income elasticities are zero and negative respectively.

Implications for Trade Flows

What implications have these results for trading opportunities? Before discussing this, the tentative nature of these elasticity results must be emphasized once again. As we have already made clear, there is ample opportunity for improvement. Also, trade has a supply side, and meat supply has been ignored here. Having said all that, however, the results summarized in Table 4 do look interesting. It is widely believed that there is a potential market for fed beef in Japan, and our results agree with this. But Table 4 suggests some other, less well known trading opportunities. The largest percentage change in predicted quantity demanded in Table 4 is for nonfed beef in the Pacific

Table 4. Estimated percentage changes in quantities demanded in response to a one percent decrease in meat prices, with producer and consumer subsidy equivalents

	Canada	European Community	Other W. Europe	Japan-South Korea	Pacific Rim
	Percent				
Fed Beef	—	—	—	0.0222	—
Nonfed Beef	0.002	0.015	0.028	0.039	0.122
Pork	0.017	0.001	0.013	0.011	0.84
Poultry	0.023	0.019	0	–0.001	0.014
Production Subsidy[a] Equivalent:					
Ruminant Meat	10	40	50	66	—
Nonruminant Meat	6	22	30	32	—
Consumer Subsidy[a] Equivalent:					
Ruminant Meat	–1	–20	–26	–33	—
Nonruminant Meat	3	–15	–23	–19	—

[a]Source: Roningen and Dixit (1989).

Rim region. This region also seems to hold some promise for pork. However, export opportunities for pork in the other four regions are quite low.

The largest poultry coefficient is for Canada, but with Canada's small population, the market potential is very modest. The European Community would be a much larger market in absolute terms. Moderate export opportunities for nonfed beef appear to exist in the other western Europe and Japan and South Korea regions.

Just what share of these potential expanded exports could be captured by U.S. producers is a question beyond the scope of this paper. Suffice it to say that there do appear to be some opportunities. The percentage changes in quantity demanded as predicted by this analysis are very small, but the absolute magnitudes of meat consumption are so large that even these small changes convert into millions of pounds of product. If U.S. meat production is as efficient as we think it is, our results, tentative though they may be, suggest that meat trade liberalization is a goal well worth pursuing.

References

FAO Yearbook-Production. Rome: Food and Agriculture Organization of the United Nations (various issues).

FAO Yearbook-Trade. Rome: Food and Agriculture Organization of the United Nations (various issues).

International Financial Statistics. Washington: International Monetary Fund, various issues.

Johnson, S. R., Z. A. Hassan, and R. D. Green. *Demand Systems Estimation Methods and Applications.* Ames, IA: Iowa State University Press, 1984.

Roningen, V. O., and P. M. Dixit. *Economic Implications of Agricultural Policy Reforms in Industrial Market Economies.* Staff Report AGES 89-36, Economic Research Service, U.S. Department of Agriculture, Aug. 1989.

Theil, H. *Theory and Measurement of Consumer Demand,* vol II. Amsterdam: North Holland, 1976.