Staff Paper Series

Staff Paper P94-8

April 1994

PROJECTED CONSUMPTION OF LIVESTOCK PRODUCTS

by

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Abstract

The U.S. consumption pattern of livestock products has changed considerably and is expected to keep changing. The first part of this paper reviews the consumption trends and the price and nonprice factors affecting those trends. In the second part, future consumption patterns are projected. The projections of the constant income elasticity model and the Tornquist functions are rejected due to recent trends which do not receive enough weight in these models. A third model which projects consumption shares is selected as a more accurate predictor. By the year 2010, national consumption of beef is estimated to decrease by 5 to 10%; pork to increase by up to 5%. Lamb and mutton will continue to be consumed less. Poultry consumption will increase dramatically while egg consumption will decrease.

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*This work was done as part of Minnesota Experiment Station Project 14-22 and is part of a larger project, "Structural Change and the Future of the Livestock Industry," funded by a grant from the Northwest Area Foundation. The authors wish to thank Dr. Jean Kinsey for her data and her help in the initial stages of this study.

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PROJECTED CONSUMPTION OF LIVESTOCK PRODUCTS

Jorunn Grande, James P. Houck and Kent D. Olson

The consumption pattern of livestock products in the U.S. has changed considerably over the past 50 years. Both the total consumption of meats, dairy products and eggs has grown and the mix of the consumption bundle has changed. Many factors affecting consumption have changed and are still changing. Compared to earlier in this century, the U.S. income level has reached a point where demand for livestock products is less responsive to income growth. Population growth in the United States is slowing down which puts a ceiling over aggregate demand for livestock products. Also, meat will probably face tougher competition from other protein sources such as fish and legumes. To improve the chances of their future success, the people and companies involved in the livestock and meat industries need to know these historical trends, understand the factors influencing these trends, and better perceive what the future may hold. Accordingly, the objectives of this paper are to (1) review consumption trends and the factors which affect consumption and (2) project future consumption patterns within the U.S. using three methods based on elasticities, population growth, income growth, and market shares.

CONSUMPTION TRENDS

Based on disappearance data, beef, veal, pork, lamb and mutton accounted for 89% of total meat consumption per capita in 1909 (Figure 1). By 1989, this share had dropped to 61%. Beef's relative share of consumption has dropped from 39% in 1909 to 31% in 1989, even though actual consumption increased to 68 lbs per capita (Figure 2). The annual per capita consumption of pork has remained quite stable (about 60 lbs per capita), but pork's share of total meat consumption has decreased from 42% in 1909 to 29% in 1989. Recent evidence points to an increase in per capita pork consumption: the average consumption per person for the 1980's was 62 lbs, which is 3 lbs above the average in both the 1970's and the 1960's. Both poultry's relative share and its annual per capita consumption have increased; poultry grew from 11% of total meat consumption in 1909 to 39% in 1989.

Even though there are some differences in definitions that need to be remembered,[1] the trend is obvious; regardless of how we measure it, poultry consumption is clearly on its way to exceed beef consumption. The overall increase in meat consumption since 1970 is due to a rapid growth in the consumption of poultry which has more than compensated for the decrease in red meat consumption (Figure 3).

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[1]Poultry is measured in ready-to-cook weight, which includes the entire dressed bird. Beef is measured in retail weight, which contains less bone and is 29.5% lighter than carcass weight (Putnam, 1990). Therefore, poultry measured in ready-to-cook weight may overstate the actual consumption of poultry compared to beef. In trimmed equivalent and boneless meat, per capita beef consumption was still ahead of poultry in consumption in 1989 (65.1 lbs versus 60.3 lbs (Putnam, 1990, p.34)).

Buse (1989) explained that the general decrease in per capita red meat consumption is mainly due to a decline in the use of less expensive steaks, bacon, sausage, and variety meats. Some of this decline was, however, offset by increased consumption of ground beef and more expensive steaks. Fresh pork consumption has increased, while the consumption of other pork products has decreased. Whole chicken consumption has declined. Increased chicken consumption was partly a result of the growing use of cut-up chicken and turkey--revealing an increased demand for convenience (Buse, 1989). Buse also found that the trend towards poultry could be partly explained by an increase in beef and pork prices relative to poultry. Wohlgenant's (1989) findings suggested that the composition of beef consumption might be affected by nonprice changes in the poultry market which have had an influence on the sensitivity of beef demand to poultry prices. These changes in the poultry market were basically in terms of the increased number of fast food chains that served chicken meals and the changing preferences in favor of poultry due to increased health concerns about saturated fat. This implied that decreases in poultry prices were likely to decrease a person's intake of beef more in recent years than they did previously. However, consumer price indexes showed the price of poultry to have increased relatively more than both beef and pork since the 1982-1984 average (Putnam, 1990). So, although the price development of meats favored poultry consumption in the 1970's, this seemed not to be the case during the last decade. Huang and Haidacher's study (1989) found that for all types of meats, their own price ranked first in influencing consumption with total food expenditures ranking second. As an illustration, they found the price of pork, per capita consumption expenditure, and the price of beef and veal to be most important in explaining pork consumption. In their study of data from 1953 - 1983, they found prices and income to explain 95% of the short run variations in consumption pattern.

The dominating trend in dairy products has been an increase in consumption of low fat products, whereas products with higher fat content like butter and whole milk have decreased in popularity. Cheese has not been following the mainstream with respect to health considerations. Its per capita consumption has increased, even though it is high in saturated fat and calories. Total consumption of milk products increased until the 1930's, but declined in the following decades until it started a slow growth again in the early 1970's. The average consumption of all milk products based on milk equivalent fat content showed no clear trend in recent years.

The decline in total fluid milk consumption, primarily from whole milk, was likely to be attributed to the concern about calories, cholesterol, and animal fat (Smith et al., 1990). The same can be said about the decreasing demand for butter. On the other hand, the increased cheese consumption conflicts with this view, so there must also be other important factors favoring its consumption. Cheese is a common ingredient in many varieties of food consumed away from home (examples are pizza, Mexican food and cheeseburgers), and in convenience food (Putnam, 1990). Also, cheese can be said to be a convenience food in itself, often used for snacks, lunches, etc. It is likely that the boom in fast food restaurants and the increasing expenditures on food away from home in recent years have increased the demand for cheese. One might also conclude that the consumers have been substituting one dairy product for another--cheese consumption has increased as butter and whole milk consumption has dropped.

A factor found to be of substantial importance to the fluid milk consumption is consumption of cereals (Smith and Yonkers, 1990). Milk is without doubt a complement to

cereals. The increase in U.S. cereal consumption has been phenomenal. In the 20 year period following 1967, cereal consumption increased 4.6 lbs per capita, a 43.4% increase. In fact, the growing cereal consumption indirectly offset 20.1% of the decline in fluid milk consumption in noncereal uses. Milk used on cereal was estimated to be 49.3 lbs per person per year based on USDA consumption data and a study by Smith and Yonkers (1990). They indicated that cereal milk had a 22.1% share of the total milk consumption in 1987, whereas it made up only 13.1% of all milk consumed in 1967 (Smith and Yonkers, 1990).

Per capita egg consumption peaked after WWII, from 1945 to 1957, with the average consumption staying above 344 eggs per capita. In 1989, consumption was only 227 eggs per person, which was the lowest since 1909. Since the early 1980s, consumption of shell eggs has decreased even more than the total numbers suggest, because the number of eggs used in processed foods has been included in the total--and that number has been increasing (Putnam, 1990, p. 16). Most analysts seem to correlate the decline in egg consumption to concerns about cholesterol intake (Putnam, 1990).

NONPRICE FACTORS INFLUENCING FOOD CONSUMPTION

Factors other than prices and income are expected to increase their influence on consumers' demand for food. Contrary to Huang and Haidacher's (1989) finding that price and income changes explained 95% of the changes in demand between 1953 and 1983, Cox et al. (1989) showed that after adjusting for shifts in prices and incomes, demographics are equally important in explaining differences in protein purchases between 1972/73 - 1980/81. Also, as noted earlier, the public's increased concern about nutrition and its correlation to health, especially the role of saturated fat and cholesterol, has been and will continue to be one of the most important factors influencing the decreasing popularity of red meat compared to poultry (Putnam, USDA, 1990). The same can also be said about low versus high fat dairy products.

An important demographic factor is the slowing population growth rate in the U.S. (Myers, 1989). From 1980 to 2010, the U.S. population is expected to grow only 15%, which is much less than the 80% increase during the 30 years prior to 1980 (Kinsey, 1990a). Thus, only slow growth can be expected in national consumption in the future, and changes in consumption patterns will be a result of substitution between food groups. The U.S. food industry, accustomed to expansion with ever-growing domestic markets, must adjust to a slowly rising ceiling in the domestic food market.

Projections by the U.S. Department of Commerce (1990) suggest a growth in real median family income during the next decades, but at a declining rate. When income increases above subsistence levels, further increases always result in a smaller share being used for food. In addition, a smaller share tends to be used on food eaten at home. Smallwood, Haidacher, and Blaylock's study (1989) suggested that higher incomes tend to favor expenditures on beef, without affecting pork consumption very much. Poultry expenditures per person also seem to have been unaffected by income except at high income levels (above $20,000 annual income in 1980-81), where they tend to increase. However, they also found that poultry consumption, both

turkey and chicken, exhibited increased responsiveness to income changes over time. That is, poultry consumption now increases as income increases.

Between 1940 and 1982 the average household size dropped from 3.8 to 2.7 persons. Single person households had a 17% share of the population in 1970, but this share increased to 24% in 1985 (Kinsey, 1990a). The number of single person households was predicted to increase further. Smaller households spend more per person on food, but use a smaller share of their income on food than larger households. One and two person households have the highest average income per member compared to larger units (U.S. Department of Commerce, 1988). Smaller households also have larger share of food eaten away from home. One person households spent 45% of their food expenditures away from home, whereas for two and three person households this share was 31 and 27%, respectively. Small households tend to favor poultry in their diet, while larger units seem to prefer more beef and fresh dairy products (Kinsey, 1986 and 1990a, and Lee, 1989). However, on average, one and two person households are likely to have a higher per capita consumption of meat than larger households (McCracken, 1989). Female headed and single, older female households spent less than average on red meat at home. The formation of smaller units and female headed households are thus anticipated to have a negative impact on beef and pork consumption (Myers, 1986) and especially beef (McCracken, 1989).

The median age of the population has increased during the last decades and is expected to increase further in the future. In 1970 the median age was 28 years, it increased to 30 years in 1980, and by 1987 it had increased to 32.1 years (US Department of Commerce, 1989). Projections for year 2000 suggest an increase to 36.3 years (Myers, 1989). The share of elderly people in the population is predicted to increase significantly by 2030, when the "baby boomers" reach an age of 66 to 84. Caloric and nutritional needs change as people get older, and also, tastes and choice of food are affected by experience and income. Surveys have shown that older people eat more meat but consume fewer milk products and eggs than children (Kinsey, 1990). Today we do not know whether the baby boomers will adopt the eating patterns of today's elderly, retain the eating patterns being established in their middle ages, or change to something in between.

The white population counted for 84.6 percent of the U.S. population in 1987 and is predicted to decline to 69% by 2005 (Kinsey, 1990a). In 1989, the Hispanic category accounted for 8% of the population and half of the immigration. They also have the highest fertility rate among immigrants and are the least well-educated. The black and Hispanic populations are predicted to be almost equal in size and together will account for more than 25% of the total U.S. population by the year 2005 (Kinsey, 1990a). Nonwhites are also relatively younger than whites. Blacks, on average, have lower incomes than whites and were also found to spend about $1000 annually less on food than whites. Data from the early 1980's show that they spent more than the average on meats, fish and eggs (30% more on fish and poultry) (Kinsey, 1990a). Even though some Hispanics tend to prefer high fat milk, nonwhites in general are less likely to consume milk or milk products and beef and more likely to eat poultry and eggs and drink sweet beverages (Kinsey, 1990a).

In 1986, 76% of the population had completed 4 years of high school compared to 24% in 1940, and the number of adults who had completed college increased from 5% in 1949 to

about 20% in 1988 (Kinsey, 1990a). Higher education seems to make people more creative in their food selection. The more educated people are the quicker they are to adopt new food varieties. They also eat food outside the home more often (Kinsey, 1990a). Educated people tend to be more concerned and better informed about health and food safety issues and will demand higher quality food and food services. College education seems to have a negative impact on red meat consumption (Lee and Brown, 1986).

The most significant change in the labor force over the last 20 years is the increased participation of married women and women with children and the decreasing share of male workers in the total. This means an increase in households with two or more workers (Kinsey, 1990). Another important characteristic is the increasing participation of nonwhites and immigrants (Kinsey, 1986). Lee (1989) found that when both spouses are employed, expenditures on red meat tend to be higher. Also, more time spent at work means less time available for preparing food at home, resulting in an increased demand for convenience food and food away from home.

Food expenditure data show that an increasing part of the consumers' food budget is spent on food away from home (FAFH). Away from home meals and snacks together increased from 24% of the food dollar in 1949, to 34% in 1969, and to 44% in 1989 (Putnam, 1990).[2] A survey from the National Broiler Council shows that the share of broilers being sold to restaurants increased from 20% to 28% between 1981 to 1985. A declining share, from 60% to 51%, went to grocery stores in the same period (Thurman, 1989). Higher incomes, more education, and increasing value of time is likely to influence FAFH positively, whereas the growth of nonwhite ethnic groups and older consumers tend to push it in the other direction (McCracken, 1989). Two studies found that older, lower income households and less time constrained households were less likely to consume food outside their home (McCracken, 1989, and Lee and Brown, 1986). However, Kinsey's (1986) work shows that the lowest 10% income households had one of the largest increases in FAFH even though Lee and Brown (1986) found food stamp participants to be more likely to eat meat at home. Retired people tend to spend less money on FAFH than the average U.S. citizen. However, as the average income of retired people increases and their health improves, this share is expected to increase (McCracken, 1989). Kinsey's (1986) study showed that one of the largest increases in FAFH is in households containing persons over 65 years of age. How FAFH expenditures will change for this group is hard to predict, but as long as they spend less on FAFH than the national average, the increasing elderly crowd is likely to put a damper on the total FAFH expenditures in the future.

Convenience food means that food preparation activities are transferred from the consumer to the food processor. Capps (1989) emphasizes the importance of added convenience as a factor in the demand for animal products at home. Convenience food products made up approximately 45% of the expenditures spent on food at home in 1983 (Capps and Pearson, 1986). The poultry industry realized early the importance of convenience attributes in their products and has introduced several types of processed foods that are easy to prepare (Capps,

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[2]However, food at restaurants includes more services and is thus more expensive than meals at home, so the expenditure share is higher than the share of the actual amount of food consumed (Putnam, 1990).

1989). This could also be one of the reasons behind its rapid increase in consumption during the last decades. The beef sector has lagged because it has been slow to adapt to the consumers demand for convenience food.

Data from 1940 and 1982 showed a doubling of the number (in all age groups) of women working outside their homes (Kinsey, 1986). More time spent in the work place meant less time for food preparation. The increased share of women's participation in the labor force decreased the households' time available for food preparation and probably increased the demand for convenience food (and FAFH). As it became more common that both spouses worked full time, it was expected that men would increase their participation in shopping and food preparation in the future. Thus, they would increasingly influence future food consumption since studies show that men buy more beef, processed meats, dairy products, and convenience foods than women (Kinsey, 1986 p. 39).

So far we have reviewed the main historical trends, commenting on the demographics and other factors that have influenced these trends. Next we look into the future by using different models to estimate future demand.

PROJECTION MODELS

National consumption of livestock products were projected in two steps. First, three separate models were used to project per capita demand for beef, veal, pork, lamb and mutton, chicken, turkey, eggs, and milk products. The Constant Income Elasticity model used estimated income elasticities, projected income growth, and projections of the median population growth to estimate national consumption. The Tornquist Functions were quite similar to the first approach except they included a satiation point for future consumption. The third model projected consumption shares which were then used to allocate a projected total per capita consumption. In the second step, the same estimates of population growth were used to translate the three projections of per capita demand into projections of national consumption.

The Constant Income Elasticity model assumed constant real prices and no influence from demographic trends and consumer preferences. This model seemed to simplify the real world too much, but it served as a good indicator of how incomes may pull the consumption of the various products and as a comparison to the other models. By keeping its limitations in mind, interesting conclusions were made. The model used to predict consumption was defined as

$$Q_i = BM(1 + \%\Delta Y * E_i) \qquad (1)$$

where Q_i = Lbs per capita of product i consumed.
BM = Benchmark quantity; the average of actual measured consumption the three years 1987 - 1989.
$\%\Delta Y$ = Percentage change in the per capita median disposable income.
E_i = Estimated income elasticity for product i.

This model was closely related to the Engel Curve (Varian, 1987), but it was linear in shape since it assumed constant elasticities for the projected period. The Engel curve described how consumption or expenditures on a commodity change as income grew or decreased, when all prices were kept constant. The curvilinear shape was typical for many food groups and it characterized the behavior of a "normal good."

The Tornquist Functions were named after its inventor and first user, L. Tornquist (Wold and Jureen, 1962). He constructed three different functions, each specified for a certain range of elasticities: necessities, relative luxuries, and luxuries. All commodities examined in this paper had an income elasticity less than one. This meant they were all considered necessities in the Tornquist context. As income or consumer expenditures increased at a specified rate, the spending on or consumption of that good increased at a slower rate. The Tornquist model specified for necessities was defined as

$$Q_i = S_i * [Y_n/(Y_n+\beta_i)] \qquad (2)$$

where $\beta_i = E_i/(1-E_i)*Y_o$, since $E_i = \beta_i/(Y_o+\beta_i)$
Q_i = quantity in lbs per capita consumed.
S_i = a constant which illustrates the finite amount a person will consume of commodity i at very high incomes (satiation level).
Y_n = median personal disposable income per capita for year n (estimated).
Y_o = median personal disposable income per capita in the base year.
β_i = a constant reflecting how fast consumption approaches satiation.
E_i = estimated income elasticity for product i.

Similar to the Constant Income Elasticity model, this model was also based on estimated income elasticities and projected income growth. It added the feature that per capita consumption could only grow to a certain point (S_i) even though income continued to grow. This assumed income elasticities declining to zero as income grew infinitely. Declining income or expenditure elasticities had been suggested by several empirical studies mentioned earlier. This was also reflected in the Engel Curve, where the quantity consumed or purchased of a good increased as income grew, but at a decreasing rate (Tomek and Robinson, 1981). For products with negative income elasticities, the satiation point (S_i) turned out to be the lower boundary of consumption. This was the case for eggs and total dairy products.

Before actual predictions were made by this model the two constants S_i and β_i had to be calculated. First, β_i was calculated based on income (Y_o) and income elasticity (E_i) for the base year 1988. Then S_i was calculated by using the income level and per capita consumption (a benchmark quantity used in Model 1) for the base year and the previously calculated β_i in equation 2. After these two constants were estimated, future consumption (Q_i) was calculated for each target year by substituting projected income (Y_n) into the above equation (Balassa, 1964).

Extrapolation of Consumption Shares. Projection of current trends into the future is a widely used approach applied to time series data. It is considered a simple method and less expensive than more rigorous models considering many variables. Extrapolation simply forecasts future behavior of time-series based on its past behavior. In this study, a variation of

this approach was used. The per capita consumption was converted to each product's share out of the total (100%) for the seven products. These shares were then projected to find future consumption shares. This model indirectly included all factors that have influenced the consumption pattern in the past including prices, income, changing demographics, preferences and so forth. One should note that this model assumed these factors would have the same impact in the future or that the consumption share of a commodity will follow the same path in the future as it did in the past. In this model, future consumption was projected by following these steps:

1. Each product's individual percentage share of the total was estimated for each year. Beef + Veal + Pork + Lamb and Mutton + Chicken + Turkey + Eggs = 100%
2. The model for predicting future shares was estimated through regression, where time was used as an independent variable and each products' share was the dependent variable. An individual model was estimated for each product. The general equation for the linear model was defined as

$$Qs_i = \beta_0 + \beta_1 * t + e \qquad (3)$$

where Qs_i = the percentage share of product i.
β_0, β_1 = coefficients to be estimated.
t = a time variable (1 = 1965, 2 = 1966,..., 25 = 1989).
e = error term.

3. Through extrapolation the estimated models were used to predict future consumption shares for the selected target years.
4. The projected shares were adjusted to add to a total of 100%, and translated into actual pounds per capita consumed of each product using a forecast of total meat and egg consumption per capita. A linear regression of the total quantity (with respect to time) was used, since it gave the lowest increase in total consumption.

In the second step, projections of the national consumption of livestock products were made by multiplying each of the three per capita projections by the same U.S. population projections.

DATA

The income elasticities estimated by Huang (1985) were used in the first two models (Table 1). These estimates were based on time series data (disappearance) in the period from 1953 to 1983. Huang's estimates of income elasticity were used for all products except lamb and mutton, for which he did not have a separate estimate. For this product an estimate based on a study by George and King (1970) was used. The income elasticity for total dairy products was calculated by using the Engel Aggregation condition, which is an expenditure share weighted average of the individual dairy products elasticities (Tomek and Robinson, 1981).

The most recent estimates from U.S. Department of Labor (1989) were used for the projected median per capita income. Disposable income estimates were taken from U.S. Department of Labor and adjusted for an average tax rate. A 14.8% tax was assumed based on the average tax paid by U.S. citizens in the period from 1981 to 1988 (U.S. Department of Commerce, 1990). Table 2 displays projected disposable income and the corresponding annual growth rates for the period from 1988 up to 2010.

The first two models needed a benchmark quantity as a starting point for the projections. The benchmark was the subsistence level of consumption at the current income and price levels. This quantity was obtained by taking the average of the three most recent years' known consumption (1987-1989). A three-year average was needed to avoid the potential of unusual observations in a single year, but it also could disguise strong up or down trends that may be present.

The third model was based on annual per capita consumption or disappearance gathered by the U.S. Department of Agriculture. One estimate was for the period 1965 to 1989 (Model 3a). A second estimated used data for a shorter period, from 1978 to 1989 (Model 3b). Linear regression (OLS) was used for all products in the estimation of future shares of per capita consumption except for veal, and lamb and mutton in Model 3a (which used a full log specification) (Table 3). A quadratic of the above model gave a significantly better fit for several of the products (as measured by R^2); however, the sum of the projected shares was very different from 100% and required excessive adjustment to reach 100%. By using a pure linear regression the unconstrained, projected shares summed very close to 100% (within 4%) before any adjustments were made. One problem with the linear trend was that it predicted negative shares for veal and for lamb and mutton. By using a full-log function for these minor products, this problem was avoided.

The projected national consumption for all the models was the projected per capita consumption multiplied by the future population based on U.S. Census Bureau's projections (U.S. Department of Commerce, 1989). The middle series estimate for the population growth projected an increase in the population from 246 million in 1988 to a peak of 302 million by 2040 (Table 2, Spencer, U.S. Department of Commerce, 1989).

PROJECTIONS OF PER CAPITA CONSUMPTION

The Constant Income Elasticity model projected beef consumption to increase 15.8 percent between 1989 and 2010--to 80 pounds per person (Table 4). Pork consumption was projected to increase to 69 pounds, a 9.5 percent increase. No significant increase was projected in the intake of poultry. Chicken and turkey were predicted to grow only 4.3 and 2.2 percent by this model. This was very different from what we would expect after observing poultry consumption during the last 10 years. The slightly negative forecast of dairy products was more in line with current trends. Egg consumption was predicted to stay much the same in the future. With the Tornquist function, the predicted changes were slightly less than those predicted by the Costant Income Elasticity model.

The third model, prediction by regression of product shares, gave very different results compared to the two other models based on income growth. Its projections, however, fit very well into some of the expected changes in consumption based on demographic influence and a more health conscious consumer. For Model 3a consumption data from 1965-1989 were used to estimate the β coefficients. Figure 4 depicts how the shares would develop in the future according to Model 3a. Most obvious was the decline in the share for eggs and beef, whereas chicken's share of total consumption grew. The short term variations observed earlier were gone, and the projected trends fit nicely into an extension of current trends. As mentioned earlier, the projected shares summed very close to 100% so only minor adjustments had to be made for each product to make it add to a total of 100%.

In actual consumption, the prediction by Model 3a showed a positive trend for both white meats but a negative trend for beef, lamb and mutton, and eggs. No significant changes in per capita consumption were projected for pork and veal. Chicken and turkey consumption were estimated to increase 35.2 and 25.5 percent, respectively; that is, or the average person would eat about 92 pounds of chicken and 21 pounds of turkey by 2010. Beef was expected to continue its current downward trend, although at a very slow pace such that per capita consumption will still be above 66 pounds by 2010.

Since 25 years may dissipate the impact of more recent trends, a shorter period of time (1978-1989) was used for another projection: Model 3b. Compared to Model 3a, the more recent trends contained a stronger negative trend for red meat and a stronger positive trend for white meat. Model 3b projected beef consumption to fall to 55 pounds by 2010. Pork was projected to take a slightly downward trend and to decrease to 61 pounds per capita. A more rapid increase was expected for chicken and turkey consumption; chicken was projected to reach 102 pounds per capita and turkey about 30 pounds per capita by 2010. This assumed that the trends seen in the market during the last decade will continue at the same speed in the future.

PROJECTIONS OF NATIONAL CONSUMPTION

Both the Constant Income Elasticity model and the Tornquist function model indicated a potential growth in the national demand for all meats, eggs and dairy products but only a slight increase for white meat (Table 5). The highest increase was expected for beef and veal. The two models predicted total demand for beef to increase from 17 billion pounds in 1989 to over 22 billion pounds in 2010. Total demand for pork was predicted to grow from 16 billion pounds to 19 billion pounds over the same period of time. The two models predicted a 3 billion lb. increase in demand for chicken, and about 0.6 billion lbs for turkey by 2010. This was attributed mainly to an overall growth in the population, since income growth alone was not expected to increase consumption of poultry a great deal. This was also the case for eggs and milk products, which were projected to increase by 1 billion and 20 billion pounds, respectively.

The two projections based on the method of regression of shares of aggregate consumption were very different from those based on elasticities. Model 3a, which has a longer base period, projected a growing demand for poultry, beef and pork, whereas Model 3b predicts increased demand only for poultry and pork. Model 3a estimated a 1.6 billion lb. increase in

demand for beef by 2010 and a 1.5 billion lb. increase in demand for pork. The national demand for lamb and mutton was projected to decrease by 0.1 billion pounds or 24%. Egg consumption also was projected to decrease by close to 2.3 billion pounds or 30%. Further, Model 3a projected a favorable 53%, or 9 billion pounds, increase in chicken consumption, and a 43%, or 1.8 billion pounds, increase in demand for turkey by 2010.

Model 3b predicted a more dramatic change for some of the products due to its use of a more recent time period. These projections led to 10% decrease in beef consumption which lowered the national demand for beef to 15.4 billion pounds by 2010. It also pushed predicted consumption of veal down 35.6% during the same period, whereas Model 3a only lowered demand by 2.5% by the same year. Due to the increase in the population, the increase in national demand for chicken was projected to grow at an even faster pace than in any of the other models. According to Model 3b, chicken consumption was projected to increase to 28.8 billion pounds by 2010--a 70% increase from 1989. Turkey consumption also was projected to expand to 8.6 billion pounds by 2010.

DISCUSSION

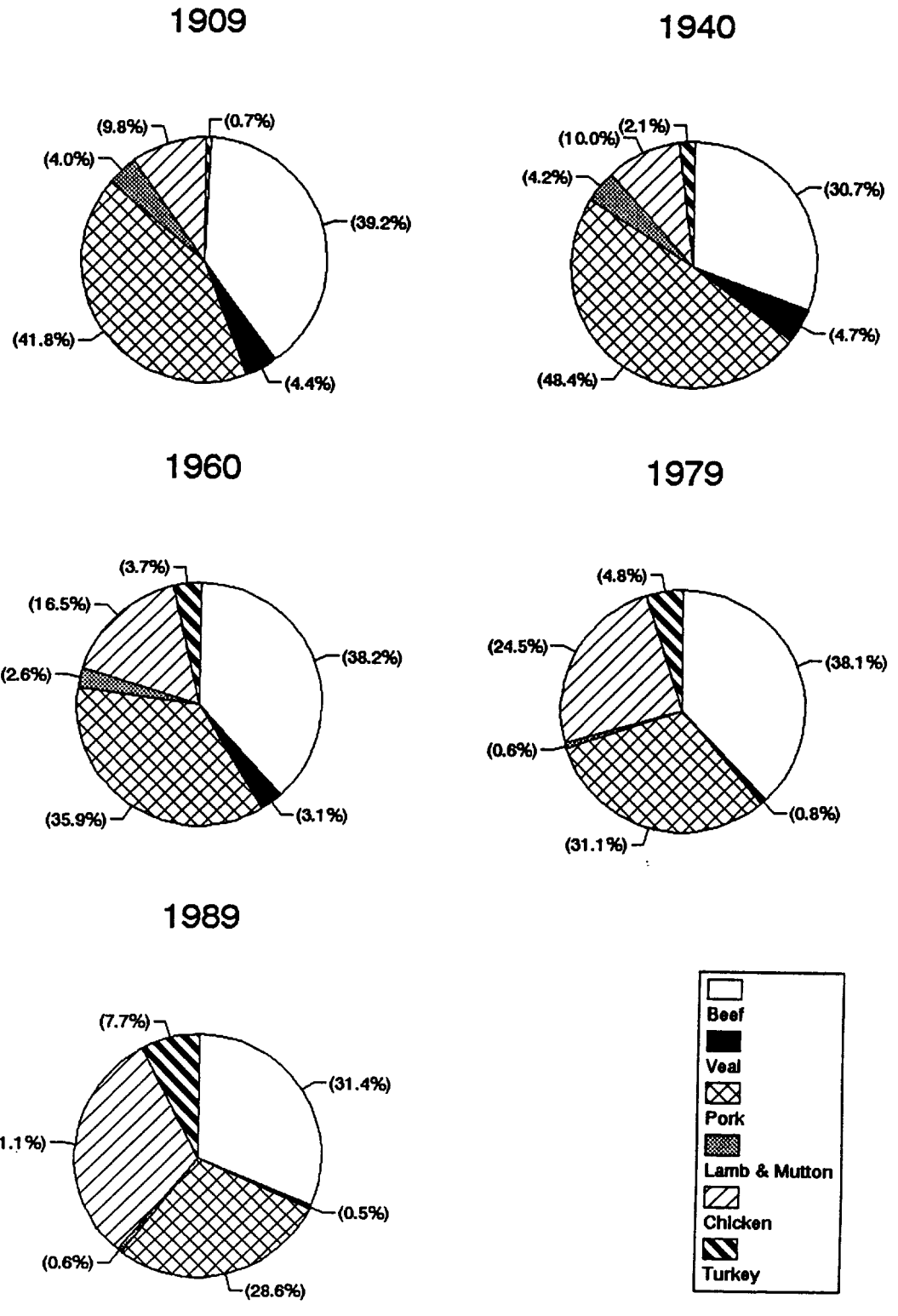
Model 3(a or b) was the most realistic model in the sense that it reflected the current trends and the expected change in demographic characteristics of the U.S. population. It reflected a more health concerned and informed consumer. We have already seen a clearly declining trend for high cholesterol foods such as eggs. An obvious preference for low-fat products can be seen in the recent switch from whole to low-fat milk. The recent increase in poultry consumption can be expected to continue.

A negative attribute of Models 1 and 2 was the inclusion of only the influence from income growth and income elasticities and the assumption assume that all other influential factors remain unchanged. This was a negative attribute because the elasticity estimates were from a long time period and not just the recent period when changes have happened rapidly. Also the projected income growth, which was used in these two models, was uncertain since it was heavily affected by general economic development both in this nation and at a international level.

Thus, Model 3 produced the best results in this study. Model 3a is between the two extreme Models, 1 and 3b, for all meats. Since increased income was expected to favor beef consumption, Model 3a seemed more reliable than 3b, because it included a higher level of beef consumption. Model 3a also predicted the lowest increase in consumption of total meats and eggs, which fit with the belief that overall per capita meat consumption will not increase significantly in the future. However, Model 3b used more recent information than Model 3a.

The exact numbers may be different, but some general trends can be seen by examining the national projections for Models 3a and 3b. Total beef consumption will decrease by 5 to 10%. Pork can expect an increase in consumption--up to 5%. Lamb and mutton will continue to be consumed less. Poultry consumption will increase dramatically while egg consumption will decrease.

Figure 1. Selected Meat's Share of Total Meat Consumption*



* Beef + Veal + Pork + Lamb & Mutton + Chicken + Turkey = 100%

Figure 2. Meat consumption for selected years.

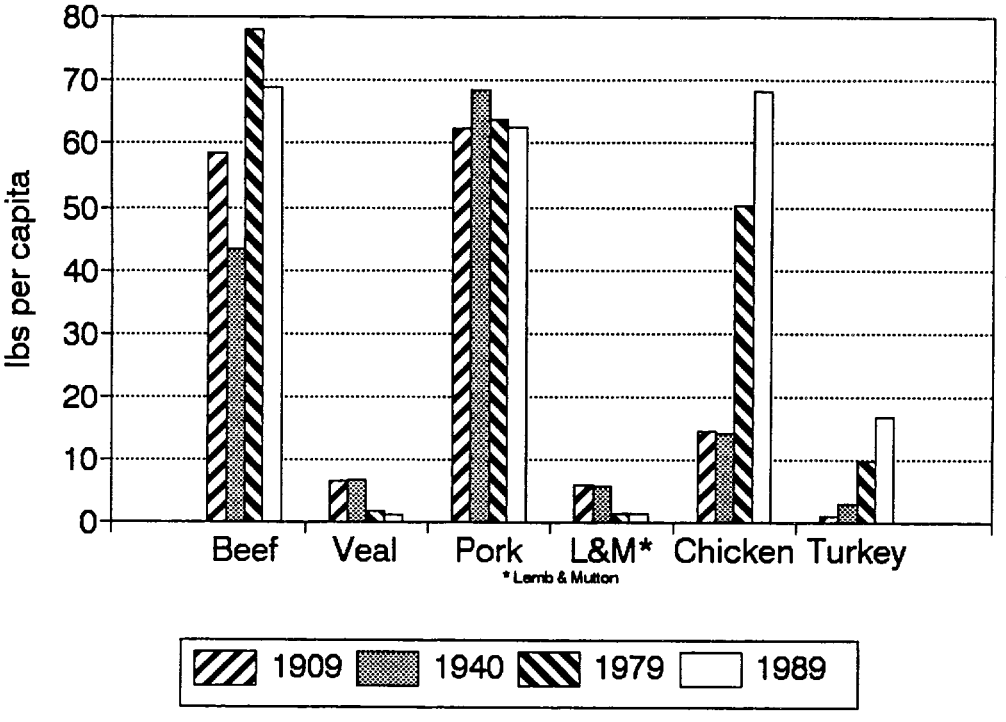


Figure 3. Beef, Pork, and Poultry Consumption, 1909-1989.

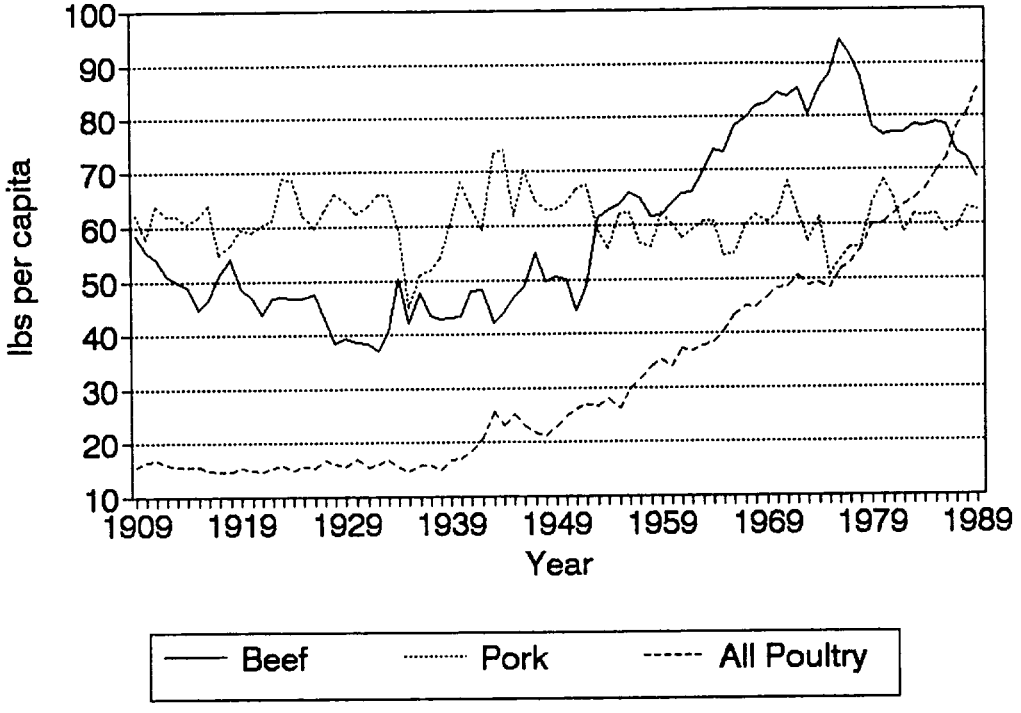


Figure 4. Consumption Shares, 1965–2010:
1990–2010 Projected by Model 3a

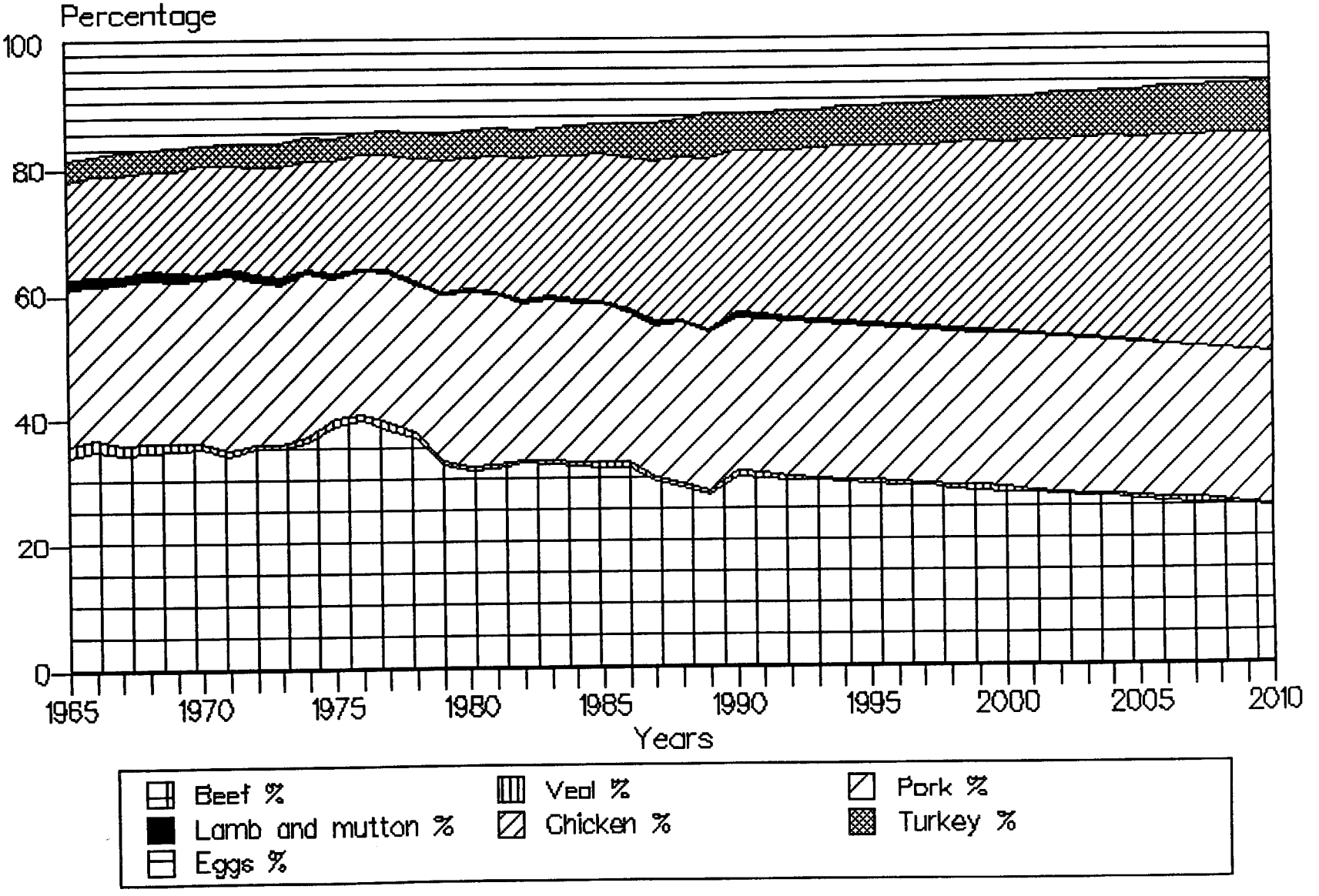


Table 1. Price, cross-price, and income (expenditure) elasticities for meat, eggs, and dairy products.

	Effect of a one percent change in the price of								
Quantity	Beef & Veal	Pork	Other Meats	Chicken	Turkey	Eggs	Cheese	Fluid Milk	Other Milk
Beef & Veal	-0.617	0.109	0.071	0.053	0.012	0.008	-0.030	-0.001	-0.002
Pork	0.191	-0.730	0.049	0.091	0.018	-0.015	-0.009	-0.033	-0.016
Other Meats	0.541	0.212	-1.371	-0.163	0.025	-0.015	0.407	-0.149	0.066
Chicken	0.293	0.264	-0.113	-0.531	-0.049	0.092	-0.039	0.179	0.035
Turkey	0.208	0.182	0.059	-0.170	-0.680	-0.027	0.149	-0.375	-0.099
Eggs	0.047	0.024	-0.008	0.073	-0.005	-0.145	0.029	-0.042	0.020
Cheese	-0.262	-0.047	-0.476	-0.069	-0.073	0.061	-0.332	0.453	-0.068
Fluid Milk	0.019	-0.024	-0.038	0.071	-0.040	-0.019	-0.103	-0.259	0.074
Other Milk	-0.012	-0.160	0.166	0.130	-0.102	0.098	-0.140	0.713	-0.826

Quantity	Income (Expenditure)
Beef & Veal	0.455
Pork	0.443
Other Meats	0.061
Chicken	0.365
Turkey	0.320
Eggs	-0.028
Cheese	0.293
Fluid Milk	-0.221
Other Milk	-0.266
All Dairy	0.086
Lamb & Mutton	0.570

Sources: Huang, 1985. George and King, 1971.

Table 2. Projection of population growth and income growth per capita, 1988-2010.

Year		Total population	% annual growth	Personal disposable income	% annual growth
		(thousand)			($)
1988	estimated	246113		11337	
1995	projected	260138	0.79	12328	1.2
2000	projected	268266	0.61	13074	1.18
2005	projected	275607	0.54	13687	0.92
2010	projected	282575	0.5	14222	0.77

Sources: Spencer, USDC, 1989.
USDC, Bureau of the Census, 1990.
US Census Bureau, Statistical Abstracts, 1990.

Table 3. Estimated share equations for model 3*.

Product	Model 3a: 1965-1989 R^2	Form	Intercept	Coefficient on Time	Model 3b: 1978-1989 R^2	Form	Intercept	Coefficient on Time
Beef	0.41	OLS	37.16	- 0.25	0.60	OLS	39.02	- 0.39
Veal	0.86	Ln	0.74	- 0.39	0.22	OLS	0.91	- 0.013
Pork	0.01	OLS	25.55	- 0.02	0.04	OLS	26.29	- 0.06
Lamb and Mutton	0.85	Ln	0.80	- 0.44	0.08	OLS	0.63	- 0.003
Chicken	0.94	OLS	13.53	+ 0.48	0.95	OLS	10.71	+ 0.63
Turkey	0.78	OLS	2.74	+ 0.12	0.91	OLS	0.05	+ 0.25
Eggs	0.96	OLS	17.98	- 0.23	0.93	OLS	17.94	- 0.23
All Meats & Eggs	0.56	OLS	227.35	+ 0.80	0.72	OLS	223.09	+ 1.00

*The dependent variable for the seven products is that product's percentage share of the total. The total of "All Meats & Eggs" is measured in pounds per capita consumption.

Table 4. Projected per capita consumption in lbs and as a percentage change from 1989. Summary of the results for the three different models.

1. Straight Income Elasticity

	1989*	2000	%	2005	%	2010	%
Beef	68.8	76.4	11.1	78.2	13.6	79.7	15.8
Veal	1.2	1.5	22.1	1.5	24.9	1.5	27.4
Pork	62.6	65.8	5.1	67.3	7.5	68.6	9.5
Lamb & Mutton	1.4	1.5	4.3	1.5	6.4	1.5	8.6
Chicken	68.1	68.6	0.7	69.9	2.6	71.0	4.3
Turkey	16.9	16.8	-0.9	17.0	0.7	17.3	2.2
Eggs	29.7	30.8	3.7	30.7	3.5	30.7	3.4
Milk	582.2	582.6	0.1	579.8	-0.4	577.4	-0.8
All Meat & Eggs	248.7	261.3	5.1	266.1	7.0	270.3	8.7

2. Tornqvist Function

	1989*	2000	%	2005	%	2010	%
Beef	68.8	76.0	10.5	77.5	12.6	78.7	14.4
Veal	1.2	1.5	21.7	1.5	23.3	1.5	25.8
Pork	62.6	65.5	4.6	66.7	6.5	67.7	8.2
Lamb & Mutton	1.4	1.5	3.6	1.5	5.7	1.5	7.1
Chicken	68.1	68.3	0.2	69.3	1.8	70.2	3.0
Turkey	16.9	16.7	-1.3	16.9	0.0	17.1	1.1
Egg	29.7	30.7	3.5	30.7	3.4	30.7	3.3
Milk	582.2	583.4	0.2	581.4	-0.1	579.8	-0.4
All Meat & Eggs	248.7	260.1	4.6	264.1	6.2	267.3	7.5

Table 4--Continued

3. Projection by Regression of Shares

Model a:

	1989	2000	%	2005	%	2010	%
Beef	68.8	71.2	3.6	69.0	0.2	66.4	-3.5
Veal	1.2	1.3	9.9	1.3	4.7	1.2	1.5
Pork	62.6	62.6	0.0	63.1	0.7	63.5	1.4
Lamb & Mutton	1.4	1.2	-14.9	1.1	-19.4	1.1	-22.3
Chicken	68.1	77.8	14.3	84.9	24.6	92.1	35.2
Turkey	16.9	17.7	5.0	19.5	15.3	21.2	25.5
Eggs	29.7	24.3	-18.0	21.5	-27.5	18.8	-36.6
All Meat & Eggs	248.7	256.3	3.1	260.3	4.7	264.3	6.3

Model b:

	1989	2000	%	2005	%	2010	%
Beef	68.8	63.3	-8.0	59.0	-14.3	54.6	-20.7
Veal	1.2	1.2	-3.4	1.0	-15.2	.9	-28.3
Pork	62.6	61.1	-2.4	61.0	-2.6	60.8	-2.9
Lamb & Mutton	1.4	1.4	-2.8	1.3	-5.5	1.3	-6.4
Chicken	68.1	84.2	23.7	93.0	36.5	102.0	49.7
Turkey	16.9	23.3	37.7	26.7	58.3	30.3	79.1
Egg	29.7	24.7	-16.8	22.1	-25.6	19.4	-34.7
All Meats & Eggs	248.7	259.1	4.2	264.1	6.2	269.1	8.2

a) Model based on the period 1965-1989.
b) Model based on the period 1978-1989.

Table 5. Projected national consumption in lbs and as a percentage change from 1989 (using middle series population growth *).

Summary of results for the three different models (million pounds)

1. Straight Income Elasticity

	1989*	2000	%	2010	%
Beef	17,116	20,498	19.8	22,521	31.6
Veal	353	393	11.4	432	22.4
Pork	16,436	17,655	7.4	19,377	17.9
L&M**	405	392	-3.3	430	6.1
Chicken	16,946	18,403	8.6	20,062	18.4
Turkey	4,201	4,494	7.0	4,880	16.2
Egg	7,624	8,261	8.4	8,677	13.8
Milk	143,409	156,279	9.0	163,162	13.8
All meats & Eggs	63,081	70,095	11.1	76,378	21.1

2. Tornqvist Function

	1989*	2000	%	2010	%
Beef	17,116	20,394	19.1	22,236	29.9
Veal	353	392	11.0	427	20.9
Pork	16,436	17,566	6.9	19,133	16.4
L&M	405	389	-4.0	424	4.7
Chicken	16,946	18,315	8.1	19,825	17.0
Turkey	4,201	4,475	6.5	4,826	14.9
Egg	7,624	8,246	8.2	8,669	13.7
Milk	143,409	156,506	9.1	163,837	14.2
All meats & Eggs	63,081	69,776	10.6	75,541	19.8

Table 5--Continued.

3. Projection by Regression of Shares

Model a

	1989*	2000	%	2010	%
Beef	17,116	19,112	11.7	18,763	9.6
Veal	353	354	0.2	344	-2.5
Pork	16,436	16,800	2.2	17,941	9.2
L&M	405	320	-21.1	308	-24.1
Chicken	16,946	20,881	23.2	26,025	53.6
Turkey	4,201	4,761	13.3	5,993	42.7
Egg	7,624	6,529	-14.4	5,318	-30.2
All meats & Eggs	63,081	68,757	9.0	74,692	18.4

Model b

	1989*	2000	%	2010	%
Beef	17,116	16,983	-0.8	15,423	-9.9
Veal	353	311	-11.9	243	-31.2
Pork	16,436	16,395	-0.3	17,178	4.5
L&M	405	365	-9.8	370	-8.6
Chicken	16,946	22,590	33.3	28,811	70.0
Turkey	4,201	6,243	48.6	8,551	103.5
Egg	7,624	6,628	-13.1	5,476	-28.2
All meats & Eggs	63,081	69,516	10.2	76,052	20.6

* Source for projected population USDC, Bureau of the Census, 1989.
** Lamb and mutton.
b) Model based on the period 1965-1989.
c) Model based on the period 1978-1989.

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