How Dairy Price Changes Influence the Consumers' Welfare

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Abstract:

The Hicksian compensating variation is used to evaluate the consumers' welfare effects of price changes because of some hypothesized removals of Federal dairy policies and programs. The results indicate that consumers would reduce dairy expenditures from about one to two billion dollars nationally.

Keywords: compensating variation, dairy demand elasticities, dairy policies and programs.

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Introduction

U.S. dairy policy has its roots in policies designed to alleviate the economic collapse brought on by the 1930s Depression. Today, as noted by Manchester and Blayney (*2001*), the two core Federal dairy programs are the dairy support purchase program and the Federal milk marketing order system. Other policies and programs have been tried, but in many instances they were relatively short-term. Calls for modifications of dairy policies have ranged from minor operational adjustments to fundamental philosophical changes. The 2002 farm bill under Title 1, Subtitle E, called for a comprehensive evaluation of a set of Federal and State programs relating to price support and supply management for milk. One facet of the mandate focuses on the consumer effects of changes in dairy policies and programs.

The primary goal of various dairy policies and programs is to influence the price producers receive for their raw milk. The policy-induced producer price adjustments bring about supply responses which, in turn, have implications for milk and dairy product production, marketing, and prices, both at the wholesale and the retail levels. At the end of the marketing channel, consumers make purchase decisions based on many factors including prices and income. The consumers' demand signals are then sent back through the marketing and production sectors to the producer level. Therefore, the consumer effects of changes in dairy policies and programs are important factors to be considered in dairy policy decisionmaking.

The objective of this study is to evaluate the consumers' welfare effects of price changes because of some hypothesized removals of Federal dairy policies and programs. An approximation of Hicksian compensating variation is applied so that the potential gains or losses in consumers' welfare in terms of consumers' spending on milk and dairy products can be measured. Since the direction of dairy policy is still under discussion, the purpose of this study is to demonstrate the usefulness of the methodology in measuring consumers' welfare effects.

Measuring Consumers' Welfare Effects

Marshall's concept of consumer surplus, defined as the area under the uncompensated demand curve resulting from a change in prices, has been widely used as a welfare measure to analyze the effects of agricultural policy on consumers. A study of agricultural price policy by Tolley, et al., (*1982*) is one example. A problem associated with using consumer surplus, as discussed in Hausman (*1981*), is its rigid assumption of constant marginal utility of income. The problem can be avoided by moving from the uncompensated to the compensated demand function as the basis for analysis. As Deaton and Muellbauer (*1980*, pp. 185-186) noted, Hicksian demand functions are the derivatives of the expenditure function, and a compensating expenditure change will offset the effect of any price changes. Thus, from the properties of compensated demand functions we can calculate welfare effects in terms of compensating variation in expenditure as a welfare measure. Willig (*1976*) and Shonkwiler (*1991*) proposed approximate Hicksian welfare measures for the case when only one commodity price changes. For practical welfare analysis, however, a welfare measure should reflect the effects of multiple price changes in consumers' budgeting as proposed in Huang (*1993b*).

Following Huang (*1993b*), a brief discussion of the procedure used in this study for measuring Hicksian compensating variation (*CV*) follows. Let an expenditure function be $E(p, u)$, defined as the minimum amount of expenditure necessary to get to a given level of utility u and a price vector p. Suppose that at some initial price level p^0 and expenditure level $E(p^0, u^0)$, the consumer achieves utility u^0. The compensating variation to reflect the change of expenditures necessary to compensate consumers for the effects of price changes moving to price level p^1 is given by

$$CV = E(p^1, u^0) - E(p^0, u^0) \tag{1}$$

A positive *CV* implies a requirement of more spending to achieve the same utility level after the price change, and thus there is a decrease in consumer welfare. On the other hand, a negative *CV* implies a drop in spending and a gain in consumer welfare. In our empirical application, we regard p^1 as a price level after removals of dairy policies or programs and use the negative of *CV* as a welfare indicator to show the savings in consumers' spending on milk and dairy products.

To develop a procedure to measure *CV*, let $q^h(p^1, u^0)$ be a vector of Hicksian compensated demand at given price vector p^1 and at the same initial utility level u^0. The *CV* can be expressed as the following inner products of price and quantity vectors:

$$CV = p^1 \bullet q^h(p^1, u^0) - p^0 \bullet q^0 \tag{2}$$

By further defining $dp = p^1 - p^0$ as a vector of price changes, and $dq^h = q^h(p^1, u^0) - q^0$ as a vector of compensated quantity changes, the above *CV* equation is transformed into

$$CV = p^1 \bullet dq^h + q^0 \bullet dp \tag{3}$$

Given the initial prices p^0 and quantities demanded q^0 for computing *CV*, two key questions are (a) how to define the price vectors of p^1 and dp, and (b) how to define a vector of changes in compensated quantities demanded dq^h. To answer the first question for defining the changes in price vectors p^1 and dp in equation 3, it is an empirical issue related to the price effects of milk and dairy products in response to removals of dairy policies and programs.

To answer the second question for defining the changes in compensated quantities demanded dq^h in equation 3, we first obtain the estimates of price and income elasticities and apply them to derive the compensated price elasticity estimates (say, e_{ij}*s) from the Slutsky equation. We then approximate the change in compensated demand, dq^h, by applying the first-order differential form as

$$dq_i^h / q_i = \sum_j e_{ij}^* (dp_j / p_j) \quad (4)$$

In short, the procedure for measuring Hicksian compensating variation can be carried out in three steps. First, the price (p^0) and quantity (q^0) at the base period should be furnished at the beginning. Second, under various scenarios of removals of dairy policies or programs, we can measure the price changes (dp) and their resulting price levels (p^1). Third, given compensated price elasticities (e_{ij}*), we can measure the change of compensated quantity (dq_i^h) based on the information of price changes. Finally, we can measure straightforwardly for *CV* from equation 3.

Empirical Results

Estimates of demand elasticities

The procedure for measuring Hicksian compensating variation is applied to evaluate the potential gains or losses in consumers' welfare when alternative hypothesized dairy policy changes are implemented. To provide basic information for measuring Hicksian compensating variation, we need estimates of demand elasticities for milk and dairy products only by implicitly assuming that the demand for milk and dairy products is separable from the demand for all other goods. These elasticities are obtained from Huang (*1993a*), in which a demand system consists of price and expenditure elasticities for 39 food categories and 1 nonfood sector. The demand system was estimated by the constrained maximum likelihood method, while the parametric constraints of homogeneity, symmetry, and Engel aggregation are incorporated into the estimation.

The milk and dairy products are classified into the following five categories: (1) fluid milk, (2) cheese, (3) other milk, (4) butter, and (5) frozen dairy products. The estimates of demand elasticities are listed in table 1. Fluid milk comprises whole milk and other milk beverages (mainly low-fat milk). The estimated own-price elasticity for fluid milk is quite low -0.04 indicating that a 10-percent increase in the price of fluid milk reduces per capita consumption 0.4 percent. Cheese is the most complicated dairy product because of the many varieties that may be classified according to structure, degree of hardness, and type of organisms responsible for the ripening process. The estimated own-price elasticities for cheese and butter are -0.25 and -0.24, respectively. Other milk including nonfat dry milk, whey, and evaporated and condensed milk has an estimate of own-price elasticity -0.28. The estimate of own-price elasticity for the frozen dairy category (mainly ice cream) is low -0.08. Finally, the estimated dairy income elasticities are listed in the last column of table 1 in a range from 0.12 to 0.54. These price and income elasticities are used to derive compensated price elasticities (table 2), which are further applied to measure consumers' welfare.

Projected price changes under hypothesized policy alternatives

One approach for examining the effects of various dairy policies on consumers is to establish some hypothesized scenarios for modifying or eliminating dairy programs or policies. The two core policies are the dairy support purchase program and the Federal milk marketing order system (FMMO). In addition, current Federal dairy policy includes a direct payment program for milk producers, called the Milk Income Loss Contract (MILC), which has been operating only a short time, and an export subsidy program, called the Dairy Export Incentive Program (DEIP). The actions of DEIP are part of the dairy price support program by most measures. We defined four hypothetical scenarios for changes in dairy policies and programs as follows:

(1) Removal of the dairy support purchase program, excluding DEIP,
(2) Removal of dairy support purchase program including DEIP,
(3) Removal of dairy purchase support program and MILC, and

(4) Removal of dairy support purchase program (including DEIP), MILC, and FMMO.

The above scenarios were constructed so that the marginal effects of eliminating policies or programs could be highlighted. These marginal effects are useful for considering a "partial deregulation" approach. The last scenario represents the case where all four programs are eliminated, and we would expect the greatest effects to be generated. Given the interconnections among these dairy programs and policies, it may not be logical, or operationally feasible, to eliminate some programs "before" another. The links among the programs in actual operation can be, and are, sometimes subtle. The brute-force imposition of constraints that remove program and policy effects are in many ways arbitrary, but it does highlight the rough magnitudes and directions of change.

A systematic empirical analysis of the dairy programs was undertaken utilizing the FAPSIM (Food and Agricultural Policy Simulator) model developed by the Economic Research Service, USDA. Many results are generated by the FAPSIM modeling framework that can contribute to a comprehensive analysis of dairy policy changes. Here, we are particularly interested in the price effects at the retail level that result from dairy program and policy changes. In the scenarios developed for this analysis, the effects of policy and program changes are traced over the 7-year life of the 2002 farm bill. The greatest policy impacts occur in the short term and then are dampened in the future as milk producers respond to the estimated changes in farm milk prices associated with policy changes. If we try to average the estimated price impacts over the life of the farm bill, they would wind up being relatively small. In the first 2 years of the model simulations, however, there are larger retail product price effects, which essentially set an upper bound on consumer responses.

The FAPSIM model has a long track record and is quite robust in the face of what can be extreme policy shocks. The short run retail price impacts pertaining to the first year after the removal of dairy policies or programs are shown in table 3. In the table, the changes in prices are reported as percent changes from a baseline. Also, the projected price of nonfat dry milk is related to a wholesale price, because nonfat dry milk is not a significant consumer product at the retail level in the United States. These simulated results underlying the estimates of the price effects of the hypothesized dairy policy changes as defined here are preliminary. Under scenario 1, the effects of removal of milk price support would reduce the prices of fluid milk by 2.4 percent, American cheese by 1.2 percent, nonfat dry milk by 15 percent, and ice cream by 0.5 percent, but the price of butter would increase by 4.6 percent. As expected, the price effects of milk and dairy products associated with increasing levels of policy removal tend to be greater. The next section will contain a detailed description of framework that has been developed to derive estimates of the consumer effects of the price changes for the five dairy product categories classified in this study.

Projected consumers' welfare effects under hypothesized policy alternatives

The base model information required for projection and comparison is listed in the upper part of table 3. This set of basic information is related to the 3-year averages (1998-2000) of each dairy

category's consumption per person and retail price. The quantities of consumption are fluid milk (196.6 pound, lb.), cheese (28.9 lb.), other milk (12.9 lb.), butter (4.6 lb.), and frozen dairy products (26.5 lb.). The retail prices of most milk and dairy products are calculated as 3-year averages of actual retail prices for the same 1998-2000 period. These prices, expressed in dollars per pound, are fluid milk ($0.32), cheese ($3.71), butter ($2.68), and ice cream represented for frozen dairy ($1.37). Since the retail price of other milk is not available, we calculate the price ($2.34) on the basis of its wholesale price by using the average of wholesale-retail price ratios of cheese and butter. Given the calculated base period prices and quantities, the total dairy expenditures per person are then calculated to be $248.95.

Under various scenarios of alternative dairy policies, the projected changes in price, quantity demanded and expenditures for each dairy category are compiled in table 4. In Scenario 1, we assume the dairy support purchase program, excluding DEIP, is eliminated. This program operates through purchases by the Federal Government of selected manufactured dairy products, butter, American cheese, and nonfat dry milk, to support the price milk producers receive. The current support price is $9.90 per cwt (100 pounds) of milk produced. Purchase prices calculated to return the equivalent of support price to producers establish a floor under manufactured product prices. If any product meets established quality standards and is offered to the Government at the purchase price, it must be purchased. Elimination of the program would be expected to result in greater product quantities on markets and reduced product prices. The main effect of the support programs is at the wholesale level so any retail price effects depend on how the wholesale price changes are transmitted up to retail. The dairy expenditures per person would be reduced by 1.62 percent. Based on U.S. population 279.25 million persons, the nation's savings for dairy expenditures would be $1,126 million.

In scenario 2, both the domestic purchase price program and the DEIP effects are removed. The DEIP program removes manufactured products from commercial markets by subsidizing export. U.S. dairy product exporters get "bonuses" that allow them to purchase products domestically and be competitive in foreign markets. The effects of DEIP have been constrained by the U.S. commitments to the WTO trade agreement. Elimination of DEIP removes the subsidized export outlet for manufactured dairy products. The effects expected in this scenario are as in Scenario 1 except greater quantities of products are involved. The dairy expenditures per person would be reduced by 2.96 percent, which is equivalent to nation's savings for dairy expenditures of $2,056 million.

In the third scenario, the effects of the MILC are removed along with both the domestic and the DEIP effects of the dairy support purchase program. The MILC is a direct payment program to milk producers similar to a target price deficiency program. Each month, milk producers receive a direct payment of 45 percent of any positive difference between $16.94 per cwt and the Class 1 milk price in Boston, Massachusetts as reported by the Agricultural Marketing Service. The payments are limited to 2.4 million pounds of milk per eligible producer. These direct payments would be expected to influence milk supplies and thus the quantities of dairy products reaching retail markets. We would expect an increase in milk supply and a decrease in consumer price when there is such a program in effect. The results obtained here are for the three programs

together. No scenario, however, was focusing on the MILC program alone in this study. The dairy expenditures per person would be reduced by 2.67 percent causing nation's savings for dairy expenditures of $1,853 million.

Lastly, the effects of all four concerned programs are removed with an addition of Federal milk marketing order (FMMO) effects. The FMMOs are regulatory institutions that establish floor prices for milk used to manufacture alternative milk and dairy products, based on end use in a classified pricing system. There are four defined milk classes in the orders: class 1 is for milk in packaged fluid milk products, class 2 is for fluid cream and soft products such as ice cream, class 3 is for cheese, and class 4 is for butter and dry milks. Producers receive a price related to a weighted average of all the class prices. While these class prices contribute directly to the input cost structure of milk processors and dairy product manufacturers, the prices can be passed on to the retail market and affect the consumer prices. The FMMO system is not analyzed in this study as a program to be eliminated separately. Removing the four policies and programs together results in estimated dairy expenditures per person being reduced by 3.02 percent; that is equivalent to have national savings for dairy expenditures of $2,099 million.

Concluding Remarks

In this study, the Hicksian compensating variation is applied to evaluate the consumers' welfare effects of potential price changes because of some hypothesized changes in Federal dairy policies. The results indicate that consumers would reduce dairy expenditures from about one to two billion dollars nationally. These results, however, are conditional on two key components of the analysis. First, the demand system underlying the consumers' welfare measure derived here implicitly treats the dairy products as final consumer goods. For many dairy products, such as butter, cheese, and almost all of the other products, a large share of production is used as intermediate ingredients by food processors and restaurants. Dairy products entering these two channels face derived demand relationships that can be much different than derived demands for dairy products as final products. Second, the projected price changes are those derived from the FAPSIM model, which has its own set of theoretical and operational structures. Since the direction of dairy policy is still under discussion, the projected results in this study are illustrative. They **do not** represent any projection or opinion of the possible ranges of the effects of policy changes.

In addition, the projection is focused only on consumers' welfare and does not explicitly recognize the supply side of the dairy markets. In particular, a critical question regarding the loss of producer revenue because of policy and program changes is unexplored. Agricultural policy decisionmakers might question whether the gain of aggregate consumers' welfare in savings could be compensated for the loss of farmers' revenue. Therefore, an extension of this research to a general demand-supply equilibrium model would be helpful for fully understanding the effects of dairy policy and program changes.

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