the extent that quality is a function of the number of items served at any one time. Number of servings embodies the most information about meal preparation output quantity and quality. For any one meal, number of servings is the product of number of items and number of persons eating the meal.

Homemaker's and spouse's daily preparation hours were self recorded as the time was used. Only the labor of adults was used. To the extent that children help with meal preparation the model is misspecified. The direction of any bias this may introduce is unclear since it is not clear whether child and adult labor are complements or substitutes in meal preparation. Time contributions for children under six were not recorded for this data set. Any measure of children's time is, therefore, downwardly biased for this sample.

A set of dummy variables can be interpreted as measuring either capital inputs or technological innovation. Use of each piece of capital equipment entails use of a different technology for food preparation, not just a different means of organizing food preparation. The kitchen equipment variables, $X_3,...X_7$ reflect whether the equipment was actually used that day rather than simply present for use. The residential location variable was used to capture differences in housing facilities in urban and rural areas.

SAMPLE

The data were collected in 1977-78 as part of an interstate comparison of family time use in two-parent two-child households. In each state samples were stratified according to age of the younger child in both rural and urban areas. Equal cell sizes were obtained with days of the week and season of the year equally represented within each cell.

Forty-five percent of the households had employed homemakers while 97 percent of the spouses were employed. Median annual income of these families was between $15,000 and $19,999. Spouses tended to be better educated than homemakers. Fourteen percent of the spouses had a graduate or professional degree beyond the baccalaureate compared to five percent of the homemakers. Nineteen percent of the homemakers and 22 percent of the spouses had a baccalaureate degree, 30 and 49 percent respectively had some college, whereas 39 and 30 percent respectively had a high school diploma. Less than eight percent of the spouses and homemakers had less than 12 years of schooling. When both the younger and older children were considered: 19 percent of the children were under 2, 28 percent were between 2 and 5, 27 percent were between 6 and 11, and 26 percent were between 12 and 18 years of age.

Table 1. Means and Standard Deviations of Food Preparation Outputs and Inputs

Outputs	Mean	Standard Deviation
Number of meals per day	3.30	1.40
Number of items per day	12.73	5.57
Number of servings per day	38.05	19.76
Inputs		
Homemakers' daily food preparation hours	1.34	0.91
Spouses' daily food preparation hours	0.14	0.38
Top of range used	0.90	0.30
Oven used	0.52	0.50
Broiler used	0.06	0.25
Microwave oven used	0.07	0.26
Small appliance used	0.69	0.46
Urban residential location	0.50	0.50

RESULTS AND CONCLUSIONS

The functional relationship between food preparation inputs and outputs is discussed first. Next the performance of the output measures is assessed. Finally the results are compared with Warren's (1940).

The log-linear function performed best regardless of which output measure was used (Table 4). The linear function consistently performed worst (Table 2). For meals the adjusted R^2 increased from 19.9 percent for the linear function to 22.1 percent for the quadratic function (Table 3) to 26.4 percent for the log-linear function. The items for adjusted R^2 rose from 30.8 percent for the linear function to 33.2 percent for the quadratic to 38.8 percent for the log-linear function. For servings the figures were 26.5 percent, 28.5 percent and 40.9 percent. Based on the superior performance of the log-linear and quadratic functions we conclude that food preparation outputs increase at a decreasing rate as labor inputs increase. A functional specification which permits this is superior to a linear specification.

Table 2. Linear Production Functions for Household Food Production

	Number of Meals Per Day	Number of Servings Per Day	Number of Items Per Day
Homemakers' daily food preparation hours	0.348*	6.081*	1.664*
Spouses' daily food preparation hours	0.181*	2.481*	0.449*
Top of range used	1.028*	12.377*	4.334*
Oven used	0.231*	7.313*	1.548*
Broiler used	0.012	5.473*	1.038*
Microwave oven used	0.189*	3.006*	1.160*
Charcoal grill used	0.177	7.535*	1.212*
Small appliance used	0.579*	8.400*	2.963*
Urban residential location	0.062	-2.141*	-0.407*
Constant	1.316	9.032	3.709
Adjusted R^2	.199	.293	.308

(n=2100)
*Significant at the .05 level

Table 3. Quadratic Production Functions for Household Food Production

	Number of Meals Per Day	Number of Servings Per Day	Number of Items Per Day
Homemakers' daily food preparation hours	0.876*	13.912*	3.970*
Homemakers' daily food preparation hours squared	-0.123*	- 1.847*	-0.543*
Spouses' daily food preparation hours	0.528*	4.465*	1.240*
Spouses' daily food preparation hours squared	-0.080*	- 0.269	-0.140*
Top of range used	0.911*	10.622*	3.819*
Oven used	0.174*	6.549*	1.317*
Broiler used	0.022	5.034*	0.905*
Microwave oven used	0.150*	2.396*	0.982*
Charcoal grill used	0.050	6.197*	0.783*
Small appliance used	0.538*	7.790*	2.783*
Urban residential location	0.063	- 2.159*	-0.411*
Constant	1.072	5.700	2.709
Adjusted R^2	.221	.314	.332

(n=2100)
*Significant at the .05 level

Table 4. Log-Linear Production Functions for Household Food Production

	Number of Meals Per Day	Number of Servings Per Day	Number of Items Per Day
Natural logarithm of homemakers' daily food preparation hours	.168*	.230*	.195*
Natural logarithm of spouses' daily food preparation hours	- .083*	- .047*	- .067*
Top of range used	.380*	0.823*	.625*
Oven used	.795*	0.286*	.180*
Broiler used	.331	0.181*	.123*
Microwave oven used	.726*	0.145*	.143*
Charcoal grill used	.646*	0.274*	.145*
Small appliance used	.195*	0.383*	.326*
Urban residential location	.014	-0.058*	- .035*
Constant	1.520	2.250	1.486
Adjusted R^2	.264	.383	.388

(n=2100)
*Significant at the .05 level

We do not go so far as concluding the log-linear function is superior to the quadratic function. Intriligator (1978) has pointed out the statistical problems inherent in directly estimating a single production function.[1] We chose to accept these problems because other alternatives required an assumption of constant returns to scale which we were unwilling to make. Negative signs of the coefficients for spouses' time in the log-linear function may indicate the presence of some of these statistical problems. One possible explanation for these negative signs is that spouses (overwhelmingly husbands) primarily contribute labor when homemakers are inefficient or incapacitated and less total output is produced in these circumstances. However, if this were the explanation we would expect to see much larger coefficients for homemakers' time than for spouses' time in the quadratic function. Although the coefficients for homemakers' time are larger, they are all less than four times larger.

Otherwise the results were robust. No significant qualitative differences appeared as a result of using different output measures. That is, no variables were significant and opposite in sign from equation to equation within any one functional form. The only coefficients which were consistently insignificant were broiler use and urban residential location in all equations for meals. Charcoal grill was insignificant in the linear and quadratic equations for meals, as was the quadratic term for spouse's labor which was insignificant in the quadratic equation for servings. The coefficients for the set of capital variables had the expected signs, and with the

[1] Estimation of a production function using direct measurements of actual inputs and outputs typically entails problems of simultaneity, multicollinearity, and heteroskedasticity. An alternative estimation procedure which would not require an assumption of constant returns to scale would be to estimate the system

$$\ln Y_j = a+b_1\ln X_1+b_2\ln X_2+\sum_{i=3}^{8} X_1+u_j$$

$$\ln Y_j = \ln b_1+\ln X_1+\ln\frac{W}{p}1+V_j$$

$$\ln Y_j = -\ln b_2+\ln X_2+kb\frac{W^2}{p}+W_j$$

Where u_j is a technical disturbance term, V and W_j are economic disturbance terms, W_1 and W_2 are the wage rates of homemakers and spouses respectively, and p_j is the price of food.

"Estimating the complete system is generally superior to estimating only the first equation from both economic and econometric standpoints. From an economic standpoint estimating the complete system expresses the assumption that the data reflect both the behavior of the decision maker (the firm) and the technology, while the first equation reflects only the technology. From an econometric standpoint the estimator of only the first equation involves simultaneous-equations bias, so the estimators will be biased and inconsistent." (Intriligator, 1978, p. 269) previously noted exception, so did all the labor variables.

For each functional form the adjusted R^2 was highest for the items equation and lowest for the meals equation. The servings equation was a close second. These results indicate output measures which capture more information about quantity and quality perform better and may be worth any extra cost to collect the data. The consistency of signs and significance among output measures might lead one to think that they were simply scalar multiples of each other. If that were the case we would expect to see scalar differences among the coefficients for each functional form. This is not the case. Comparison of the coefficients for each functional form reinforces previous statements about differences in quality information contained in the output measures. Warren (1940) found that output increased at a constant (figures 1 and 3) or increasing rate (figure 2) as homemakers' time inputs increased. We found output increased at a decreasing rate as labor inputs increased. Whereas Warren disaggregated food preparation into meal preparation, baking, and lunch packing, we have aggregated meal preparation and lunch packing. Baking time is included in labor inputs but the output is included in the items and servings measures, and only if the output was offered to the family that day. These differences alone do not account for the difference in our results. Perhaps an S-shaped function would fit both Warren's data and ours better than any of the functions fitted to date.

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VOLUNTEER WORK PARTICIPATION IN DUAL-EARNER FAMILIES[1]

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ABSTRACT

Factors affecting the amount of time spent in volunteer work by husbands and wives in dual-earner families were studied. Multiple regression analysis identified the most important predictors for both husband's and wife's time as: time spent in paid work, spouse's volunteer time, children's volunteer time, and leisure time. Implications for a family theory of volunteer work participation and ways to increase volunteer work time for dual-earner families are discussed

In the 1980's, the economic situation has stimulated interest once again[4] in volunteerism as a way of providing human services. Voluntary agencies have been urged to assume the services no longer provided by public agencies due to budget cuts. Communities have responded by organizing food and clothing banks, shelters for the homeless, and a variety of human service programs. Participation in various cooperatives, especially for child care, has increased as consumers seek ways to minimize their cost of living. Although volunteerism does help to provide human services at a minimal cost to the community, it has a high cost in time spent by individuals.

It would seem that the current emphasis on volunteerism comes at a time when families have less available time for volunteer work than in the past. In recent years, more and more families have become dual-earner families. With both parents in the labor force, total time available for volunteer work is considerably less than in one-earner families. Thus, the focus of this study is the volunteer work participation of dual-earner families. The purpose is to examine the relationship between selected socioeconomic factors and the amount of time spent in volunteer work by husbands and wives in dual-earner families.

LITERATURE REVIEW

Since 1965, three national surveys have been conducted to investigate volunteer work and the characteristics of its workers. In the 1965 and 1974 studies conducted by the Bureau of the Census [8, 1], volunteer work was defined as "any unpaid work performed for or through an organization" [8, p. 21]. During 1965, 18.5 percent of all the civilian, noninstitutional population participated in volunteer work, whereas 24 percent volunteered during 1974. The third national study was conducted by the Gallup Organization and had a broader definition of volunteer work, "working in some way to help others for no monetary pay" [4, p. i]. As would be expected, volunteer work participation was higher with 52 percent of American adults volunteering [4, p. iv]. In all three studies, voluteer workers were more likely to be women than men and to be in the middle years of adulthood than younger or older. Volunteer work participation was positively related to family income. Additionally, the Gallup study found that people were more likely to volunteer if they were suburban or rural residents rather than urban residents.

Other studies have focused on women volunteers since they comprise a greater proportion of all volunteers and are more likely to volunteer than men. In a study of Army officers' wives, Finlayson [2] found women with school-age or older children were more likely to volunteer than those women with preschoolers, but Schram and Dunsing [6] did not find this to be a significant relationship. Both studies did find a positive relationship between volunteer work participation and social class. In a sample of highly-educated women, Mueller [5] found that the number of hours spent in volunteer work had a negative, though not significant, relationship with one's own wage rate. Time spent in paid work has been studied categorically as part-time work, full-time work, and not gainfully employed, rather than continuously. Finlayson [2] and the U.S. Department of Labor [8] found that part-time workers volunteered more than the other two groups. This relationship was not significant in the Schram and Dunsing study [6].

HYPOTHESES

It is hypothesized that the amount of time (minutes) the husband spends in volunteer work will be positively related to: (1) age of the younger child and (2) his age. It will be negatively related, though, to (1) minutes of paid work and (2) own wage rate. Time spent in volunteerism also will be greater for (1) husbands living in rural than urban areas, (2) husbands with a family income of $20,000 and over than a lower family income, and (3) husbands with the highest social class than a

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[4] Throughout history, voluntary participation seems to be tied to social, economic, and political conditions [7].

lower social class. Further, it is hypothesized that these same relationships will hold true for the minutes the wife spends in volunteer work.

Three variables were available for testing which were not found in the literature. Since this was an exploratory study and the predicted relationships seem logical, the variables were included in the study. Minutes spent in leisure time is expected to be negatively related to minutes spent in volunteer work for both husbands and wives. Volunteer work can be considered an alternative time use for leisure activities. Minutes of spouse's volunteer time and children's volunteer time were both expected to have positive relationships with minutes spent in volunteer work for both husbands and wives. It is assumed that one's participation in an activity is influenced by the participation of immediate family members.

OPERATIONAL DEFINITION AND EXPLANATION OF VARIABLES

Definitions for the dependent and independent variables used in this study follow. Following each definition is an explanation of how the variable was measured.

Volunteer time is time spent in work or service done as an unpaid worker for relatives, friends, family business or farm, social, civic, or community organizations. It was measured as the mean minutes spent in unpaid work, including travel time, on two record days.

Time in paid work includes time at work for which pay was received and was measured as the mean minutes spent in paid work, including travel, for two record days.

Leisure time is time in social and recreational activities. It was measured as the mean minutes spent in leisure, including travel time, on two record days.

Age of younger child was measured in actual years with children less than one year of age assigned 1; range = 1-17.

Place of residence, rural/urban residence, was introduced in the regression equation as a dichotomous variable with the rural group as the omitted group.

Family income is comprised of three groups of total annual family income: up to $9,999; $10,000-$19,999; and $20,000 and over. Income was treated as a dummy variable with the last group as the omitted category.

Social class was constructed by combining measures of occupational status and educational achievement of the main earner (husband), following the procedure used by Hollingshead [3]. Seven occupational categories were used. Hollingshead's original educational categories were modified to more clearly parallel current educational levels which resulted in six, rather than seven, educational categories. From these two scales, a composite scale was constructed in which occupation was given a weight of seven and education a weight of four. Thus, the minimum score on this scale was 11; the maximum was 73. On the basis of these scores, five social classes were identified for use in this analysis:

Class	Range of Scores
1 (lowest)	11-17
2	18-31
3	32-47
4	48-63
5 (highest)	64-73

The highest class was used as the omitted category in the regression equation.

Wage rate is the wage per hour for the primary job.

Age is the actual number of years.

METHODOLOGY

Instrument

Data were collected using two instruments. The time record is a chart comprised of a grid along which each hour of the day is designated at top and bottom. Each hour is divided into ten-minute segments which can be further sub-divided into five-minute segments. Along the left and right columns, 18 activities are listed. These include paid work, unpaid work, school work, social and recreational activities, organization participation, eight household production activities, two categories for care of family members, two categories for personal care activities, and other--a category used when individuals cannot recall or do not wish to say what filled a given block of time. The second instrument is a questionnaire used to obtain information regarding socioeconomic characteristics of the family and its members.

Sample

The sample for this analysis comes from a larger study, "An Interstate Urban/Rural Comparison of Families' Time Use." The states participating in the larger study used the same criteria for sample selection. Previous research has established the relationship between family size and age of youngest child with use of time in various activities, particularly household production [9]. Consequently, the sample for the interstate study is limited to two-parent, two-child families. The sample is stratified by residence (one-half urban, one-half rural in all but two states) and by age of the younger child. Stratification by age of younger child is accomplished using the following categories: less than one year, one year, one to five years, six to 11 years, and 12 to 17 years of age.

States included in the present analysis are: California, Connecticut, Louisiana, New York, North Carolina, Oklahoma, Oregon, Texas, Virginia, and Wisconsin. Each state's data includes an original sample of 210 families equally divided between rural and urban residence, except Louisiana in which the sample consists of 105 urban families only and North Carolina in which the sample consists of 105 rural families only. The sample for the present analysis is comprised of families in which both husband and wife are in the labor force. Observations with missing responses to any of the variables used in this analysis are deleted, yielding a net sample of 405 families.

Data Collection

Data were obtained by personal interview conducted in the respondent's home. The person identified as the "homemaker" was the spokesperson for the family. At the first interview, information about the family's socioeconomic characteristics was obtained as well as a 24-hour recall of the activities on the previous day for all family members age six and older. Trained interviewers used color-coded symbols to complete the chart, simultaneously instructing the respondent in how to complete the chart so that a second record could be prepared for the following day. On the second day following the initial interview, the interviewer returned to confirm the completion of the recall chart and pick up the completed diary chart.

Data collection was handled in like manner for all the states. Interviews were systematically scheduled across all the days of the week so that an equal number of each day was ampled. Interviews were scheduled throughout a one-year period in each state, with a quota of interviews to be completed in a given period of time. For the total sample, data collection occurred between 1976 and 1978, but was restricted to one calendar year for any given state.

Method of Analysis

Multiple regression was used to test the hypotheses. Two separate regression equations were obtained, one for the husband's volunteer time and one for the wife's volunteer time. Beta coefficients were examined to identify the best predictors of each dependent variable.

FINDINGS

Socioeconomic characteristics of the sample are in Table 1. Almost 55 percent of the families had incomes of $20,000 or above. Fifty-six percent of the husbands had some education beyond high school and, fifty-three percent of their wives had this amount of education. Husbands were more likely to

TABLE 1. Socioeconomic Characteristics of the Sample.

	Husband (n = 405)	Wife (n = 405)
Occupation	%	%
Unskilled laborer	1.5	1.0
Operative, semi-skilled worker	13.0	20.3
Skilled manual worker	27.7	7.4
Clerical, sales worker	17.9	39.9
Administrative	6.2	17.6
Managerial, small business owner	18.8	4.3
Executive, proprietor, professional	15.0	9.3
Level of education		
8 years or less	2.5	1.0
9-11 years	7.7	5.4
High school graduate	33.6	40.3
Some college; technical training	23.5	28.6
College graduate	19.3	16.6
Advanced degree	13.5	8.1
Family Income		
$1,000-$9,999	3.7	3.7
$10,000-$19,999	42.0	42.0
$20,000 and above	54.3	54.3
Social class		
1 (lowest)	.7	--
2	17.8	--
3	36.0	--
4	28.1	--
5 (highest)	17.3	--

be employed in professional, technical, or managerial occupations (40 percent) while the same percent of their wives were clerical or sales workers. The majority of the husbands had social class scores of three or four on a scale of five.

Results of the two regression equations indicate slightly different explanations for volunteer work participation of husbands and wives (Table 2). Although both were significant at the .001 level, the adjusted R^2 was higher in the equation for wives than for husbands; it was .13 and .09, respectively. The same independent variables were significant in each equation but with different levels of significance and different beta weights.

For husbands, the most important predictor was minutes of paid work. This relationship was negative and significant at the .001 level. Other variables significant at the .001 level were minutes of spouse's volunteer work and minutes of children's volunteer work. Both relationships were positive. Minutes of leisure time was negatively related to minutes of volunteer work and significant at the .05 level. Thus, minutes spent in volunteer work by husbands increased as (1) minutes in paid work decreased, (2) minutes of spouse's volunteer work increased, (3) minutes of children's volunteer work increased, and (4) minutes of leisure time decreased.

The most important predictor of volunteer work time for wives was minutes of children's volunteer work. Significant at the .001 level, this relationship was positive. The next most important predictors were minutes of leisure time and minutes of spouse's volunteer work. The relationships were negative and positive, respectively. Both were significant at the .001 level. Minutes of volunteer work was negatively related to minutes of paid work and significant at the .05 level. For wives, then, minutes in volunteer work increased as: (1) minutes of children's volunteer work increased, (2) minutes of leisure time decreased, (3) minutes of spouse's volunteer work increased, and (4) minutes of paid work decreased.

CONCLUSIONS AND IMPLICATIONS

Although the variables in this study did not explain a great deal of variance in the two dependent variables, some new and important relationships were ascertained. All three relationships posited on a logical basis were confirmed, as well as one of the relationships found in the literature.

The importance of both spouse's and children's volunteer work participation has implications for development of a family theory of volunteer work participation. Volunteer work may be a way that families spend time together. The greater importance of the children's volunteer work participation in determining the wife's volunteer time, than the husband's, is probably related to her traditional maternal role. This relationship may be somewhat different in families that have more of a shared parental relationship with their children. Another implication is for the investigation of socialization for volunteer work. It seems likely that a pattern of volunteering as a child and having parental role models for volunteering would tend to influence volunteering in adulthood.

The relationship for paid work is not unexpected. The greater importance in determining husband's volunteer work time is undoubtedly a function of his traditional role as primary breadwinner. Since husbands generally tend to work more hours in paid work than wives, they would have fewer hours available for volunteer work. This relationship, too, would probably differ in families with shared parental and work responsibilities.

Finally, the relationship between volunteer work time and leisure time confirms the fact that there is a trade-off between volunteer work and leisure time. This relationship deserves further investigation since volunteer work might be considered a form of leisure for some, but not for others who might consider it an obligatory activity. Trade-offs between volunteer work participation and housework time also should be investigated. It is possible that some volunteer work is viewed as child care, for example.

Even though they have a greater time constraint than single-earner families, dual-earner families might be able to increase their time spent in volunteer work. One way might be for them to perceive volunteer work as part of leisure or housework, rather than as added time expenditures. Especially important would be for them to see the possibilities for increased family interaction which can result when the family volunteers together. Finally, the parents can use volunteer work to teach their children the values of working with and helping others.

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TABLE 2. Results of Regression on Minutes of Volunteer Work by Husbands and Wives (n = 405).

	Husband		Wife	
Independent variables	Beta	b (Std. error)	Beta	b (Std. error)
Minutes of paid work	-.23***	-.0511 (.01)	-.11*	-.0241 (.01)
Minutes of leisure time	-.17*	-.0527 (.02)	-.17***	-.0470 (.01)
Minutes of spouse's volunteer work	.17***	.2148 (.06)	.16***	.1277 (.04)
Minutes of children's volunteer work	.15***	.1271 (.04)	.26***	.1755 (.03)
Age of younger child	-.01	-.1267 (.63)	.09	.6427 (.53)
Place of residence[a]	-.06	-5.1667 (4.47)	-.01	-.5315 (3.40)
Family income[a]				
Under $1,000-$9,999	-.04	-9.1150 (12.29)	.01	2.5226 (9.35)
$10,000-$19,000	-.04	-3.8956 (5.06)	.06	4.6686 (3.74)
Social class [a]				
1	-.02	-8.5015 (26.68)	-.01	-2.4665 (20.23)
2	.04	4.8410 (7.81)	-.05	-5.0145 (5.84)
3	.00	.0160 (6.74)	.04	2.8213 (5.07)
4	.03	3.5414 (6.71)	.07	5.3990 (5.07)
Wage rate	-.06	.0072 (.01)	.00	.0001 (.00)
Age	-.06	-.3849 (.42)	-.06	-.3240 (.40)
Adjusted R^2	.09***		.13***	
Mean value of dependent variable	16.08		13.56	

[a]Coded as dummy variables

*$p \leq .05$

***$p \leq .001$

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ESTIMATING HOUSEHOLD PRODUCTION FUNCTIONS: A CASE STUDY[1]

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ABSTRACT

The NE-113 Time Use sample is used in a methodological study which attempts to estimate directly the household laundry production function. Number of loads of laundry completed per day is regressed on special estimates of the times spent doing laundry by family members. The special estimates of time use are designed to purge any correlation with the random disturbance term. Both linear and Cobb-Douglas laundry production functions are estimated. As expected, the marginal product of the wife's time in laundry is much lower than that for any other family member. Given diminishing marginal productivity and the fact that she spends much the most time in the activity, the results are reasonable.

Household production is a curious phenomenon. Everyone does it and everyone consumes its fruits, but only infrequently are they ever observed with sufficient clarity to measure them with any degree of accuracy. The reason is simple. Since households consume the commodities they produce, the commodities never pass through markets. For them to be traded in markets there must be implicit agreement among buyers and sellers as to the units and prices in which the commodities are traded. Lacking both units and prices for home-produced commodities, the analyst has little or no data to analyze. One conseqence of this situation is that most household production does not appear in the national economic accounts, there not being sufficient agreement as to the accuracy of measures of either the quantity or the value of home production. Another consequence is that consumer economists have difficulty in discussing and analyzing the efficiency of household production, there not being any hard evidence as to the amount produced with given amounts of inputs.

There have been several alternative tactics employed to circumvent these difficulties. Some of those interested in valuing household production have taken a "value-added" approach and attempted to value the time spent in household production (e.g., Gauger, Hawrylyshyn, and Zick and Bryant). Given data on what has been produced, others have valued it at market replacement prices (e.g., Sanik and Stafford, and Goldschmidt-Clermont). The only attempt at empirically deriving the household production function has been Gronau's. He used an indirect approach by which the household production function is inferred from the wife's home-time supply function. To the present, no one has attempted to estimate a household production function directly.

This paper describes a direct attempt to estimate a particular household production, that of laundry production. The purpose is methodological and has neither a policy nor a management focus. It is an extension of the M.S. thesis by Henze. We view the paper as a modest step toward the day when we will have the methods and the data with which we can measure the various dimensions of household output and understand their determinants.

Section I lays out the theoretical household production function we attempt to estimate. Section II follows with a description of the data with which we make the attempt. Section III lays out the econometric model linking the theory to the data. Section IV presents, interprets, and evaluates the estimates while Section V draws overall conclusions.

SECTION I

The theoretical notion of a household production function is quite simple. It is a mathematical function relating the output of the production process per unit of time to the quantities of inputs used in the process. The form of the mathematical function represents the technology; i.e., the way in which the inputs are combined to produce the output. It is the recipe, so to speak.

In the present case we have data on the amounts of clean clothes produced per day along with some but not all of the inputs used to produce them for a sample of households. Hence, let C_h represent the quantity of clean clothes household h produces per day; T_{hi} ($i = 1,\ldots,4$) represent the time person i in household h spends laundering per day; X_h represent the quantities of detergent, water, energy, etc. used per day in laundering; W_h represent the services of washers used per day; D_h represent the services of dryers used per day in laundering in household h. Then, the laundry household production function can be represented as

$$C_h = c(T_{h1}, T_{h2}, T_{h3}, T_{h4}, X_h, W_h, D_h). \qquad (1)$$

This is the theoretical function that is to be estimated.

Several things are to be noted about this function. The output, C_h, represents not only the quantity

[1]The paper could not have been written without the expert programming assistance of Bill Putsis and Robert Weagley. We are indebted to them.

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of clean clothes but also the quality. Suppose that N_h represents the quantity of clothes laundered while Q_h represents the quality or the cleanliness achieved by the process, then

$$C_h = N_h Q_h. \quad (2)$$

Next, X_h represents a vector of inputs that might be called the operating inputs. W_h, the services used per day of the washer, is measured as a flow, and does not refer to the mere presence of the machine. The same is true of D_h. Finally, the mathematical form of the function is not specified. In fact, we know nothing about the mathematical form of the function *á priori*.

SECTION II

The data used in this study comes from the NE-113 Time Use sample collected from 2,100 two-parent, two-child families in 11 states in 1977-1978 (see Lovingood for details). Each family was asked to record the time use of each member of the family over the age of six for each of two days (the day before the interview and the day after) along with a wealth of other information about the family. There are, therefore, 4,200 sample points, two for each family. Included in the data collected are data on number of loads of laundry done per day, time spent by each of the family members over the age of six in the laundry activity (sorting, washing, drying, folding, ironing), whether the family owned an automatic or a nonautomatic washer, and whether it owned a dryer. The data on these variables form the basic information about the inputs and outputs that we possess.

Clearly, these variables reflect only imperfectly the quantities of the actual inputs used in the laundry activity and the actual quantity of outputs achieved by each family on each of the two days. While the number of loads of clothes laundered may capture the quantity of clothes laundered, what about the quality? To the extent that families control the quality by reducing the number of clothes washed and dried per load, the number of loads also captures the quality dimension. The absence of any data on the types and amounts of water, detergent, bleach, fabric softener, and the like is a defect that cannot be overcome. The results must be evaluated in the light of their absence. Ownership of washers and dryers was almost universal. Consequently, we worked with a subsample of owners of both automatic washers and dryers.

SECTION III

The econometric specification of the model is much more complex than the theoretical model. This is because the theory refers to a technological phenomenon whereas the data are the result of family behavior. The two are not the same yet the former must be inferred from the latter. To do so requires that both the stochastic and behavioral elements of the data be taken into account as well as the data inadequacies.

We deal with the data inadequacies first. The lack of data on service flows from the laundry equipment possessed by the household and the universality of ownership is dealt with by assuming that the service flow from a washer or a dryer is constant given possession and by restricting the analysis to only those families who possess both an automatic washer and a dryer. In addition, we deleted those families who did no laundry on any day. This left us with a sample of 1,754 observations, two for each of 877 families. Not having any measure of C_h, we make do with the number of loads of laundry done per day, N_h. Then, we can reformulate the laundry production function as

$$N_h = n(T_{h1}, T_{h2}, T_{h3}, T_{h4}, X_h). \quad (3)$$

N_h can be viewed as a measure of C_h that contains measurement error. This measurement error is one justification for attaching a random disturbance term to equation (3). Note, too, that equation (3) contains the amounts of operating inputs, X_h, for which no data exist in our data set. On the assumption that the use of X_h varies randomly among households, X_h can be included in the random error term.

Households cannot all be expected to behave efficiently. If they are satisfaction maximizers, then to launder efficiently implies that two conditions are met. The first is that the household launders such that any given level of laundry output is produced at lowest cost. This implies that the ratio of the marginal products, MP, of any two inputs in the laundry activity must be equal to the ratio of their opportunity costs; i.e.,

$$(MP_y/MP_z) = P_y/P_z, \quad (4)$$

where Y and Z are any two inputs into laundry production, and P_y and P_z denote their respective opportunity costs to the household. The second condition is that the amounts not only of laundry, but of all other things the household consumes as well, be the amounts that maximize the household's satisfaction, given the household's resources of time, money, etc. This occurs when the ratio of the marginal utilities of laundry, MU_c, and other things, MU_o, is equal to the ratio of their opportunity costs, P_c and P_o, respectively, i.e.,

$$(MU_c/MU_o) = P_c/P_o. \quad (5)$$

Because households make management errors, we assume that these two conditions are met only approximately. To take account of such mistakes a random disturbance term must be included in equation (3). It also includes X_h as well as the measurement error in N_h as assumed above. This random error term can be added to equation (3) to form

$$N_h = n(T_{h1}, T_{h2}, T_{h3}, T_{h4}) + e_h \quad (6)$$

where e_h is the random error term.

Equation (6) would be the correct econometric specification if it were the case that the arguments of n(.) were independent of the error term. Unfortunately, the process of satisfaction maximization implies that the optimum input levels are not independent of the optimum level of N. This is so because the household decides how much N_h to produce and consume to maximize satisfaction. Given this optimum level of N_h, the optimum levels of the T_{hi} are chosen. Thus, the T_{hi} are determined conditional on N_h. In consequence, the T_{hi} are correlated with e_h. Equation (6), therefore, consists entirely of endogenous variables plus a random error term. An ordinary least squares estimate of equation (6) would yield biased estimates of the technical parameters underlying the laundry activity (Hoch), and consequently reveal nothing of the underlying technology.

A solution to this problem is to use measures of the T_{hi} in the estimation of equation (6) which are purged of the correlation with e_h. To obtain such measures, note that the household's demand functions for the T_{hi} can be written as

$$T_{hi} = t_i(w_1, w_2, w_3, w_4, I, FC, S, DD) + u_h \qquad (7)$$

where:

wi = opportunity cost of time of the i^{th} person ($i = 1,...4$);

I = family income;

FC = vector of family characteristics which affect either the households' preferences for or productivity in laundry;

S = vector of day of week and season of year variables to adjust to the weekly and seasonal habits of families;

DD = a dummy variable to distinguish the recall from the record day.

Estimates of equation (7) can be made and predicted levels of T_{hi}, T^*_{hi}, can be used to replace the T_{hi} in equation (6). Since the T^*_{hi} are functions only of opportunity costs, income, family characteristics, and weekly and seasonal variables, all of which are exogenous and do not involve e_h, they are uncorrelated with e_h. The econometric specification of the theoretical model is, therefore,

$$N_h = n(T^*_{h1}, T^*_{h2}, T^*_{h3}, T^*_{h4}) + e_h \qquad (8)$$

Two final points need to be made about the model. First, equation (7) was estimated by Tobit. This was done because the dependent variables are truncated at zero, making ordinary least squares inappropriate. Second, both linear and log-log functional forms were tried in the case of equation (8). The log-log form is the well-known Cobb-Douglas function much used in production function analyses.

SECTION IV

Table 1 contains the means and standard deviations of the number of loads of laundry done per day as well as the observed and estimated values of the times spent by each family member doing laundry. Each family did about 2.4 loads of laundry per day. While the wife spent about 41 minutes per day, on average, doing laundry, the rest of the family members spent only about one minute per day, on average, doing laundry. What is interesting is that neither the husband nor the older child spent more time doing laundry than the younger child. The estimated mean values of the times spent doing laundry by each family member from the tobit estimates are very close to the observed means. Naturally, the standard errors of these estimates are much smaller than for the observed values.

The ordinary least squares estimate of the linear form of the laundry production function is

$$N = 1.3931 + .0204T^*_w + .0707T^*_f + .0468T^*_t + .0132T^*_y, \quad R^2 = .0118 \quad F = 6.19 \qquad (9)$$

where w = wife, f = husband, t = older child, and y = younger child. The t-ratios for the variables in the equation are: 5.814, 3.901, 2.392, 2.348, and .737, respectively. The equation as a whole and all of the variables except T^*_y, therefore, are significantly different from zero at the one percent level or higher. Despite the very high significance levels, the equation accounts for a disappointingly small proportion of the variance in N.

Table 1. Means and standard deviations of laundry loads and times spent by family members in laundry activities per day.

	Mean	Standard Error
Number of laundry loads per day	2.4	1.4
Laundry time, min. per day†		
Wife		
observed, T_w	40.9	44.7
estimated, T^*_w	42.9	6.9
Husband		
observed, T_h	1.1	7.0
estimated, T^*_h	1.1	1.2
Older child		
observed, T_o	1.0	7.7
estimated, T^*_o	1.2	1.8
Younger child		
observed, T_y	1.0	8.7
estimated, T^*_y	1.3	2.1

†Estimated laundry times based on $T_{hi} = f_i$ (wife's shadow wage rate, husband's marginal wage rate, wife's education, wife's age, ages of children, sexes of children, income, no. of rooms in dwelling, urban/rural, season of year, day of week, interview day). The estimates of the laundry time use supply functions available from W. Keith Bryant upon request.

The ordinary least squares estimate of the log-log form of the laundry production function is

$$N = -.4984 + .3391 \ln T^*_w + .0484 \ln T^*_f + .0419 \ln T^*_t + .0032 \ln T^*_y; \; R^2 = .0018 \quad F = 6.208. \qquad (10)$$

The t-ratios are, respectively, 1.635, 4.147, 2.831, 2.776, and .231. The equation as a whole and all the variables in it except the constant term and T^*_y are significantly different from zero at the one percent level or higher. Again, the proportion of the variance accounted for by the equation is disappointingly small.

The interpretation of these results is straightforward. The coefficients on the variables in the linear equation are estimates of the marginal products of each family member's time in laundry production. Since in this equation, the marginal products do not change as the time spent in laundry changes (in contrast with production theory), these estimates must be interpreted as estimates at the sample means. Thus, for instance, if the wife were to increase the amount of time she spends in laundry by one hour and other family members' times remained constant, she could expect to increase the number of completed loads of laundry per day by 1.224 (i.e., .0204 loads per minute times 60 minutes). Likewise, if the husband were to increase the time he spends doing laundry by one hour, he could expect to increase the loads of laundry completed per day by 4.242 (.0707 x 60).

The coefficients of the variables in the log-log equation represent output-input elasticities; i.e., the percentage increases in loads of laundry done given one percentage increases in the times spent by the family members, ceteris paribus. For instance, if the wife's time in laundry activities were to increase by one percent, the number of loads of completed laundry would increase by .34 percent. Since in the log-log version of the production function the output-input elasticities do not change as times spent change, the elasticities are to be interpreted as estimates at the point of sample means.

There are several implications of these results which can be investigated. While they are interesting in their own right, they can also be used to check the reasonableness of the results. We investigate five.

Since estimates of the opportunity costs of time for both the wife and the husband are available, we can use equation (4) to check to see if the sample families are, on average, technically efficient in laundry activities. The sample average estimate of the opportunity cost of the wife's time doing laundry is \$2.67 per hour or \$.04 per minute. This is the estimate of the reservation wage rate of the wife. The reservation wage rate is her wage rate, if she is employed, and the lowest wage rate which would draw her into the labor market, if she is not (see Zick and Bryant for details and estimates based on this data set). The husband's actual wage rate is his opportunity cost of time since in this sample all are employed. The average wage rate for husbands in the sample is \$8.13 per hour or \$.14 per minute.

The ratio of the marginal product of the wife to that of the husband from the linear equation is .29. In the log-log version the MP of any family member's time is b_i (N/T_i) where b_i is the output-input elasticity for member i and $\bar{N}$ and T_i are taken at their means. Thus, from the log-log version $MP_w = .0199$, $MP_f = .1056$, and the ratio of the two is .19. The ratio of the two opportunity costs of time is 2.67/8.13 = .33. The ratios of MP's from both linear and log-log versions were tested for equality with the ratio of the two opportunity costs. This is a test for the truth of equation (4) at the point of sample means. Both tests were confirmed at above the one percent level of confidence. We conclude, therefore, that sample families, on average, allocate parental time in a technically efficient manner; i.e., in a least cost manner.

The orders of magnitude of the family members' marginal products from both versions are roughly consistent with the times each family member spends in the laundry activity on average (see Table 1). Given the principle of diminishing marginal productivity, the marginal products of each family member can be expected to be negatively correlated with the times each spend in laundry production. Since the wife spends much the most time doing laundry, her marginal product can be expected to be lowest. In fact, only the younger child's is lower. This is to be expected, not on the grounds of the time it spends in the activity, but because the younger child will be the least proficient, its average age in the sample being only five years.

Equation (4) can also be used to derive implicit estimates of the opportunity cost of time of each child. Given estimates of the MP's of a parent's and child's times and an estimate of a parent's opportunity cost of time, then the implicit opportunity cost of the child's time can be calculated from equation (4). It is calculated only for the older child given the lack of significance of the estimates for the younger child. The estimates are \$6.13 and \$13.14 per hour based on the wife's opportunity cost of time and the linear and log-log estimates of the MP's respectively. The estimates are \$5.38 and \$7.17 per hour based on the husband's opportunity cost and the linear and log-log estimates respectively. Given the value of children's time in school and the natural inclination of parents to do things for them, none of these estimates seem out of line.

If the family maximizes satisfaction with respect to the laundry activity, the ratio of the opportunity cost of any input, p_z, to its marginal product, MP_z, will be equal to the implicit value the family places on the output of the activity, p_n; i.e.,

$$p_z/MP_z = MU_c/MU_m = p_n \qquad (11)$$

where MU_c is the marginal utility of clean clothes and MU_m is the marginal utility of money. The estimates of the sample average implicit dollar value of clean clothes per load are $1.74 per load based on p_w/MP_w and $1.92 per load based on p_f/MP_f from the linear results. The analagous log-log results are $2.25 and $1.28 per load respectively. Laundromats charge approximately $.75-$1.00 to wash and dry a load. This does not include folding or any ironing nor does it include transportation to and from the laundromat and the time involved. These estimates of the implicit value of a load of completed clean clothes, then, appear within a reasonable range.

Finally, using the log-log version one can test whether economies of scale are present in laundry production. If economies of scale do exist, then the sum of the output-input elasticities over all family members will exceed one. If diseconomies of scale exist, the sum will be less than one. And, if constant returns to scale exists, the sum will equal one. The sum is .4326, a number significantly lower than one at the one percent level of confidence. There is strong evidence for diseconomies of scale, therefore. This is not surprising since the analysis has held laundry equipment constant.

SECTION V

The paper has attempted the estimation of a household laundry production function in order to develop appropriate methods for estimating household production functions. The method entails estimating the derived demand functions for the inputs into the productive activity under study and then to regress the output of the activity on the values of the inputs as estimated by the derived input demand functions. This technique purges the input variables of any correlation they may have with the error term in the household production function.

The results appear to be somewhat more reasonable for the linear version of the laundry production function than for the log-log (Cobb-Douglas) version. Neither version accounted for more than a very minor proportion of the total variance in number of loads of laundry done per day. The reason for this may be found in Table 1. Note that the estimated time uses, T^*_{hi}, have much smaller variances than the actual time uses, T_{hi}. The variance removed from the time use variables in order to make them exogenous may well account for some of the variance in N. The cost of estimates of the production parameters with good statistical properties may be much reduced R^2's.

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TRADITIONAL AND HOUSEHOLD PRODUCTION MODELS OF CONSUMER CHOICE: SIMILARITIES AND DIFFERENCES

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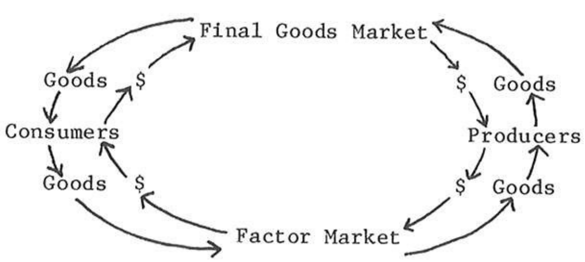
Abstract

The traditional static model of consumer choice is compared to the static household production function model. Similarities and differences are noted. The household production function model is consistent with the dual role of consumers. The value of the last dollar spent is shown to be the decision making rule, although the composition between models differs. One data set available for testing the household production function model is the 1975-76 Time Use Diary. Three studies using it investigated joint production, volunteer activity, and home repair.

The circular flow diagram, found in most principles of economics texts, is used to display the relationships among the various segments of an economic system. In its simplest form there are two groups, producers and consumers, and two markets, final goods and factor. This is shown as Figure 1. The basic economic principle represented by this diagram is that consumers as well as producers are buyers and sellers.

Figure 1



Traditional economic theory focused on consumers as buyers. Through maximizing utility subject to a budget constraint, a system of demand equations and associated theoretical constraints are derived as the basis for the study of consumer demand. This approach neglected completely the resource management aspects relating consumers to the factor market. Beginning with the work of Becker [1], Lancaster[4], and Muth [6], economic theory has focused on the entire economic activity of consumers. This is the household production approach in which consumers behave in a manner analogous to a firm. Market goods are combined with household resources, principally labor, to produce desired goods and services usually referred to as commodities.

While many of the advantages of the new approach are well known, it is felt that one particular theoretical formulation of the problem is well suited for straightforward interpretation. Unfortunately, the published literature does not take advantage of this methodology. The present paper is an effort to address this shortcoming. A clear distinction is drawn between the traditional and household production models. First order conditions for utility maximization for the two models are compared and interpreted. Conclusions are drawn regarding the advantages of the newer approach. The paper ends with an overview of a data source which has been used to test household production models.

TRADITIONAL VERSUS TIME ALLOCATION MODELS

Traditional economic theory assumes that a consumer derives utility directly from market goods acquired each budget period. The only constraint is that expenditures equal income in each period. There is no possibility for borrowing or saving within this static model. The left-hand side of Table 1 presents the basic equations of the classical utility maximization model. Equation 1 indicates that utility, U, is a function of market goods, X_i, of which there are n. Acquiring market goods is constrained by the ability to purchase them in the final goods market. This is the budget constraint shown as equation 2, where Y represents income, and P_i is the market price per unit of good X_i. Notice that this traditional model only relates a consumer to the final goods market in Figure 1. No consideration is given to the interaction with the factor market as income is determined outside the model.

Maximizing equation 1 subject to equation 2 is a straightforward calculus problem. Its solution in a two good world (n = 2) is the graphical equivalent of locating the point of tangency between the budget line and the set of indifference curves. Equation 3, the solution to the problem, identifies the key decision making criteria.[1] The marginal utility (MU) of a good divided by its price is referred to as the value of the last dollar spent. Each numerator represents the change in utility a consumer receives from an incremental unit of a good. Each denominator is the market price per unit of

[1]For a complete discussion of these conditions, see Deaton and Muellbauer [2].

Table 1

Traditional Model	Household Production
Utility	Utility
(1) $U = u(X_1, \ldots, X_n)$	(1a) $U = u(Z_1, \ldots Z_m)$
Constraint	Constraints
Income	Production
(2) $Y = \sum_{i=1}^{n} P_i X_i$	(2a) $Z_i = z_i(X_1, \ldots, X_n, t_i)$
	Income
	(2b) $Y_i = \sum_{i=1}^{n} P_i X_i + V$
	Time
	(2c) $T = \sum_{i=1}^{m} t_i + t_w$
First Order Conditions	First Order Conditions
(3) $\frac{MU_{X_i}}{P_{X_i}} = \frac{MU_{X_j}}{P_{X_j}}$	Among Market Goods
	(3a) $\frac{MU_{Z_i} MP_{Z_i X_k}}{P_{X_k}} = \frac{MU_{Z_j} MP_{Z_j X_1}}{P_{X_1}}$
	Time Allocation - Household Production
	(3b) $\frac{MU_{Z_i} MP_{Z_i t_k}}{w} = \frac{MU_{Z_j} MP_{Z_j t_1}}{w}$
	Market Goods vs. Time Allocation
	(3c) $\frac{MU_{Z_i} MP_{Z_i X_k}}{P_{X_k}} = \frac{MU_{Z_j} MP_{Z_j t_1}}{w}$

the respective item. A ratio comprises the consumer's assessment of whether one unit more or less of a good is worth the price which must be paid. Should an inequality occur then at least one good has a higher value of the last dollar spent. Purchases should be rearranged, more of X_i and less of X_j bought, until the ratios are equated. Assuming diminishing marginal utility, as X_i increases (decreases) MU_{X_i} falls (rises), thereby equating the values of the last dollar spent.

The household production approach is a utility maximization model which is consistent with the circular flow diagram. A complete mathematical discussion of it is in Becker [1]. Decision making is not restricted to the final goods market alone. Resource allocation, or interaction with the factor market in Figure 1, is part of the framework. Utility is derived from the use of commodities, Z_i, of which there are m. This is expressed as equation 1a.

Commodities are considered to be the end results of household economic activitiy in which market goods and time are combined to produce desired items. The amount of transformation between market goods and time, t_i. The set of production relations are shown as equation 2a. In order to keep the subscript notation to a minimum, each production function has n market goods included, although it is recognized that some of the X_i may have a value of zero in the production of a specific Z_j. Leisure can be considered a commodity; because although time is an essential input, market goods are also necessary to derive utility from leisure. Purchases of market goods are limited by the ability to buy. Money income is disaggregated into earned and unearned components. Earned income is determined as the wage rate, w, multiplied by the number of hours worked, t_w. V denotes unearned income. Equation 2b is the budget constraint. The remaining constraint is that of time. Only a fixed amount of time per budget period, T, is available to a household. T must equal the sum of household production time plus time at work. This is equation 2c.

A household maximizes equation 1a subject to the constraints 2a through 2c. Consumer decision making focuses on the purchases of the X_i and the allocation of time among the t_i and t_w. The first-order conditions for the optimal solution to the problem can be shown as equations 3a through 3c. Examination of these equations involves straightforward economic interpretation and provides clear insight as to the economic pressures confronting a household. Unfortunately, much of the literature has not focused on the usefulness of these insights.

Either side of these equations can be interpreted as a value of the last dollar spent. The numerator indicates how changes in an input affects utility, and the denominator represents the opportunity cost of the respective input. The numerator could be called the marginal utlity product. It represents how a change in an input affects commodity production (the marginal product of X_k in producing Z_i is $MP_{Z_i X_k}$) which, in turn, causes a change in utility.[2] The cost is the final good's market price or the factor market wage rate.

Equation 3a holds whenever the household has made the optimal X_i purchases. How much X_i to buy is determined by the marginal product of the good in commodity production, the marginal utility the household places on the resulting change in Z_j, and the unit cost of the input. Similarly, time allocation in non-marketplace work is determined by the productivity of the time in producing Z_j, the marginal utility of Z_j, and the opportunity cost of such time which is the wage rate. The third equation isolates on trade-offs between market goods and time allocation. Both are needed in household production. Changes in time at work affect the amount of time available for household production, hence its marginal productivity. But changes in t_w also affect the income available for purchasing market goods.

How does a household arrive at the optimal solution? The adjustment can be outlined by replacing the equalities in equations 3a-3c with inequalities. Those inputs which have greater (smaller) values of the last dollar spent should be used more (less). Assuming diminishing marginal utility and diminishing marginal productivity, such reallocations move the household toward the optimal solution of the problem. For example, suppose the left-hand side of equation 3c is greater than the right-hand side. The household should increase its use of X_k and decrease its use of t_i. This lowers the marginal utility product of X_k for Z_i and raises the marginal utility product of t_i in Z_j. These changes serve to bring about an equality. Furthermore, the changes have to make the household better off. Because the left-hand side value of the last dollar spent increases (X_k increased) and greater than the right-hand side which decreases (t_i decreased), there has to be a net increase in utility.

The two columns of Table 1 summarize the similarities and diferences between the two approaches. With respect to the similarities, the following are noted. Both models assume that consumer behavior is not a completely stochastic process. Instead, consumer behavior is viewed as a systematic process in which utility is maximized subject to constraints. Both are static models, making no provision for borrowing or lending. The same assumptions about the manner in which preferences are formed are employed so that utility can be expressed as equation 1 or 1a.[3] The value of the last dollar spent is the consumer's guide in determining the optimal bundle of goods.

Distinctions between the models are significant, however. The determinants of utility are quite different. Decision making in the traditional model revolves around market goods alone. Resource allocation, household production, and the purchase of market goods are important components of the production model. These constraints describe a more realistic situation, and they comprise consumer activity in both markets of the circular flow diagram. Consumer demand for market goods is the end result of the traditional choice model. Consumer demand for market goods in the newer model is a derived demand. Market goods are not bought because they generate utility directly; rather, they derive their usefulness from their role as inputs in the production of commodities.

The last distinction is quite important in analyzing consumer market behavior. It allows for many more factors to enter into the analysis of the demand for final goods. Furthermore, this approach allows for an economic analysis of areas of consumer behavior which are ommitted from the traditional model. Production technology is important as it determines how the inputs of

[2]Diminishing marginal productivity has the same analytical meaning as diminishing marginal utility.

[3]For a discussion of the axioms about consumer preferences, see Phlips [8].

market goods and time generate the commodities. Changes in production technology, then, can affect consumer demand. For example, purchases of newer durable goods and convenience goods have the effect of reducing the time required to produce many household commodities.

One obvious consequence of the household production approach is to blur the traditional distinction between consumer economics and family economics (the former being concerned with individual's market activities, while the latter focuses on allocation decisions within the home). Note that in the household production approach, goods inputs purchased in the market are used in consumption in the home. Similarly, market participation results from prior decisions made in the home. As equations 3a-c make clear, equilibrium requires consideration of both home and market activites.

It may be useful to keep the ideas of consumer and family economics as a heuristic device, making it easier to organize the tremendous amount of material involved. However, that stops short of saying there is a clear distinction. Indeed, it may be more useful to emphasize the interrelationships among economic elements -- whether family or consumer -- than their unique qualities. The following illustrations demonstrate that point. Consumer oriented advertising should be directed toward providing household production information. Wages have a significant role to play, because the wage is the opportunity cost of time spent away from the factor market. The advantages of do-it-yourself versus hiring someone to do the work can be analyzed. Finally, the age distribution of household members is important in determining the marginal utility and marginal productivity of household time.

APPLICATIONS OF THE HOUSEHOLD PRODUCTION APPROACH

A Data Source for Estimation

Although the household production model provides a more complete, realistic framework for the analysis of consumer behavior, data requirements have been a major stumbling block to empirical investigations. The traditional model utilizes expenditure data, which have been available for some time on both a cross-section and a time-series basis. Empirical work with the new model requires much more information. How a family allocates its time to home production and to marketplace work must be known. It is a difficult, tedious, and expensive task to acquire such data. Total income must be separated into earned and unearned income. Relevant production data, including the price of utilities and the quantity used for the various commodities must be gathered.

A data source which provides much of this type of information is the University of Michigan, Survey Research Center's (SRC) 1975-1976 Time Use Survey. The objective of the project was to obtain accurate estimates of household time allocation so that the data could be used to generate estimates of the value of home production. A national probability sample was used. There were 1,519 respondents and 887 spouses comprising a total of 2,406 cases. Respondents were between 17 and 65 years of age, and they did not have to be married.

Applied Studies

The SRC data have been used to test three separate household production models. These studies were the dissertation research of three doctoral candidates in the Consumer Area at The University of Tennessee, Knoxville. A very brief overview of each research project is given below along with a summary statement of the significant economic conclusions.

One research project examined joint household production which is the generation of more than one commodity at the same time, Marlowe [5]. Among the important changes in the typical American household are the increase in the labor force participation of married women and husbands taking on a second marketplace job. These two changes decrease the amount of time available to the household for the production of commodities which could necessitate joint production.

The SRC data contain information on the amount of time married respondents spent in joint production during the week and on weekends. A household production model was created and tested for the amount of joint production time recorded by males and females. Variables found to have a significant and positive effect on home joint production time were education, unearned income, hours worked in the marketplace, and the number and ages of children.

Volunteer activities for charitable organizations have been examined using a household production framework, Peccolo [7]. The model developed in this study generated several hypotheses which are supported by the SRC data. Two measures of the volunteer commodity were used. One is the amount of time, hours worked per week in volunteer activities, and the other is the monetary contribution, annual dollars. Regression analysis identified the following variables as significant determinants of the two measures of volunteerism: wage rate, hours worked in the marketplace, the satisfaction associated with the commodity, and the respondent's religion.

Home repairs are another area of commodity production which has been examined, Garner [3]. Ten home repair commodities are identified in the time use survey data. The SRC data provided information as to whether the repair was made on a do-it-yourself or a contractual basis. Discriminant analysis is used to distinguish between the households having the two types of repairs. A household production model is constructed to identify the variables which discriminate between the two groups. Results indicate that the following variables have an effect on the likelihood of self-producing home repairs: household income, household size, respondent repair skill, respondent satisfaction in doing repairs, and age of the housing unit.

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SUGAR QUOTAS, THE NEW PROTECTIONISM AND CONSUMER WELFARE

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ABSTRACT

In recent years economic conditions in the United States and other developed countries have resulted in an increase in non-tariff barriers to trade.

The purpose of this paper was to examine the implications of the new protectionism for consumer welfare. The first part of the paper examines the impact of various trade restrictions on consumers and the economy as a whole. In the second part of the paper a recent trade restriction for sugar is analyzed. The analysis indicates the cumulative impact of trade restriction on the welfare loss and raises questions concerning the equity and efficiency of the new protectionism.

INTRODUCTION

In recent years economic conditions in the United States and other developed countries have been characterized by slow rates of economic growth, recessions and rising levels of unemployment. In many instances economic conditions have been aggravated by imports which have reduced the demand for domestically produced goods. As a result import impacted industries and workers in these industries have sought protection from imports. The response of government to petition for import relief has resulted in a new wave of protectionism which has resulted in sector agreements, quantitative restrictions, and antidumping actions. The growth of these non-tariff barriers to trade have negated the concurrent reductions in tariff barriers to trade (5).

Morkre and Tarr note that this development has been counter to the post World War II philosophy which was that "quantitative restraints should not be employed as a means of regulating international trade" (7, p. 169). The fact that quantitative restrictions are voluntarily accepted by the exporter, who is afraid of mandatory controls, has meant that the General Agreement on Tariffs and Trade (GATT) has been circumvented.

The purpose of this paper was to examine the implications of the new protectionism for consumer welfare. The first part of the paper examines the impact of trade restrictions on consumers and the economy as a whole and compares the welfare loss from quantitative restrictions to the welfare loss from tariffs. In addition methods for estimating both absolute and relative welfare losses are discussed. In the second part of the paper a recent trade restriction for sugar is analyzed. The analysis indicates the cumulative impact of trade restrictions on the welfare loss and raises questions concerning the equity and efficiency of the new protectionism.

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THE IMPACT OF TRADE RESTRICTIONS ON CONSUMERS

Consumer losses from trade restrictions are both direct and indirect. The direct losses from higher product prices or reduced choice have been summarized by Bergsten as follows.

> "Consumers suffer from restriction on international trade in several ways. Tariffs raise the price of imported goods. Quotas and 'Voluntary' export restraint agreements reduce the quantity of foreign goods available. Thus they also raise prices. They also limit significantly the range of consumer choice by making some goods totally unavailable, both because of the low levels set by the quotas themselves and because foreign sellers can often reduce their losses from the imposition of quantitative controls by discontinuing lower priced items in favor of those with higher unit prices. Low-income consumers generally suffer most because low-price goods from abroad are the primary targets of U.S. import restrictions" (1, p. 2).

The indirect losses from trade restrictions include reduced competition and innovation on the part of protected domestic industries due to the reduction in international competition. Bergsten notes that international competition is of particular importance for industries "dominated by few large firms" since they tend to be unresponsive to the "usual pressures of the market" (1, p. 4). He states "only the Volkswagon forced Detroit to make a compact car and only foreign success with the oxygen process forced the U.S. steel firms to modernize." Bergsten's examples pertain to the acceptance of foreign innovation by domestic firms under the pressure of foreign competition. However, domestic firms may also undertake innovations on their own in an effort to meet competition from low-cost imports. Domestic producers may adopt more efficient production techniques and increase the capital intensive nature of the production process in order to compete with imports from low wage countries. Alternatively they may rely on product quality and design or product innovation to compete with imports. Such responses will either reduce prices or increase consumer choice in the domestic economy.

Comparison of the Welfare Loss from Different Trade Restrictions

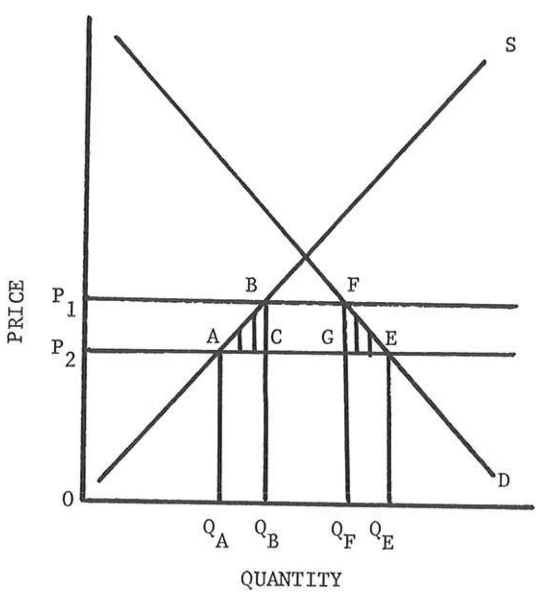
Either tariffs or quotas may be used to increase prices in the importing country. There are two kinds of quotas -- mandatory quotas and "voluntary" quotas.

The latter are called orderly marketing agreements or voluntary export restraints and differ from mandatory quotas in that they are established with the consent of the exporting country.

While a voluntary quota is more desirable than a mandatory quota in that trade reprisals from other countries are minimized, its effect on competition and prices is the same. Voluntary quotas also generate a higher welfare loss.

A comparison of the impact of tariffs and quotas is shown in Figure 1. In the initial situation the domestic price is given by P_1 with imports accounting for $Q_E - Q_A$ units and domestic production accounting for Q_A units. Imposition of a tariff shifts the world supply price from P_1 to P_2 with a resulting decline in imports to $Q_F - Q_B$. The loss in consumer surplus from the price increase is equal to the area P_1P_2FE. Part of the loss, however, is returned to the government in the form of tariff revenue - area CBFG. In addition there is a gain in producer surplus from the higher prices which is equal to the area P_1P_2BA. The deadweight loss from the tariff is equal to the two areas ABC and EFG. The first area represents a production efficiency loss when domestic production replaces lower cost imports. The second area represent a consumption efficiency loss as some consumers who were willing to buy low cost imports are forced out of the market due to higher prices.

FIGURE 1. Welfare Loss from a Tariff or Quota



Imposition of a quota limiting imports to $Q_F - Q_B$, could achieve the same price increase from P_1 to P_2 and entail similar gains and losses to producers and consumers respectively. However, the area CBFG, which is called the scarcity rent, may go to either the importing or exporting country. If the importing country auctions quotas, then the scarcity rent will accrue to the government in the same manner as tariff revenue. If the importer is free to select his source of supply among exporters, then the importer as opposed to the government will gain the scarcity rent. Mintz (6, p. 17) comments, however, that both these developments are unlikely and notes that "when quotas are assigned to specific countries, the exporters in these countries typically control the allocation of the quota and pocket the profit. This is always true of voluntary quotas which means high profits for selected foreign exporters -- profits which are, of course, a pure burden on the importer's economy." Voluntary quotas will thus result in a higher welfare loss than tariffs due to the loss of scarcity rent.

The relative loss from tariffs or quotas may also be obtained by comparing the net welfare loss to the gain in producer surplus. In the case of tariffs the relative cost of protection is equal to the deadweight loss from consumption and production (the two shaded areas in Figure 1) divided by the gain in producer surplus. In the case of voluntary quotas the relative cost of protection is equal to the deadweight loss from consumption and production and the scarcity rent divided by the gain in producer surplus. Again voluntary quotas will result in a higher relative cost of protections than tariffs.

A final comparison between tariffs and quotas relates to the degree of producer protection provided by the trade regulation. Most authorities agree that a tariff does not provide the same degree of protection to the domestic manufacturer as a quota since a reduction in world market prices will weaken the protective effect of a tariff. In contrast, a quota limits the quantity of foreign goods that may be imported irrespective of price changes. Mintz states "it is the predictability of imports and consequent security of the home industry which makes quotas a much stronger protectionist tool than tariffs." If the voluntary marketing agreement is limited to a few countries, however, their effectiveness is likewise limited since non-participating countries may respond to the export opportunity created by such agreements.

The above discussion is particularly relevant in view of the growing importance of quotas in trade regulation policies. Bergsten stated in 1972 that the "U.S. now has an array of quotas and 'voluntary' export restraints which have an even greater price effect than tariffs. Indeed they cover commodities which represent about $100 billion of U.S. consumption and make up 15-20 percent of the entire Consumer Price Index" (1, p. 3). Continuation of this pattern throughout the 1970's was noted by Morkre and Tarr.

> "In recent years, the United States and EC have turned increasingly to quantitative restraints (QR's) to restrain trade. In the United States the principle form of QR is the Orderly Marketing Agreement (OMA) and its predecessor the Voluntary Export Restraint (VER)" (7, p. 169).

Costs of Tariffs and Quotas

There have been several studies concerning the costs of tariffs and non-tariff restrictions. One estimate by Bergsten ranged from $10 billion to $15 billion. Major areas included oil quotas ($5,000 million), textiles ($2,500 to $4,800 million), and agricultural products. Bergsten (1) estimated the following costs for agricultural commodities:

> "Sugar imports are also subject to quotas and U.S. sugar prices have generally been about twice as high as world market prices in recent years. The annual consumer cost is about $500 million. 'Voluntary' restraints by the major foreign suppliers of fresh and frozen meat probably cost the U.S. consumers about $350 million annually and hit low-income families with particular severity because most meat imports are used in the manufacture of lower cost items such as frankfurters and hamburgers. Tight quotas on imports of dairy products add about $500 million more to the annual consumer's bill."

Mintz's estimates were somewhat higher than Bergsten's and ranged from $580 to $700 million a year for sugar quotas and were $600 million for meat quotas.

More recent estimates are available from Morkre and Tarr (7) and Decker (2). Morkre and Tarr estimated consumer losses from the use of Orderly Marketing Agreements (OMA's) for nonrubber footwear in 1980. The two countries affected by the agreement were South Korea and Taiwan. Annual consumer losses were $288 million. A smaller annual loss of $49 million were observed in the case of CB receivers where a tariff was imposed. Decker examined the impact of a voluntary export restraint (VER) for Japanese automobiles. Consumer losses in the Japanese automobile market ranged from $460 million to $560 million for the first year of the VER. In addition some upgrading of product lines occurred, an outcome which had been mentioned by Bergsten.

One interesting finding by Morkre and Tarr pertained to the results of an OMA with Japan for color television. At the time of the OMA (1977) Japan was the dominant supplier so that higher prices were anticipated. However the incentives created by the OMA which encouraged countries such as Korea and Taiwan to establish TV industries combined with the appreciation of the yen meant that the OMA was less restrictive than anticipated. Thus, "the welfare costs to consumers and the inefficiency losses to the U.S. economy have been marginal" (7, p. 87). This indicates the importance of alternative sources of supply in determining the impact of a quantitative restriction.

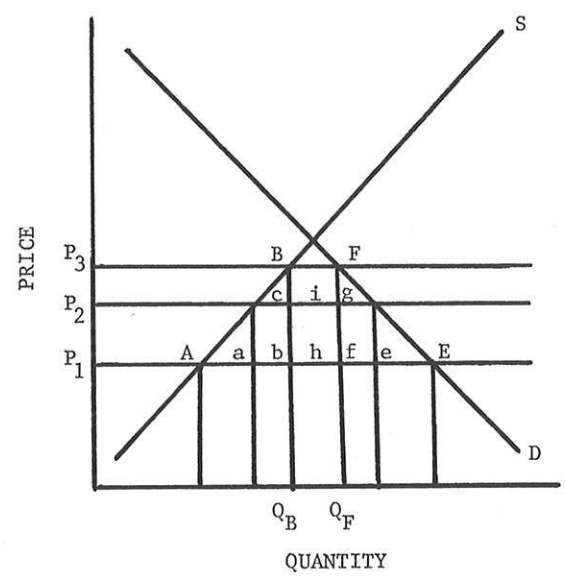
SUGAR QUOTAS

Sugar import quotas were imposed by President Reagan on May 5, 1982. Their purpose was to raise the price of sugar in the U.S. to the market stabilization price of 19.88 cents a pound, a result which could not have been achieved by increasing tariff rates due to statutory limitations on the degree to which tariff rates could be increased. As a result the domestic sugar producers are now protected by a combination of tariffs and quotas. The purpose of this analysis was to examine the absolute and relative cost of protecting sugar producers and to illustrate the equity/efficiency aspects of the new protectionism.

Welfare Loss Model

The welfare cost of a combined system of protection (tariffs and quotas) is given in Figure 2. Again P_1 represents the world price in the absence of trade restrictions while P_2 is the price once the tariff is imposed. Imposition of a quota limits the quantity that may be imported to $Q_F - Q_B$. As a result, the price increases to P_3. The loss in consumer surplus from the total change in price from P_1 to P_3 is equal to P_1P_3FE while the gain in producer surplus from the price increase is equal to P_1P_3BA. In addition, there is a gain in tariff revenue (area h). The welfare loss due to the tariff and quota is then given by the areas a, b, c, e, f, g, and i. The areas a and e represent the cost of the tariff while the areas b, c, f, g, and i represent the additional cost of the quota once a tariff is in effect. The quota cost has three components. The first component is the loss in tariff revenue due to the reduction in imports (areas b and f). The second component is the loss due to increased domestic production and reduced domestic consumption (areas c and g) while the third component in the loss in scarcity rent (area i). This loss would not have been incurred under a tariff.

FIGURE 2. Welfare Loss from a Tariff and Quota



The model must be modified to reflect the fact that one component of the tariff is eliminated when the quota is successful in increasing the U.S. price. As a result of the fall in the tariff rate, when a quota is in existence, the scarcity rent (area i) increases while there is a corresponding reduction in the tariff revenue (area h). The other results are unchanged.

Data Used in the Analysis

The welfare loss for sugar was based on the tariff rate and the estimated price impact of the quota. According to an article in Regulation, the price of imported raw sugar was 15.1 cents a pound in July, 1982 (9). This included shipping costs of 1.5 cents a pound and tariffs costs of 6.2 cents a pound. (The tariff rate declines to 2.81 cents a pound once the quota is in effect.) Assuming that the quota would succeed in raising the domestic sugar price to 19.88 cents a pound then the price impact of the quota is 4.78 cents a pound. Data were also available from the International Trade Commission concerning domestic production and consumption of sugar before the quota. As a result of the quota the quantity of raw sugar imported will decline from 7.60 billion pounds to 3.36 billion pounds per year.

The final data requirements were the price elasticities of demand (n_d) and supply (n_s). The implicit price elasticity of demand for imports (n_m) is 1.76 based on the percentage increase in price and the percentage reduction in quantity due to the quota. A price elasticity of demand of 0.2 was used, based on results reported in the literature (4). The price elasticity of supply was then estimated from the following equation.

$$n_m = n_d\,(D/M) + n_s\,(S/M) \text{ where} \qquad (1)$$

D = quantity of domestic consumption

S = quantity of domestic production, and

M = quantity of imports.

All quantity and elasticity values pertain to the pre-quota situation. A price elasticity of supply of 0.82 was obtained which is within the range reported in the literature (7).

Welfare Loss Estimates

The impact of sugar quotas in 1982 is given in Table 1. The loss in consumer surplus is equal to \$888 million while domestic producers and foreign producers gain \$626 million and \$276 million respectively. In addition the U.S. loses \$260 million in tariff revenue due to the reduction in the quantity of imports and \$114 milion due to the reducion in tariff rates. The absolute welfare loss is equal to the loss in consumer surplus and in tariff revenue (\$1,262 million) minus the gain in producer surplus or \$636 million. The relative welfare loss (absolute welfare loss divided by the gain in producer surplus) is equal to 1.01 which means that every dollar received by U.S. sugar producers costs U.S taxpayers and consumers \$2.01.

TABLE 1. Impact of Sugar Quotas (\$ million)

Loss to U.S. Sugar Consumers	888
Gain to Foreign Sugar Producers (Scarcity Rent)	276
Gain to U.S. Sugar Producers	626
Tariff Revenue Loss (reduction in imports)	260
Tariff Revenue Loss (reduction in tariff rates)	114

It is also of interest to compare the absolute and relative welfare losses of tariffs and quotas. The data are given in Table 2. The absolute welfare loss for tariffs is \$170 million compared to \$636 million for quotas. However, the change in produce surplus is fairly similar ranging from \$598 million for tariffs to \$626 million for quotas. As a result, the relative welfare loss ranges from 0.28 for tariffs to 1.01 for quotas. These differences reflects the cumulative impact of trade restrictions and the higher welfare loss from quotas as opposed to tariffs. The combined effect of tariffs and quotas results in an absolute welfare loss of \$806 million and a relative welfare loss of 0.66.

TABLE 2. Absolute and Relative Welfare Loss from Trade Restrictions[a]

Restrictions	Absolute Loss (\$ million)	Change in Producer Surplus (\$ million)	Relative Loss (%)
Tariffs	170	598	28
Quotas			
Dead Weight	100		
Tariff Revenue	260		
Scarcity Rent[b]	276		
Total	636	626	101
Tariffs and Quotas	806	1,224	66

[a]Assumes that the sugar quotas are only designed to aid U.S. sugar producers.
[b]Includes the loss in tariff revenue due to the reduction in tariff rates.

The role of sugar quotas as a form of foreign aid was also discussed in the article in Regulation (9). It was pointed out that the sugar quotas might have two objectives: The first objective is to assist the domestic sugar producer while the second objective is to assist selected foreign countries. Sugar quotas are thus a substitute for the Carribean Basin Initiative which had been changed by Congress to a program with limited United States control. If sugar quotas had two objectives then both the gains to domestic and foreign sugar producers should be deducted from the loss in consumer surplus and in tariff revenue to obtain the welfare loss.

The revised welfare loss estimates are given in Table 3. Welfare losses are unaffected in the case of tariffs but decline in the case of quotas. The absolute welfare loss of quotas declines by $276 million while the change in producer surplus increases by $276 million. As a result the relative welfare loss of quotas declines from 1.01 to 0.40. When tariffs and quotas are combined the absolute welfare loss is $530 million while the relative loss is 0.35.

TABLE 3. Absolute and Relative Welfare Loss from Trade Restrictions[a]

Restrictions	Absolute Loss ($ million)	Change in Producer Surplus ($ million)	Relative Loss (%)
Tariffs	170	598	28
Quotas			
Dead Weight	100		
Tariff Revenue	260		40
Total	360	902	
Tariffs and Quotas	530	1,500	35

[a]Assumes that the sugar quotas are designed to aid U.S. and selected foreign sugar producers.

While these results are more favorable than those shown earlier it might be queried whether domestic sugar consumers should underwrite foreign aid expenditures rather than taxpayers. A similar comment might be made with respect to protection of the domestic sugar producer. The fact that sugar is a staple item in the food budget of many low-income consumers also raises serious question concerning the regressive nature of the sugar quota. Consumers with the least ability to pay are taxed in a manner similar to those with the greatest ability to pay. Unfortunately political feasibility rather than efficiency or equity considerations seem to dominate trade policy. As a result low income consumers are likely to bear a disproportionate share of the cost of protecting domestic industries and providing foreign aid.

DISCUSSION

The new protectionism which has developed in the past two decades has serious implications for consumer welfare. It has defeated the post World War II movement towards a reduction in trade barriers by replacing tariff barriers by non-tariff barriers. It is generally recognized that quantitative restrictions, in particular "voluntary" quotas impose higher losses than mandatory quotas or tariffs. However, such restrictions have played an increasingly important role in the regulation of imports. Morkre and Tarr give the major reason for the popularity of quantitative restrictions (QR's) such as Orderly Marketing Agreements (OMS's) or Voluntary Export Restraints (VER's).

> Despite the fact that QR's impose the additional costs on the domestic economy of expropriated profits by exporters and the potential for creating domestic monopoly power, they have become increasingly popular in the 1970's. Ironically it is precisely the feature of OMA's that makes them more costly to the domestic economy that makes them politically attractive. In general the exporting nation can be expected to be a major political obstacle in a protectionist effort. In offering an OMA, however, the exporting nation may be "bought off" by the possibility of expropriating the scarcity rents; this considerably reduces the possibility of retaliatory trade actions (7, p. 169).

The consumer is thus subsidizing both the domestic and foreign producer. Since most quantitative restrictions are regressive in nature this means that the burden of producer assistance is borne disproportionately by low-income consumers. Quantitative restrictions thus suffer from equity as well as efficiency limitations.

The dichotomy between producer and consumer interest in the case of free trade places a burden on consumer educators to alert consumers to the gains from trade and the losses imposed by trade regulations. Unfortunately as Milton Friedman notes consumer organizations have not been as active in this area as they might have been (3, p. 32). As a result trade restrictions which are detrimental to consumer welfare continue to be imposed. The situation is unlikely to change unless consumers become as highly organized and lobby as effectively as producers or workers. The dominance of producer interests in determining trade policies was recognized by Adam Smith more than two hundred years ago and his statement remain as true today as they were in 1776.

> Consumption is the sole end and purpose of all production; and the interest of the producer ought to be attended to only so far as it may be necessary for promoting that of the consumer. The maxim is so perfectly self-evident that it would be absurd to attempt to prove it. But in the mercantile system the interest of the consumer is almost constantly sacrificed to that of the producer; and it seems to consider production, and not consumption, as the ultimate end and object of all industry and commerce.
>
> In the restraints upon the importation of all foreign commodities which can come into competition with those of our own growth or manufacture, the interest of the home consumer is evidently sacrificed to that of the producer. It is altogether for the benefit of the latter that the former is obliged to pay that enhancement of price which this monopoly almost always occasions (8, pp. 287-289).

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