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There is considerable evidence to support the hypothesis that seafood, poultry and meat are close substitutes in consumer demand. Thus the relationships among prices are important in determining consumption patterns among these protein sources. In addition, there are at least two kinds of outlets in which seafood, poultry and meat are sold to consumers: retail stores, including supermarkets, and away-from-home outlets, including restaurants.

Because restaurants and retail stores add different sets of services to their products (dining facilities vs. packaging, for example), one would expect the price relationships among the three protein categories to be different, as between the two outlets. In turn, this should

lead to consumption patterns that are different in restaurants than in retail stores.

Some, however, argue that this is not the case because the different prices in the two outlets can be assigned directly to the services provided by the respective outlets and thus should not be included in the prices of the protein items themselves. Under this argument, there should be no differences in the consumption patterns as between the two outlets.

This study presents a theoretical background and model of the issue, reviews the competing hypotheses, and performs an empirical test. Unfortunately, neither hypothesis can be supported from the observations of a restaurant that participated in the study. However, supplemental data from a family restaurant chain provides evidence that the consumption ratios of the two protein sources is not responsive to change in the prices of the services provided.

# Consumption of Seafood, Poultry and Meat in Restaurants vs. Supermarkets

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## I. INTRODUCTION

U.S. food consumption expenditures have been growing substantially over the last quarter century. Figure 1 shows the trend in U.S. food consumption expenditures (excluding alcoholic beverages), both at-home and away-from-home, from 1965 to 1990. Both expenditures clearly indicate a dramatic upward trend. Figure 2 represents "expenditure index" for U.S. food consumption expenditures on the two levels, from 1965 to 1990, using 1965 (=100) as a base. This expenditure index measures the ratio of the expenditures for a year to that for the between years (1965), providing "changes" in expenditures over years (Salvatore 1991, pp. 127-28). As the figure indicates, away-from-home food expenditures increased even faster during the period than did at-home food expenditures. An increasing share of the consumers food dollar was spent in the away-from-home food sector.[1]

There are two usual explanations for the rise in consumption expenditures in restaurants relative to at-home. One is the opportunity cost of time (Prochaska and Schrimper

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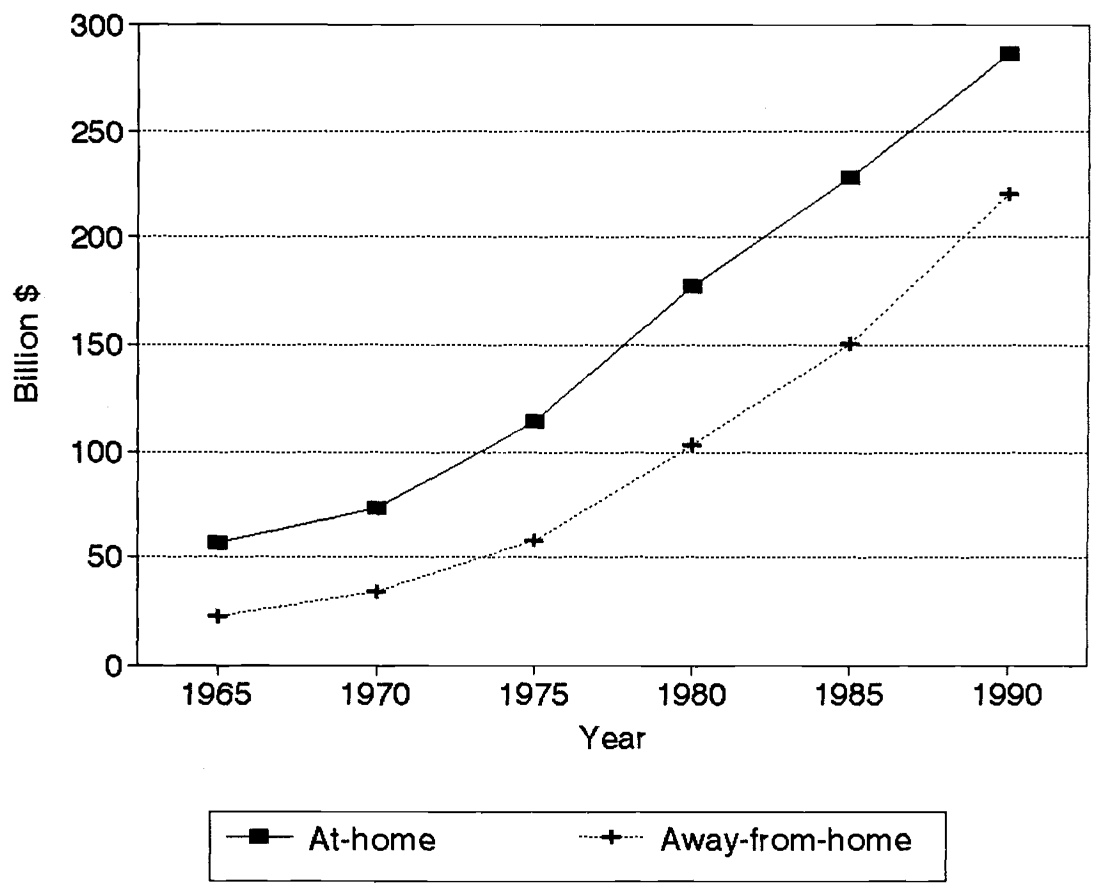
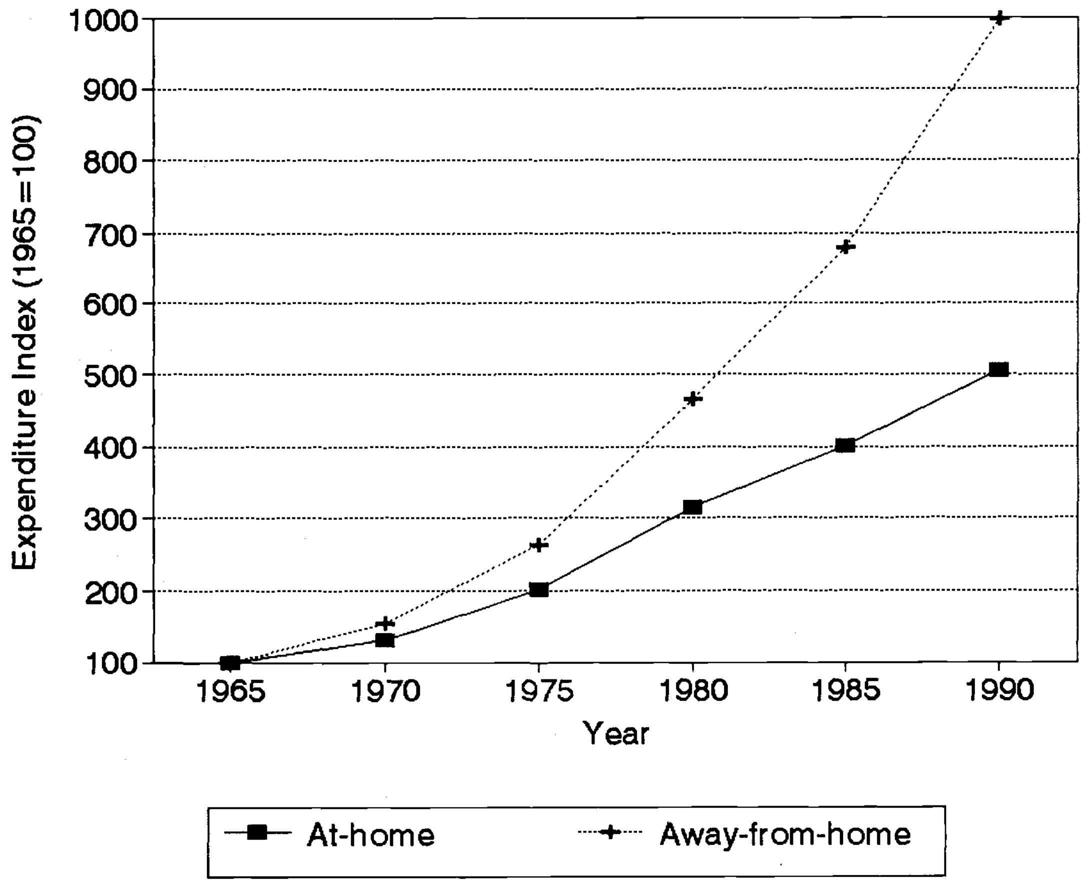
[1]Although fast food outlets are growing rapidly, restaurants have been getting the largest share of the away-from-home expenditure (USDA 1991, pp. 33).

Figure 1. U.S. Household Consumption Expenditures, At-home and Away-from-home, 1965-1990.




Source: FoodReview, USDA Economic Research Service, July-September (1991) vol. 14, iss. 3.
Note: Consumption does not include alcoholic beverages and the 1990 data are preliminary.

Figure 2. Expenditure Index for U.S. Household Consumption Expenditures, At-home and Away-from-home, 1965-1990 (1965=100).




Source: FoodReview, USDA Economic Research Service, July-September (1991) vol. 14, iss. 3.
Note: Consumption does not include alcoholic beverages and the 1990 data are preliminary.

1973). The other is the desire for services. Personal income has risen during the past quarter century due to an increase in the number of households with more than one earner. Such households generally have less time and more money, so that they eat more in restaurants, where cooking time is saved, despite paying prices that are higher than those in grocery stores.

If consumers tend to eat in restaurants more and more, what mix of foods is chosen in restaurants? Is it the same as the mix of foods consumed at home?

The neoclassical theory of consumer choice does not give any reason to believe that the consumer would purchase different bundles of food at home than in the restaurant. On the other hand, if away-from-home diners tend to have higher incomes than those who seldom eat outside of the home (two-income household, restaurants do not accept food stamps, etc.), this may tend to increase the share of high-priced food items purchased in restaurants. In addition, it is likely that people working away-from-home consume a greater share of their meals, especially lunches, at restaurants than do those who do not work outside of home (housewives, retired persons). If the former group has different food preference than the latter, this could be reflected in the mixes of food purchases.

It is the thesis of this research that the answer lies in relative prices, in an extension of the so-called "shipping the good apples out" proposition.

The "shipping the good apples out" issue is a very interesting real economic phenomenon with several varied applications. The example cited in Borcherding and Silberberg (1978) appears in the "Troubleshooter" column of the Seattle Times, where an irate consumer writes (Seattle Times, October 19, 1975):

> "Why are Washington apples in local markets so small and old-looking? The dried-up stems might seem they were taken out of cold storage from some gathered last year. Recently, some apple-picking friends brought some apples they had just picked, and they were at least four times the size of those available for sale here. Where do these big delicious apples go? Are they shipped to Europe, to the East or can they be bought here in Seattle? - M.W.P." (Borcherding and Silberberg 1978, pp. 132).

The answer was provided by a leading economist several days later (Seattle Times, October 28, 1975):

> "Regarding M.W.P.'s complaint that all the good apples were being shipped East, you might be interested to know that 'shipping the good apples out' has been a favorite classroom and exam question in the economics department at U.W. for many years.
>
> It is a real phenomenon, easily explained:
>
> Suppose, for example, a 'good' apple costs 10 cents and a 'poor' apple 5 cents locally. Then, since the decision to eat one good apple costs the same as eating two poor apples, we can say that a good apple in essence 'costs' two poor apples. Two good apples cost four poor apples.
>
> Suppose now that it costs 5 cents per apple (any apple) to ship apples East. Then, in the East, good apples will cost 15 cents each and poor ones 10 cents each. But now eating two good apples will cost three - not four poor apples.
>
> Though both prices are higher, good apples have become relatively cheaper, and a higher percentage of good apples will be consumed in the East than here.
>
> It is no conspiracy - just the [law of demand]" (Borcherding and Silberberg 1978, pp.132).

This is a specific case of the general proposition supplied ten years earlier by Alchian and Allen (1964), namely, that if a given transport cost is added equally to the prices of two similar goods, then, because this will reduce the relative price of the more expensive (*i*.e., higher quality) good, the effect will be a relative increase in the consumption of the higher-quality good.

This proposition can be applied to other "fixed charge" phenomena. In Borcherding and Silberberg (1978), the argument is applied to consumption in restaurants as following: "most top grade (e.*g*., USDA 'prime') beef is sold to restaurants, where the 'relative' cost of consuming such beef is lower than at home, given the cost of cooks, waiters, fancy decor, etc." (Borcherding and Silberberg 1978, pp. 137).

The example provides the basis for the hypothesis about consumer consumption patterns in restaurants vs. supermarkets. Hence, this study focuses on the above restaurant example, especially concerning the effect of differing price ratios on consumer choices among protein source items such as salmon, beef, pork and chicken.

When a consumer purchases such protein source items at a retail outlet, she faces a certain price comparison between those items. If an approximately identical "fixed charge" is added to each of those items (as in the case of a restaurant, where the cost of food preparation and presentation as a "center of the plate" menu item is added to the food price), the resulting price ratio will be different. Do consumers perceive the difference between these price ratios, and act as theory would predict, consuming relatively more of the lower priced item at retail outlets and relatively more of the higher-cost protein at restaurants?

The proposition is not without controversy. Its formulation has been debated in the literature, and we now have two different, alternative formulations. These two formulations differ in their assumptions about how consumers perceive prices. One formulation (Borcherding and Silberberg 1978) supports the hypothesis that consumers view the fixed per-unit charge as a change in the price ratio, as just discussed. The other formulation (Umbeck 1980) hypothesizes that consumers view the charge not as affecting the price ratio at all, but, rather, as a fixed lump-sum charge for a separate third good or service. In the restaurant, this would be the portion of the patron's bill which pays for everything other than the food cost of her meal, including decor, ambience, the services of waiters and maitre d's, heating, lighting, etc. Under this latter formulation, relative prices of the food items themselves would be the same for restaurants as for retail stores.

While the Alchian and Allen proposition has been applied to explain several economic phenomena, no statistical test has yet been devised for distinguishing between these two formulations. The purpose of this study is to empirically test the hypothesis of Alchian and Allen proposition, and also to test the two alternative versions of its formulation. To do so, the question of whether the ratio of two protein source consumptions is different in restaurants than in retail food stores, in view of the different price ratios in the two markets, will also be examined.

This study contains seven chapters. Chapter I outlines the problem and objectives. Chapter II reviews previous related studies. Chapter III summarizes the theoretical basis of the competing hypotheses, Borcherding and Silberberg formulation, and Umbek formulation. Then drawing on the work of Opaluch (1982), an econometric model that permits exploration of the competing hypotheses is developed in Chapter IV. It also discusses alternative econometric models to be used in this study. Chapter V presents the data collected for this study. Chapter VI reports the estimation and test results. Finally, Chapter VII summarizes the study and discusses an evidence from supplemental data.

## II. REVIEW OF LITERATURE

### Shipping The Good Apples Out

The original proposition, titled "shipping the good apples out", was first presented by Alchian and Allen (1964). The argument was as follows: if a given transport cost is added equally to the prices of two classes of items (one is a higher-quality goods with a higher price and the other is a lower-quality goods with a lower price), then the price of the higher-quality goods (relative to the lower-quality) will be relatively lower at the more distant places than at the places of manufacture. This will lead, through the law of demand, to a relative increase in the consumption of the higher-quality goods as compared with the lower-quality, at the distant locations. Using this proposition, the following empirical economic phenomena are explained: why the proportion of good grapes, relative to bad, shipped to New York from California is greater than the proportion consumed in California; why a tourist must be more careful in buying leather goods in Italy than in buying Italian leather goods in the United States; and why young parents with children go to expensive plays rather than movies relatively more often than do young couples without children (pp. 78).

Gould and Segal (1968), however, demonstrated that, in a two-goods world, Alchian and Allen's proposition hold only in the income compensated case since income effects are always indeterminate, and in a three-goods world the proposition does not follow from the law of demand, since interactions with the third goods might destroy the effect. For these reasons, the counterexamples were presented to show that: first, if the lower-quality goods is an inferior goods, the consumer might, by the income effect, switch consumption from the higher-quality goods to the lower-quality one; second, if the third goods is a substitute with respect to both the higher- and the lower-quality goods, then the consumption of both the higher- and lower-quality goods will be reduced, and this may result in a smaller proportion of the higher-quality goods being consumed after adding the transport cost. In addition that authors asked rhetorically: "How often is it heard, for example, that the way to get really good farm produce is to drive out to the country and buy it at a roadside stand or that one must go to Maine to get truly delectable lobsters?" (pp. 137).

With respect to the last point Borcherding and Silberberg (1978) pointed out that the farm produce and lobster examples do not contradict Alchian and Allen's proposition at all, because first, "it does not matter if the goods are shipped to the consumers or the consumers are shipped to the goods" (pp. 133); and second, the example of lobsters depends on spoilage, though the "Alchian and Allen's proposition is assumed that nothing happens to the goods themselves as a result of the price changes." (pp. 133). They also algebraically reformulated the theoretical model and concluded that as an empirical matter, if the two substitutes are close, the direct substitution effect tends to dominate the interaction effect with the third good. (We will discuss their formulation in detail in next chapter.) They, moreover, demonstrated several applications of the proposition beyond that of transportation cost. These are: "(1) more higher-quality meat (relative to lower-quality) will be consumed in restaurants than at home; (2) relatively more higher-quality fabric will be used on finely tailored suits than on less well tailored suits; and (3) relatively more nice homes will be built on expensive land than on inexpensive land" (Umbeck 1980, pp. 199).

However, Umbeck (1980) pointed out that the restaurant service charge (including waiters and waitresses, cooks, fancy decor, *etc.*) used in Borcherding and Silberberg's restaurant application is not a fixed charge, but a price for additional restaurant services. That is, the restaurant service charge is different from the transportation charge, which is assumed in the theory to be a fixed cost (*i.e.*, a charge for a non-economic good).[2] Under this

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[2]Borcherding and Silberberg explicitly note that " the Alchian and Allen proposition assumes that nothing happens to the goods themselves as a result of the price changes"

interpretation, there exists a problem: a charge for something which is not an economic goods would be logically impossible, "since no one would ever pay a price greater than zero for a thing with no value" (pp. 203). In order to solve this problem, Umbeck reformulated the original Alchian and Allen's proposition by introducing the concept of an "admission fee" as the interpretation of the fixed charge. Thus the consumer faces a lump-sum charge equal to his consumer's surplus as an "admission fee" for the right to purchase good. This pricing scheme is like that of a two-part tariff, or a so-called a block pricing arrangement. (We will discuss his formulation in detail in the next chapter.) By the use of his formulation, Umbeck showed that the Alchian and Allen's proposition is correct.

Silberberg (1990) admitted that his analysis could not really be applied to "restaurant amenities" (including the services of waiters, waitresses, and cooks, fancy decor, *etc.*), because there are goods and services that enter the utility function directly, and could in principle, be purchased separately (pp. 387, footnote). He, however, stated that the analysis is still valid since it boils down to the response to a change in the price of some third good. (pp. 387, footnote). He finally concluded that "the resolution of the puzzle may lie in the economics of the way goods are bundled together" (pp. 387, footnote).

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(1978, pp. 133).

Thus the issue appears to be one of how consumers perceive prices. This has both conceptual and empirical components. If consumers view the prices of meals in restaurants as incorporating a service that could be purchased separately, there would be no reason to expect proportions of higher to lower-quality foods purchased to be different in restaurants than in retail stores. If the services are not separable from the foods themselves, different proportions should be observed. How, then, would one formulate an empirical model that allowed the analyst to choose between these competing hypotheses? This is reminiscent of a debate on consumer purchases of water under block pricing arrangements. The literature on this issue is reviewed next.

## Controversy Over Price Specification

The proper specification of price (average price versus marginal price[3]) has been debated in recent studies of water demand under block pricing, in which the marginal price declines with increased consumption, in stair-step fashion. Many early studies of water demand considered the average, not the proper marginal price.

Howe and Linaweaver (1967) first explicitly presented

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[3]The average price is the total expenditure on water divided by water consumption, and the marginal price is the price of the final block.

the rationale for using the marginal price in a micro-level study of residential water demand. In their study, only the marginal price was used as a predictor in the demand function; however, this has a problem, because the income effects of a change in intramarginal rates[4] with marginal price constant cannot be properly accounted for.

This problem was treated by Taylor (1975). He presented a theoretical analysis of the problems caused by block pricing by using the neoclassical theory of consumer behavior. He suggested that both the marginal price (the final block price) and average price (excepting the final price) should be included as predictors in the demand function, or alternatively, the total expenditure payment excepting the final block could be used in place of the average price (pp. 79-80).[5]

Subsequently, Nordin (1976) demonstrated that Taylor's suggestion was inappropriate, and modified the proper specification to include both the marginal price and an expenditure differential variable equal to the excess of the

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[4]The intramarginal rates means those block price rates other than the final block price.

[5]He suggested the use of both prices, because "if average and marginal price are positively correlated (as is likely to be the case), then use of one of the prices in the absence of the other will lead, in general, to an upward bias in the estimate of the price elasticity" (pp. 80) due to the impact of an omitted variable. He also stated that "the coefficient on total expenditure up to the final block should be equal in magnitude, but opposite in sign, to the coefficient on income" (pp. 80).

actual total payment over what the total payment would have been if the marginal price had prevailed in all blocks. The expenditure differential variable suggested by him is appropriate because one-unit increase in this variable has the same effect as one-unit increase in a lump-sum subtraction from income.

Accordingly, Billings and Agthe (1980) used the specification suggested by Nordin to estimate the residential demand for water and the price elasticity of demand under increasing block rates.[6] They used a Nordin-type model because they believed that use of the average price as the single price variable in the estimating equation would tend to produce excessively large estimates of the price elasticity of demand under block pricing. They concluded that their Nordin-type model produced theoretically sound and statistically strong estimates of the elasticities of demand for residential water, and that the use of this model should facilitate more accurate predictions of consumer response to alterations in the rate structure under block pricing (pp. 83-84).

Howe (1982) also used a Nordin-type model to estimate the household water demand and the price elasticities under

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[6]The following model was used: $Q = f(P, D, Y, W)$, where Q is water consumption; P is the marginal price; D is the expenditure difference; Y is income; and W is evaporation minus rainfall. They used average values for the city from monthly time-series data from January 1974 to September 1977 in Tuscon, Arizona.

decreasing block price from the Johns Hopkins Residential Water Use Project data of 1963-65.[7] He compared the price elasticity estimates with those in his 1967 study (that model did not include an expenditure differential variable, but only the marginal price), and the coefficients of the expenditure differential variable with those of other studies. Then, he concluded that the exact interpretation of the expenditure differential variable and the rationale for the magnitude of its estimated coefficient remain something of a mystery (pp. 716).

On the other hand, there is an argument supporting the use of only the average price. Foster and Beattie (1979) presented a generalized, multivariate model of the residential demand for water produced and distributed by urban waterworks.[8] For the explanatory variables they used average price, median income, precipitation during the

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[7]The following demand function was used: Q = $f$(D, V, P, MD), where Q is water consumption; D is the expenditure difference; V is residential property value; P is the marginal price; and MD is the moisture deficit between winter and summer.

[8]They offered the following regionalized model, with dummy variables for the constant and price coefficients (allowing variation in these parameter among regions): Q = $f(P, Y, R, N, V_i)$, where Q is the quantity of water demanded; P is the average price; Y is income; R is precipitation; N is the average number of residents; and the $V_i$ are dummy variables that take the values 1 if the observation is from the $i$th category (region or size of city), 0 otherwise ($i = 1, 2, \cdots, 6$ for regional models, and also $i = 1, 2, 3, 4$ for size-of-city models). Model parameters were estimated using cross-sectional data from a sample of 218 U.S. cities.

defined growing season, and the number of residents per meter.

Griffin, Martin, and Wade (1981), however, objected to the use of average price by Foster and Beattie in an investigation of the effect of price on water consumption. In general, a declining multiple-part tariff consists of a fixed service charge, which usually covers the first few hundred cubic feet, combined with a charge for each unit (the marginal price), which falls as the customer's consumption increases. Therefore, when this block pricing arrangement is in force (as is the case for many water utilities), the average price will fall as a customer's consumption increases. Moreover, the average price is not closely related to the marginal price faced by a consumer. For example, if two consumers are facing different rate block pricing schedules, the average prices paid by them might differ, even though the marginal price faced by them is the same. Thus, they claimed that "the relationships between average price and quantity consumed found by Foster and Beattie are not demand functions, but supply functions reflecting the form of the rate schedule" (pp. 252), *i.e.*, the identification problem. Hence, they suggested a technique for generating a rough approximation for the marginal price of water from a utility rate schedule with relatively few blocks.

In reply, Foster and Beattie (1981a) argued that they used average price as a proxy for the unknown, applicable, marginal block price because they believe that most consumers more likely perceive their total water expenditure function as a ray line owing to their lack of knowledge concerning marginal prices (in this case, price is a constant so that their perceived average and marginal prices are equal). They further showed that Griffin, Martin, and Wade failed to see the difference between the water utility's aggregate supply function and the administratively determined supply schedule facing the individual consumer; hence, the alleged identification problem is nonexistent or, at most, not serious. They also pointed out that even though Billings and Agthe (1980) used Nordin specification, their elasticity estimates were similar to the elasticity estimates of Young (1973) and Wong (1972) which used average price as the only price variable; therefore, the misspecification, if any, was much less severe than their statement (1981b, pp. 625).

Foster and Beattie (1981b) then stated that the proper specification of price (average price versus marginal price) depends on how consumers perceive prices rather than what theory predicts; therefore, whether consumers respond to average or marginal price is an empirical question and should be subject to testing with available data.

Thus the issue of whether the marginal or the average price should be used has been subjected to empirical testing with available data on residential water or electricity demand under block pricing. The literature on this empirical test is reviewed next because of its relevance to the issue of how to compare the competing interpretations of the "Shipping the Good Apples Out" hypothesis.

## Test of Price Specification

The proper specification of price (average price versus marginal price) has been examined empirically in the models of residential water and electricity demand under block pricing. Gibbs (1978) used individual household observations from 44 firms in Miami, Florida, to estimate two demand models which were identically specified except for the price variable (one contained average price and the other marginal price), and compared the two specifications of price regarding the responsiveness of consumption to both price and income.[9] His results showed that "the average price model overestimated the response to price changes by 22% and to income changes by 57%" (pp. 18); hence, he

[9]The following model was used: $Q = f(AP \text{ or } MP, I, RS, HWH, D_i)$, where Q is quarterly household water consumption; AP is the average price; MP is the marginal price; I is annual household income; RS is persons per household; HWH is percentage of homes with hot-water heat; and $D_i$ is a set of seasonal dummy variables.

concluded that "the appropriate measure of price is marginal price, not average price" (pp. 15). (However, the expenditure differential variable by Nordin is not included in his model.)

Foster and Beattie (1981b) reestimated the parameters of their 1979 model through following the Nordin-type specification and using the data from their original study (1979).[10] This model was specified by adding the marginal price and expenditure differential variable instead of the average price in their original model (1979). By the estimation of these two types of model, they found that the estimated parameters of the average price model were not significantly different from the estimated parameters of a Nordin-type marginal price model, and that other statistical criteria (F-test or $R^2$) supported their contention that the average price model was a better specification.

Polzin (1984) used separate econometric models to compare three alternative specifications of the price variable in the demand for natural gas, using time series data for a single utility serving residential customers in Great Falls, Montana. His three alternative variables representing the price of natural gas were (1) the average price; (2) monthly bill (monthly expenditure / quantity); and (3) the marginal price and the expenditure differential

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[10]The following model was used: $Q = f(MP, D, Y, R, N)$, where MP is marginal price; D is expenditure differential; and the other variables are as stated in footnote 8.

(Nordin-type specification).[11] He found the following: (1) none of the three alternative price specifications is clearly superior to the other two on statistical grounds, and the Nordin-type model is relatively inefficient because one degree of freedom is lost by including two variables; (2) there is no statistically significant evidence of specification bias from using the average price variable; and (3) the Nordin-type specification does not have superior predictive characteristics. Therefore, he concluded that the Nordin-type specification may not be the best description of consumer behavior when faced with a block-rate price schedule (pp. 309).

Stevens, Adams, and Willis (1985), however, pointed out several problems in Polzin's analysis. First, the values of the individual consumer's response to a change in the rate structure might be different from the values of the aggregate response; consequently, the use of aggregate data will understate the true effect of the change in the marginal price. Second, the average price is determined, in part, by the quantity consumed, which causes a simultaneity problem (*i.e.*, an endogeneity bias in the estimate of the

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[11]The following three models were used: (1) GAS = *f*(DEGDAY, HSLDSISE, AVEPRICE); (2) GAS = *f*(DEGDAY, HSLDSISE, GASBILL); and GAS = *f*(DEGDAY, HSLDSISE, MP and D), where GAS is annual natural gas consumption; DEGDAY is annual number of heating degree days; HSLDSISE is persons per household; and AVEPRICE is calculated from total revenue divided by sales. The data used in his study are time-series data, annual observations for 1960 to 1981 for the Great Falls Gas Company.

coefficient on the average price variable). Third, the estimation suffers from biases due to the omission of variables representing income and the prices of substitute energy sources. As a result of these problems, Stevens, et al concluded that "the empirical comparisons presented by Polzin (1984) are inappropriate and may be misleading" (pp. 328).

Accordingly, Raffiee (1986) used the Hausman test to examine the hypothesis of endogeneity in the average price specification in the natural gas demand function estimated by Polzin (1984).[12] He concluded that the estimated coefficient for average price is biased away from zero, confirming the concern of Stevens, Adams, and Willis (1985); and he provided an alternative, unbiased, estimate generated by the use of instrumental variables.

In response to Raffiee's examination, Polzin (1986) concluded that, in his 1984 analysis, specification bias, "while it may exist, is not a significant problem given the level of statistical error in this case" (pp. 335). He argues that, "if these conditions are present in other cases, it suggests that specification biases do exist but are relatively small, and aggregate data and simple estimation techniques may be appropriate" (pp. 335).

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[12]He does not conduct a test of endogeneity bias using marginal price, expenditure differential, and gas bill specifications because the actual rate structure data are not available.

In 1982, Opaluch suggested a single equation econometric model to determine whether consumers respond to average price or to marginal price. Thus, the question of whether use of the average price leads to simultaneous equations bias has not been fully resolved. Up to 1982 the issue of whether the average or marginal price was the more appropriate was also an open question. And the empirical side of that question had been examined by looking at alternative specification of demand. (We will discuss his single equation econometric model in detail in Chapter IV.)

Charney and Woodard (1984), however, pointed out two logical inconsistencies in Opaluch's test: (1) the lagged value of the average price is the appropriate measure for uninformed consumers, rather than the current average price; (2) no income adjustment term should be included for consumers who respond to average price. Hence, they provided modifications including the lagged average price and a reformed income term.

In reply, Opaluch (1984) defended his econometric specification, by arguing that, with respect to Charney and Woodard's point (1), the lagged and current values of average price will likely produce essentially identical results; and with respect to point (2), his demand function can be derived mathematically. (Again his specification is more fully discussed in Chapter IV.)

Chicoine and Ramamurthy (1986) empirically examined the hypothesis concerning the price to which consumers respond under block pricing, using the procedures proposed by Opaluch (1982).[13] They used household level, pooled time-series and cross-sectional data from a sample of Illinois rural water district customers. They concluded that "neither the marginal price model nor the average price model could be rejected" (pp. 31), suggesting that customers react to both measures of price.

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[13]The following model was used: $Q_{it} = f(M_t, P1_{it}, P2_{it}, INC_{it}, NUMRES_i, BATH_i)$, where $Q_{it}$ is water consumption by household *i* in month *t*; $M_t$ is a monthly binary variable; $P1_{it}$ is the marginal price paid by the *i*th household in month *t*; $P2_{it}$ is the second decomposed price variable for the *i*th household in month *t*; $INC_{it}$ is the monthly income of household *i* less the income effect of the block rate structure for month *t*; $NUMRES_i$ is the size of household *i* measured by the number of persons; and $BATH_i$ is the number of bathrooms in household *i*.

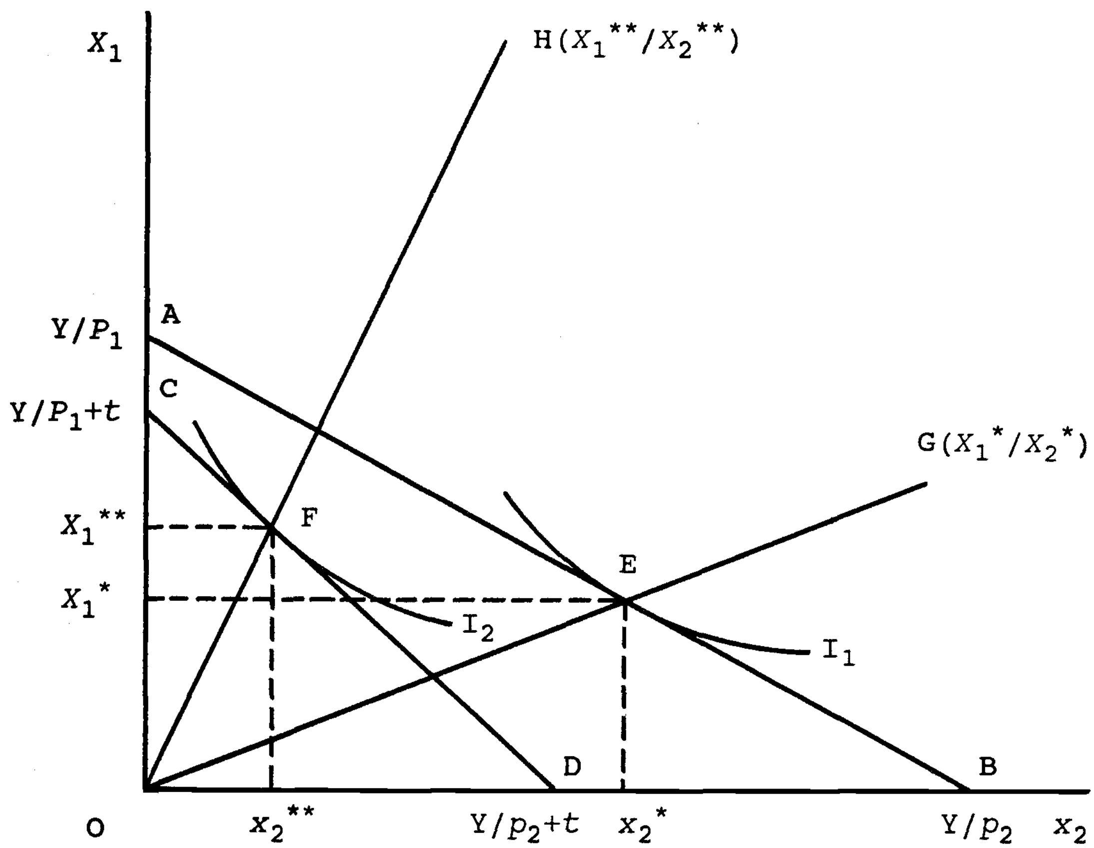
# III. THEORETICAL MODEL

## The Original Alchian and Allen Proposition

The original Alchian and Allen proposition was presented in a two-goods world, involving a higher-quality goods, $x_1$, with higher price $p_1$ and a lower-quality goods, $x_2$, with lower price $p_2$. Their proposition can be graphically illustrated on a two-dimensional graph as in Figure 3.

The higher-quality goods $x_1$ with price $p_1$ is depicted on the vertical axis and the lower-quality goods $x_2$ with lower price $p_2$ is depicted on the horizontal axis. Assuming that the individual consumer has income Y, hence, she faces a budget line AB, where $p_1 > p_2$ is assumed so that the slope of AB is less than one in absolute value. In this circumstance, the utility-maximizing consumer purchases the bundle $(x_1^*, x_2^*)$ at point E, which is the point of tangency with the consumer's indifference curve $I_1$. The slope of line OG, $x_1^*/x_2^*$, gives the consumption ratio of $x_1$ to $x_2$. If a transportation or other "fixed" charge, $t$, is added equally to prices $p_1$ and $p_2$, the consumer having the same income and utility function will operate on the new budget line CD (which is steeper than AB). She will then choose a new bundle $(x_1^{**}, x_2^{**})$ at point F, tangent to indifference curve $I_2$. Hence, the slope of line OH, presenting the new

Figure 3. Original Alchian and Allen Proposition.

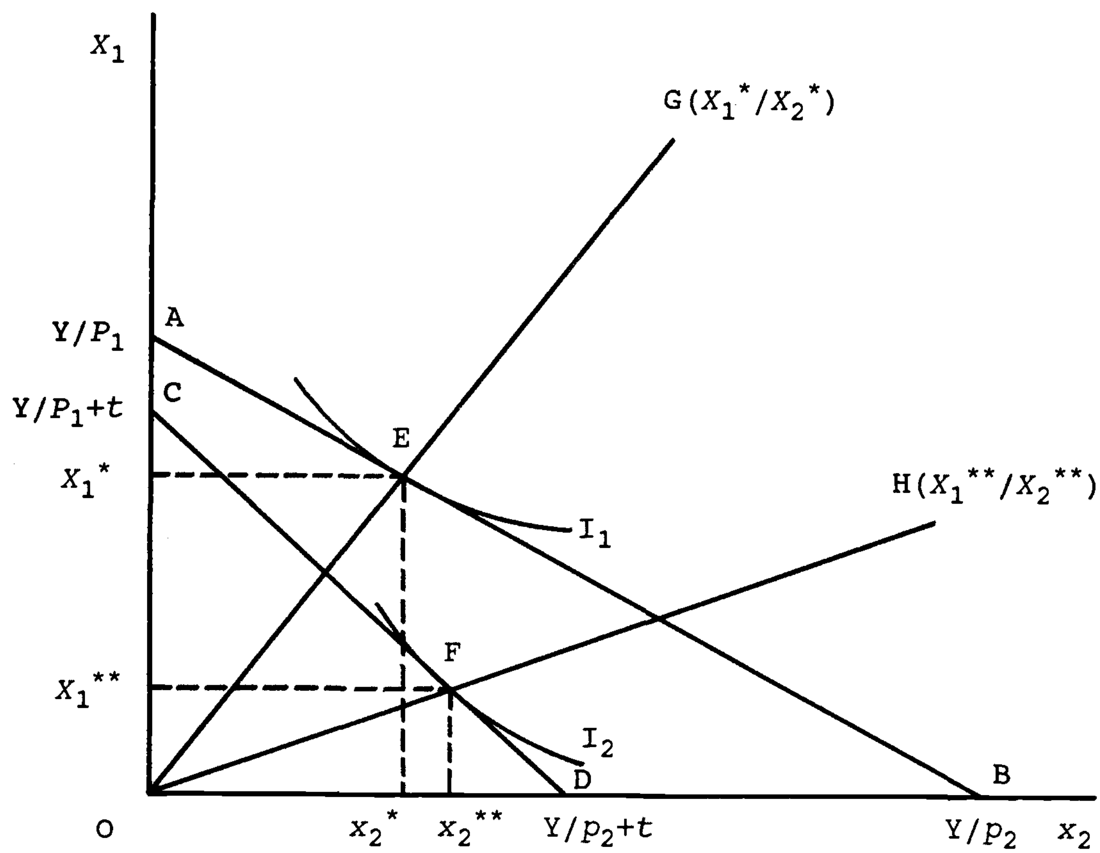


consumption ratio between $x_1$ and $x_2$, becomes steeper than the original line OG ($x_1^{**}/x_2^{**} > x_1^{*}/x_2^{*}$). Therefore, consumption of the higher-quality goods $x_1$ (relative to the lower-quality goods $x_2$) will increase as the "fixed" cost $t$ is added equally to both prices $p_1$ and $p_2$ ($p_1 > p_2$).

However, Alchian and Allen proposition requires one important assumption: that no income effect exists (*i.e.*, income changes are compensated). This assumption was suggested by Gould and Segal (1969). They showed that, if the lower-quality goods is an inferior goods and an income effect is permitted, then the proposition may no longer hold, indicating that the "no income effect" assumption is important in the application of Alchian and Allen proposition. This situation is illustrated in figure 4.

The consumer first purchases the bundle ($x_1^{*}$, $x_2^{*}$) at point E, facing a budget line AB. Then, if the fixed cost $t$ is added equally to both prices $p_1$ and $p_2$, the budget line AB changes to CD. (So far, everything is the same as before.) If $x_2$ is an inferior goods, however, the utility maximizing consumer switches from the higher-quality goods $x_1$ to the inferior goods $x_2$. Therefore, the consumer will choose the new bundle ($x_1^{**}$, $x_2^{**}$) at point F ($x_1^{**} < x_1^{*}$). The slope of line OH, presenting the consumption ratio of $x_1$ to $x_2$ becomes flatter than the original line OG ($x_1^{**}/x_2^{**} < x_1^{*}/x_2^{*}$).

Figure 4. Counterexample of Alchian and Allen Proposition.



This phenomenon is always a possibility if the lower-quality goods $x_2$ is an inferior goods. Thus no income effect is an important assumption in the Alchian and Allen proposition. Then, in the real world, we further have to consider more than the two goods of the Alchian and Allen formulation. This is discussed next.

## The Borcherding and Silberberg Formulation

The theoretical model of the Alchian and Allen proposition is reformulated by Gould and Segal (1969)[14], and Borcherding and Silberberg (1978). Both models are algebraically demonstrated by use of the composite commodity theorem[15] and Hicks' law. Although they are very similar, the latter model is made more tractable by use of Hicks' third law[16]; hence, the latter model is discussed here.

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[14]Their formulation uses Samuelson's development of the theory of consumer behavior (Samuelson 1948, pp. 90-124).

[15]The composite commodity theorem states that if the prices for a group of $k$ (<n) commodities always change in the same proportion in n-commodity space, the aggregate demand for the $k$ commodities behaves as if they were a single commodity (Henderson and Quandt 1986, pp. 48).

This was first introduced by John R. Hicks (Hicks 1939, pp. 312-313).

[16]Hicks' third law is derived from the homogeneity of degree zero of the compensated demand curves, $x_i^U = x_i^U(p_1, \cdots, p_n, U^0)$, with respect to prices. From Euler's theorem, we have:

$$p_1 \cdot \partial x_i^U / \partial p_1 + \cdots + p_n \cdot \partial x_i^U / \partial p_n \equiv 0.$$

Letting $s_{ij} = \partial x_i^U / \partial p_j$, the pure substitution effect on $x_i^U$ of a change in $p_j$, we have:

$$p_1 s_{i1} + p_2 s_{i2} + \cdots + p_n s_{in} \equiv 0.$$

Suppose that we have a three-goods world, where goods $x_1$, $x_2$, and $x_3$ have prices $p_1$, $p_2$, and $p_3$, respectively, and where $x_3$ is a composite commodity representing all other goods. Let $x_1$ and $x_2$ be, respectively, the higher-quality and lower-quality goods, so that $p_1 > p_2$. Assume further that $x_1$ and $x_2$ are transported from another location, with a unit transport cost $t$, and $x_3$ is produced locally, producing a set of prices $p_1 + t$, $p_2 + t$ and $p_3$. (In the restaurant example, $t$ is a unit cost of restaurant services.)

In this situation, we can set up the dual (expenditure minimization) problem. The objective function is given by

$$M = (p_1 + t)x_1 + (p_2 + t)x_2 + p_3x_3, \qquad \text{subject to} \quad U(x_1, x_2, x_3) = U^0. \tag{1}$$

However, the consumer perceives the price $p_1^*$ $(= p_1 + t)$, $p_2^*$ $(= p_2 + t)$, and $p_3^*$ $(= p_3)$; since she does not know the commodities price, $p_i$, and a unit transport or restaurant services cost, $t$, separately.[17] Hence, the objective

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However, for compensated changes $s_{ij} = s_{ji}$; hence,

$$p_1s_{1i} + p_2s_{2i} + \cdots + p_ns_{ni} \equiv 0.$$

These results are known as Hicks' third law. The law can be stated succinctly as

$$\Sigma^n_{i=1}p_is_{ij} = \Sigma^n_{j=1}p_js_{ij} = 0.$$

Hicks' first two laws are, respectively, $s_{ij} = s_{ji}$, $s_{ii} < 0$. (Silberberg 1990, pp. 342-343).

[17]This point was suggested by Dumagan (Economic Research Service, USDA) in his helpful correspondence (Dumagan 1993, pp. 3-5).

function above for the consumer is represented as

$$M = p_1^* x_1 + p_2^* x_2 + p_3^* x_3,$$

$$\text{subject to} \quad U(x_1, x_2, x_3) = U^0. \tag{2}$$

From the solution to this problem, the income compensated demand functions are derived (Binger and Hoffman 1988, pp. 183-193). The generalized forms of these compensated demand functions for each of the three commodities will be

$$\begin{aligned} x_1^U &= x_1^U(p_1^*, p_2^*, p_3^*, U^0) \\ x_2^U &= x_2^U(p_1^*, p_2^*, p_3^*, U^0) \\ x_3^U &= x_3^U(p_1^*, p_2^*, p_3^*, U^0). \end{aligned} \tag{3}$$

These are demand functions which hold utility constant and allow income to vary. We consider only compensated demand here because income effects are always indeterminate.

According to Borcherding and Silberberg (1978), Alchian and Allen proposition can be stated as

$$\frac{\partial \left( \frac{x_1^U}{x_2^U} \right)}{\partial t} > 0. \tag{4}$$

That is, as the transport or the restaurant services cost rises, consumption of the higher-quality goods increases relative to that of the lower-quality goods, holding utility and the prices of all other goods constant.

Using the quotient rule, equation (4) expands as

$$\frac{\partial\left(\frac{x_1^U}{x_2^U}\right)}{\partial t} = \frac{1}{\left(x_2^U\right)^2}\left(x_2^U\frac{\partial x_1^U}{\partial t} - x_1^U\frac{\partial x_2^U}{\partial t}\right). \tag{5}$$

An increase in $t$ is equivalent to increasing $p_1{}^*$ and $p_2{}^*$ by the equal amount; hence, $\partial x_i{}^U/\partial t = \partial x_i{}^U/\partial p_1{}^* + \partial x_i{}^U/\partial p_2{}^*$, i = 1,2,3.[18] Letting $s_{ij} = \partial x_i/\partial p_j$, the Hicksian pure substitution terms[19], equation (5) is expressed as

$$\frac{\partial\left(\frac{x_1^U}{x_2^U}\right)}{\partial t} = \frac{x_1^U}{x_2^U}\left(\frac{s_{11}}{x_1^U} + \frac{s_{12}}{x_1^U} - \frac{s_{21}}{x_2^U} - \frac{s_{22}}{x_2^U}\right). \tag{6}$$

Let us convert these terms to elasticities. Letting $\epsilon_{ij} = (p_j{}^*/x_i{}^U)(\partial x_i{}^U/\partial p_j{}^*)$, equation (6) is further transformed to

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[18]This is derived from the compensated demand functions, equations (3). Taking the total differential for these equations (3), we have:

$dx_i{}^U = \partial x_i{}^U/\partial p_1{}^* \cdot \partial p_1{}^*/\partial t \cdot dt + \partial x_i{}^U/\partial p_2{}^* \cdot \partial p_2{}^*/\partial t \cdot dt + \partial x_i{}^U/\partial p_3{}^* \cdot \partial p_3{}^*/\partial t \cdot dt$.

Substituting $\partial p_1{}^*/\partial t = \partial p_2{}^*/\partial t = 1$ and $\partial p_3{}^*/\partial t = 0$, since $p_1{}^* = p_1 + t$, $p_2{}^* = p_2 + t$, and $p_3{}^* = p_3$; and dividing both sides by dt, we get:

$\partial x_i{}^U/\partial t = \partial x_i{}^U/\partial p_1{}^* + \partial x_i{}^U/\partial p_2{}^*$, i = 1,2,3.

[19]In this case, $\partial x_1/\partial t = \partial x_1/\partial p_1 + \partial x_1/\partial p_2 = s_{11} + s_{12}$; $\partial x_2/\partial t = \partial x_2/\partial p_1 + \partial x_2/\partial p_2 = s_{21} + s_{22}$.

$$\frac{\partial\left(\frac{x_1^U}{x_2^U}\right)}{\partial t} = \frac{x_1^U}{x_2^U}\left(\frac{\epsilon_{11}}{p_1^*} + \frac{\epsilon_{12}}{p_2^*} - \frac{\epsilon_{21}}{p_1^*} - \frac{\epsilon_{22}}{p_2^*}\right). \tag{7}$$

Dividing the equation of Hicks's third law, $\Sigma^n{}_{j=1}p_j{}^*s_{ij} = 0$, by $x_i$, we have:

$$\epsilon_{11} + \epsilon_{12} + \epsilon_{13} = 0$$

and (8)

$$\epsilon_{21} + \epsilon_{22} + \epsilon_{23} = 0.$$

Then, substituting these expressions for $\epsilon_{12}$ and $\epsilon_{22}$ into equation (7), we finally obtain:

$$\frac{\partial\left(\frac{x_1^U}{x_2^U}\right)}{\partial t} = \frac{x_1^U}{x_2^U}\left[(\epsilon_{11} - \epsilon_{21})\left(\frac{1}{p_1^*} - \frac{1}{p_2^*}\right) + (\epsilon_{23} - \epsilon_{13})\left(\frac{1}{p_2^*}\right)\right]. \tag{9}$$

Equation (9) shows the implication of Alchian and Allen proposition. Since $x_1{}^U$ is the higher-quality goods, $p_1{}^* > p_2{}^*$, so that $1/p_1{}^* - 1/p_2{}^* < 0$. Also, $\epsilon_{11} < 0$ because own price elasticity is negative and $\epsilon_{21} > 0$ because two qualities of the same goods are presumably substitutes[20]. Hence, the first term in the square brackets on the right

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[20]In general, $\epsilon_{ij} > 0$ if i and j are substitutes, $\epsilon_{ij} < 0$ if complements, and $\epsilon_{ij} = 0$ if unrelated.

hand side of the equation (9), the direct substitution effect, must be positive. The last term, however, the interaction effect of $x_1$ and $x_2$ with $x_3$, $(\epsilon_{23} - \epsilon_{13})$, is mathematically indeterminate.

Alchian and Allen proposition is that $\partial(x_1^U/x_2^U)/\partial t > 0$. Hence, this equation holds when either; first, only the first term is the entire expression in equation (9) (that is when a two-goods world is assumed, as demonstrated by Gould and Segal (1968)); second, the higher and lower-quality goods interact in the same manner with the composite goods $x_3$, that is, $\epsilon_{13} = \epsilon_{23}$; or third, the consumer substitutes $x_3$ for $x_2$ in greater proportion than $x_3$ for $x_1$, that is, $\epsilon_{23} > \epsilon_{13}$.

The "shipping the good apple out" issue was conceived of in a situation where the higher-quality goods, $x_1$, and the lower-quality version of the same goods, $x_2$, are fairly close substitutes. It is not necessary that the goods be "higher" and "lower" quality versions of the same goods, however, as long as they can be viewed as fairly close substitutes, where we can expect relatively high absolute values of $\epsilon_{11}$ and $\epsilon_{21}$, making the first term, $\epsilon_{11} - \epsilon_{21}$, in equation (9) relatively large. Moreover, the closer substitutes $x_1$ and $x_2$ are, the smaller their interaction with the composite commodity $x_3$ becomes, making the absolute values of $\epsilon_{13}$ and $\epsilon_{23}$ small. This means that the second term, $\epsilon_{23} - \epsilon_{13}$, in equation (9) will tend to be small.

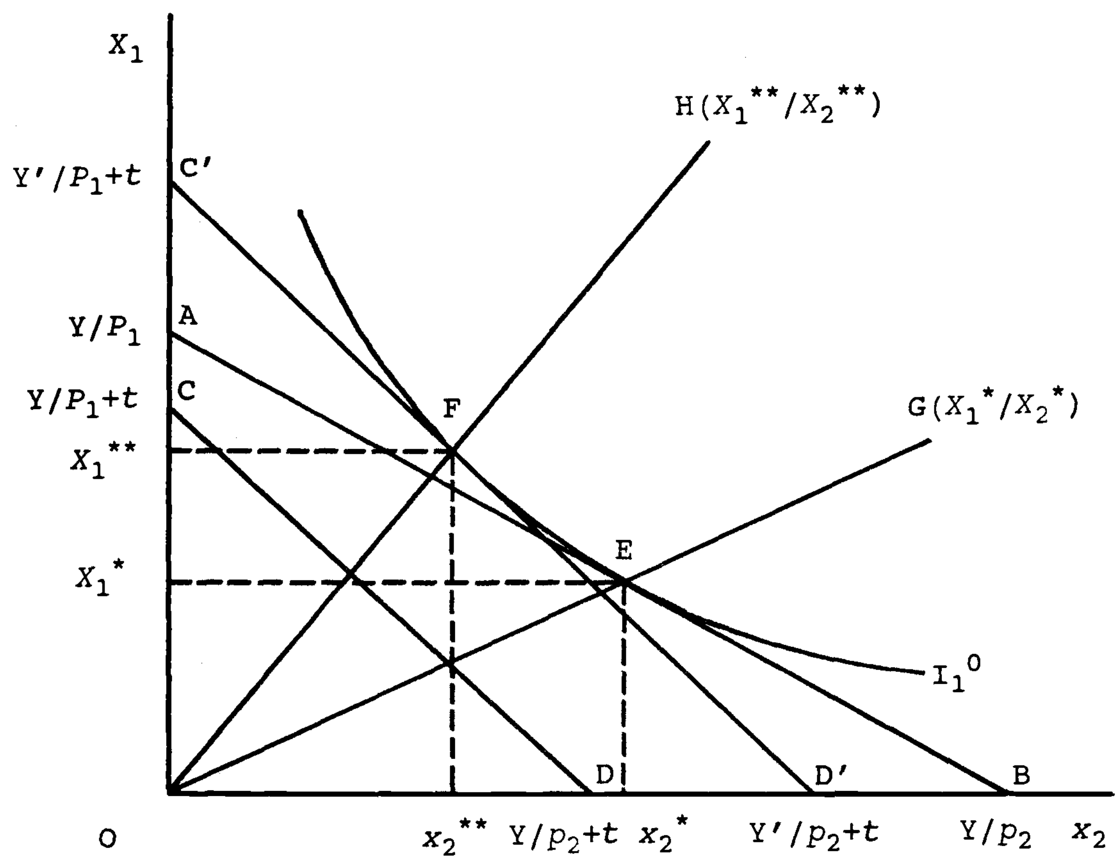
Therefore, equation (9) can be approximated by the first term in the square brackets as an empirical matter:

$$\frac{\partial\left(\frac{x_1^U}{x_2^U}\right)}{\partial t} \approx \frac{x_1^U}{x_2^U}(\epsilon_{11} - \epsilon_{21})\left(\frac{1}{P_1^*} - \frac{1}{P_2^*}\right). \tag{10}$$

This formulation is graphically illustrated in Figure 5. The utility-maximizing consumer facing a budget line AB purchases the bundle ($x_1^*$, $x_2^*$) at point E. Then, if the fixed cost $t$ is equally added to both prices $p_1$ and $p_2$, the budget line AB changes to CD. Since no income effect is assumed in this formulation, the consumer's income is compensated, that is, her income will increase from Y to Y' so that the consumer can reach the original indifference curve, $I_1^0$. This income compensation is described as a parallel shift of the budget line, so that the consumer now faces the new budget line C'D'. In this circumstance, the consumer will choose new bundle ($x_1^{**}$, $x_2^{**}$) at point F, tangent to the indifference curve $I_1^0$. The slope of line OH, representing the new consumption ratio between $x_1$ and $x_2$, becomes steeper than the original line OG ($x_1^{**}/x_2^{**} > x_1^*/x_2^*$).

Thus when $x_1$ and $x_2$ are close substitutes, as an empirical matter, Alchian and Allen proposition will hold; that is, consumption of the higher-quality goods should rise

Figure 5. Borcherding and Silberberg Formulation.



relative to that of the lower-quality goods, if the same fixed cost is added to the price of both goods.

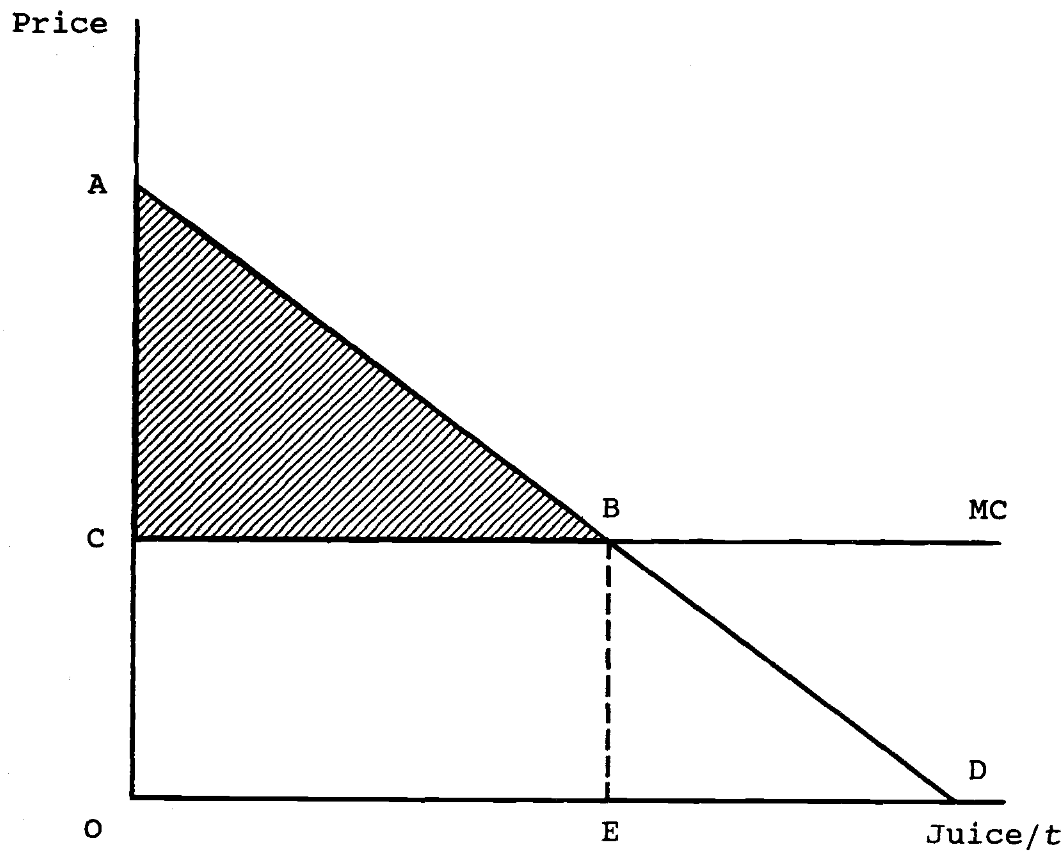
## The Umbeck Formulation

Another formulation of Alchian and Allen proposition is derived by Umbeck (1980). He points out that the Borcherding and Silberberg formulation is not useful in applying the proposition beyond the case of transport cost, because their *t* variable is assumed to be a non-economic goods. That is, the restaurant services are not fixed charge (non-economic goods) at all but merely a price for third goods. He argues that only transport costs and taxes qualify as such "non-economic goods". Hence, he suggests that, rather than viewing such a fixed charge as an addition to price, it should be thought of as an "entrance fee".

Consider a consumer with a linear and compensated demand curve for apple juice as illustrated in Figure 6. Assume that the marginal cost of producing a unit of apple juice is constant at OC and that all transaction costs are zero. Assume further that consumer demands are homogeneous across consumers. The shaded area, ABC, thus represents consumer surplus.

In a two-part tariff scheme involving an admission fee, customers are asked to pay a lump-sum fee for the right to buy any quantity of the goods, which has a uniform price.

Figure 6. Consumer Surplus.



Amusement parks, for example, charge an entrance fee before any service is offered, although there is no connection to the cost involved in letting a customer enter the park. In this case the profit-maximizing owner of the park charges an entrance fee equal to the customer's consumer surplus (Phlips 1983, pp. 160-163; Pindyck and Rubinfeld 1989, pp. 389-393).

Umbeck suggests viewing the "shipping the good apples out" proposition as an example of such two-part pricing. The goods demanded is apple juice and the entrance fee is what is charged for access to the juice (the skin). In Figure 6, the seller can charge up to ABC, the consumer surplus, for the right to purchase apple juice and then charge one price, OC (the marginal price), per unit.

In the case of one time period, the situation is as depicted in Figure 6. However, when we consider more than one time period, the situation changes. Assume that the quantity which the consumer purchases in each time period is inversely related to the quantities which she expects to purchase in the following time periods. To minimize the per unit cost, the consumer will reduce the number of times she buys apple juice and buy more juice each time.

With this background, consider Alchian and Allen proposition as follows. Suppose we have a higher-quality apple, $x_1$, and a lower-quality apple, $x_2$, with prices $p_1$ and $p_2$ respectively. Also assume that the price $p_1$ is double $p_2$

and that the higher-quality apple has two times as much juice as the lower-quality apple.

Now the apples are shipped out to another location at a cost of $t$ per apple, producing a set of prices $p_1+t$ and $p_2+t$. Payment of the fixed cost $t$ is always required in order to purchase an apple, a payment for the right to buy. Thus it can be regarded as an "entrance fee" because it fits the requirements of a fixed charge. It is an essential condition for obtaining access to both apples and it has no value of its own. Because the marginal price of juice has not changed and we have assumed compensated demand curves, those consumers who continue to buy apples will buy the same amount of juice. However, they will buy fewer apples in order to minimize this entrance fee, and therefore they will switch to the higher-quality apple with more juice.

According to Umbeck (1980), this formulation also avoids the problem raised by Gould and Segall that substitution effects with some third goods might destroy the "shipping the good apples out" effect.

Umbeck concludes, then, that the consumer increases the relative consumption of "high quality" to "low quality" apples not because their relative prices change but, rather, because this economizes on the payment of the entrance fee. However, he argues that this reasoning does not apply to the restaurant meal example because there is no comparable entrance fee in that case. The services provided by the restaurant are unlike transportation services in the restaurant or in the household: "... a nice, air-conditioned restaurant with a friendly waitress serving the food, a cook preparing the food, and a dishwasher to clean up afterward all have a value of their own" (Umbeck 1980, pp. 202).

If restaurants have a comparative advantage (over the household) in providing some of these services, the consumer will purchase more of them in the restaurant than at home. However, since there in no effect on the relative prices of the items, there is no reason to believe that the ratio of "high quality" to "low quality" food items consumed will be different at the restaurant than at home[21].

Thus, there are two views of the issue. If that portion of the price of a restaurant meal in excess of what the consumer would pay to eat the same meal at home can be thought of as analogous to a transportation cost, affecting relative prices, then the "shipping the good apples out" proposition will lead to the prediction that the ratio of "high quality" (higher priced) food items to "low quality" items consumed in restaurants will exceed the ratio pertaining to home consumption[22]. The alternative

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[21]That is, unless the substitutional relationships in consumption between services and the "high quality" food is different than that between services and the "low quality" food.

[22]Using Umbeck's reinterpretation of the Alchian and Allen proposition, one could argue that the charge for restaurant services is like an entrance fee in the same sense that charging a single price for a package that

hypothesis is that the services provided by a restaurant are not analogous to transportation services and, thus, the "high quality" to "low quality" ratio will be the same in the restaurant and home.

With these two alternative views of the Alchian and Allen proposition, it is appropriate to discuss ways to distinguish between them empirically. In so doing the literature on consumer response to block pricing, is helpful in developing the empirical specification so that it provides a critical test of competing hypothesis. We turn to this topic next.

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contains a razor and razor blades can be viewed as a case of multi-part pricing. The consumer pays the entrance fee associated with the razor plus a price per blade. Without blades, the razor is of little value to the consumer, although it could be priced independently of the blades. The higher the fixed charge the more likely is the consumer to purchase "high quality" (*i.e.*, longer-lasting) blades in order to minimize payment of the entrance fee. Viewed this way, the higher the price charged for restaurant services the less frequently the consumer will dine in restaurants but the more likely that, when she does, she will select higher quality food items.

# IV. ECONOMETRIC SPECIFICATION

## The Applied Opaluch Model

In the neoclassical theory of consumer behavior, the determinants of quantity demanded are the price of the goods, prices of related goods, income and tastes. Hence, the demand relationship can be represented simply by the following single equation model:

$$Q = f(p_1, p_2, Y). \tag{11}$$

In the Alchian and Allen proposition, the consumption ratio of two goods of different quality will be further affected by "fixed charge" variables such as transport cost $t$. In this case the demand function for goods that are shipped to a similar distance would be represented by

$$\frac{x_1}{x_2} = f(p_1, p_2, Y, t), \tag{12}$$

where:

$x_1/x_2$ = the ratio of the consumption of the higher-quality goods, $x_1$, to that of the lower-quality goods, $x_2$;

$p_1$ = the price of the higher-quality goods, $x_1$ at the point of origin;

$p_2$ = the price of the lower-quality goods, $x_2$, at the point of origin;

Y = consumer's income; and

$t$ = the unit transport cost.

As discussed in Chapter III, there are two alternative formulations of the Alchian and Allen proposition in the case of restaurant vs. at-home food consumption. Under the formulation by Borcherding and Silberberg, the "fixed" cost (added equally) causes the price ratio of the two goods to change; the higher-quality goods becomes relatively less expensive and, consequently, consumption of that goods increases relative to that of the lower-quality goods. In this formulation, the demand equation (the ratio of the consumption of the higher-quality goods to that of the lower-quality goods) can be characterized by

$$\frac{x_1}{x_2} = f\left(\frac{p_1 + t}{p_2 + t}\right), \tag{13}$$

where:

$x_1/x_2$ = the ratio of the consumption of the higher-quality goods, $x_1$, to that of the lower-quality goods, $x_2$; and

$p_1+t/p_2+t$ = the price ratio of $p_1$ to $p_2$ with $t$, now used to represent the restaurant's service cost, added equally.

Income term will now be dropped from the demand equation, since only the price term and fixed cost term, $t$, are considered in this study. Hence, the consumer's income is assumed to be fixed in econometric model and for this assumption, only one restaurant will be focused in empirical analysis.

On the other hand, under Umbeck formulation, the consumption ratio of the two goods is only affected, if at all, by payment of $t$ as an "up front" service charge, viewed much like an entrance fee, not by the change in price ratio but by the cost of services. Hence, the demand function (the consumption ratio of the higher to the lower- quality goods) would be described as

$$\frac{x_1}{x_2} = f\left(\frac{p_1}{p_2},\ t\right), \tag{14}$$

where:

$x_1/x_2$ = the ratio of the consumption of the higher-quality goods, $x_1$, to lower-quality goods, $x_2$;

$p_1/p_2$ = the price ratio of $x_1$ to $x_2$; and

$t$ = the unit cost of restaurant services (or entrance fee).

In the Borcherding and Silberberg formulation, consumers respond to the new price ratio with the fixed cost added equally, $p_1+t/p_2+t$. In the Umbeck model, however, the consumer's behavior does not depend on the new price ratio, but on the amount the payment of the service charge subtracts from her income and the substitutional relationships between the restaurant services and each of the two goods. The substitutional relationship is not observable, but the service charge is.

To test the competing hypotheses we draw on a similar debate in the literature on water demand (summarized in Chapter II) where the issue is whether consumers choose on the basis of average or marginal prices, when faced with a multi-pricing arrangement (Gibbs 1978; Foster and Beattie 1981b; Opaluch 1982; and Polzin 1984). To test these competing hypotheses Opaluch (1982) suggests a single equation econometric model:

$$Q = B_0 + B_1P_x + B_2MP + B_3(D/Q) + B_4(Y - D), \qquad (15)$$

where:

$Q$ = total purchases of the goods;

$P_x$ = a price index for other relevant goods;

$MP$ = the block price of Q, *i.e.*, marginal price;

$Y$ = consumer's income; and

$D$ = the expenditure difference between the actual utility bill and what the bill would have been if all Q units had been priced at the marginal price.[23]

A test of the competing hypothesis is: if consumers choose on the basis of the average price, then $B_2 = B_3$ so that the equation becomes: $Q = B_0 + B_1P_x + B_2MP + B_4(Y\text{-}D)$; if consumers choose on the basis of marginal price, then $B_3 = 0$ so that the equation turns into: $Q = B_0 + B_1P_x + B_2AP + B_4(Y\text{-}D)$.

Applying Opaluch's approach to our formulation of Alchian and Allen proposition, we have:

$$\frac{x_1}{x_2} = \alpha_0 + \alpha_1 t + \alpha_2\left(\frac{p_1}{p_2}\right) + \alpha_3\left(\frac{p_1 + t}{p_2 + t}\right), \qquad (16)$$

where:

$x_1/x_2$ = the ratio of the consumption of the higher-quality goods, $x_1$, to lower-quality goods, $x_2$;

$t$ = the unit cost of restaurant services (or entrance fee);

$p_1/p_2$ = the price ratio of $x_1$ to $x_2$; and

$p_1{+}t/p_2{+}t$ = the price ratio of $p_1$ to $p_2$ with $t$ added

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[23]D is Nordin's lump-sum income effect term (Nordin 1976, pp. 719). Average price can be shown as: $AP = MP + D/Q$ mathematically; therefore, if $B_2 = B_3$, this equation becomes: $Q = B_0 + B_1p_x + B_2AP + B_4(Y - D)$.

equally.[24]

Following Opaluch's hypothesis testing procedures, if consumers respond to the change in price ratio between $p_1$ and $p_2$ when the fixed cost is added equally, then $\beta_1 = \beta_2 = 0$ ($\beta_3$ is expected to be negative). Hence, the demand model can be written as Borcherding and Silberberg formulation:

$$\frac{x_1}{x_2} = \alpha_0 + \alpha_3\left(\frac{p_1 + t}{p_2 + t}\right). \tag{17}$$

Alternatively, if consumers treat $t$ as an entrance fee, then $\beta_3 = 0$ ($\beta_2$ is expected to be negative), and equation (16) reduces to Umbeck formulation:

$$\frac{x_1}{x_2} = \alpha_0 + \alpha_1 t + \alpha_2\left(\frac{p_1}{p_2}\right). \tag{18}$$

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[24]In private correspondence, Opaluch has pointed out that, strictly speaking, the two sets of competing hypotheses are not comparable. In the case of water demand, the lump sum variable, D, is paid independently of the number of units of the goods purchased. For the restaurant meal, the service charge, t, is paid each time a meal is consumed. This seems to be at the heart of the matter. Umbeck seems to be suggesting that units of the service can be purchased in varying quantities, independently of the number of meals consumed. Under the "fixed charge" alternative interpretation one could view the two goods, meals and units of service, as being different economic goods but sold in fixed proportions. These differing views no doubt underlie Silberberg's statement (1990, p. 387, footnote), "The resolution of the puzzle may lie in the economics of the way goods are bundled together".

Thus, to compare the validity of these alternative behavioral models, the following tests can be employed.

Test 1:

$H_0$: $\alpha_1 = 0$;

$H_A$: $\alpha_1 \neq 0$.

Test 2:

$H_0$: $\alpha_2 = 0$;

$H_A$: $\alpha_2 < 0$.

Test 3:

$H_0$: $\alpha_3 = 0$;

$H_A$: $\alpha_3 < 0$.

The possible outcomes from these three tests and their implications for the Alchian and Allen proposition are summarized in Table 1. Outcome 1 suggests that consumers react to the price ratio between $p_1$ and $p_2$ with $t$ added equally, *i.e.*, Borcherding and Silberberg formulation is correct. Outcome 2 proposes that consumers respond not to the $t$-laden price ratio but rather, treat $t$ as an entrance fee, so that Umbeck formulation is correct. Outcome 3 would indicate that consumers do not react to price at all. Outcome 4 is indeterminate. As Opaluch (1982) states, this indeterminacy may simply be a reflection of weak data. It may also arise if some consumers react to the price ratio between $p_1$ and $p_2$ with $t$ added equally while others react to

Table 1. Possible Four Results from Three Tests

| Outcome | Test 1 | Test 2 | Test 3 | Implications |
|---|---|---|---|---|
| 1 | $\alpha_1 = 0$ | $\alpha_2 = 0$ | $\alpha_3 < 0$ | Borcherding and Silberberg formulation |
| 2 | $\alpha_1 \neq 0$ | $\alpha_2 < 0$ | $\alpha_3 = 0$ | Umbeck formulation |
| 3 | $\alpha_1 = 0$ | $\alpha_2 = 0$ | $\alpha_3 = 0$ | No price response |
| 4 | Other Combinations | | | Indeterminate |

an entrance fee. Alternatively it might support a more general model of consumer behavior.

## An Alternative Model

In the preceding discussion of the theoretical model in Chapter III, the Borcherding and Silberberg formulation is stated as equation (9) in page 33, which uses the compensated demand function. Equation (9) shows that the ratio of compensated demand $x_1^U$ to $x_2^U$ is a function of $t$ and that the partial derivative of the ratio $x_1^U/x_2^U$ with respect to $t$ would be positive. Therefore, the demand model can be considered as Borcherding and Silberberg formulation:

$$\frac{x_1^U}{x_2^U} = \beta_0 + \beta_1 t, \tag{19}$$

where:

$x_1^U/x_2^U$ = the ratio of the compensated demand for the lower-quality goods, $x_1$, to lower-quality goods, $x_2$; and

$t$ = the unit cost of restaurant services.

On the other hand, Umbeck formulation asserts that the consumer chooses the higher-quality good relative to the lower-quality good not because their relative prices change but, rather, because of the entrance fee (income effect). Hence, the ratio of the compensated demands $x_1^U$ to $x_2^U$ is not affected by the restaurant service, $t$, as the entrance fee at all, since the compensated demand implies no income effects. The ratio of compensated demand depends on only the price ratio of $p_1$ to $p_2$. Thus, under Umbeck formulation, the demand model would be written as

$$\frac{x_1^U}{x_2^U} = \beta_0 + \beta_2\left(\frac{p_1}{p_2}\right), \tag{20}$$

where:

$x_1^U/x_2^U$ = the ratio of the compensated demand for the lower-quality goods, $x_1$, to lower-quality goods, $x_2$; and

$p_1/p_2$ = the price ratio of $x_1$ to $x_2$.

In order to test the competing hypotheses, we can form a single equation econometric model as suggested by the Opaluch version of the demand for water:

$$\frac{x_1^U}{x_2^U} = \beta_0 + \beta_1 t + \beta_2\left(\frac{p_1}{p_2}\right), \tag{21}$$

where:

$x_1^U/x_2^U$ = the ratio of the compensated demand of the higher-quality goods, $x_1$, to that of the lower-quality goods, $x_2$;

$t$ = the unit cost of restaurant services; and

$p_1/p_2$ = the price ratio of the higher-quality goods, $x_1$ to the lower-quality goods, $x_2$.

Then, assuming that the consumers have homothetic preferences, the ratio of compensated (Hicksian) demands, $x_1^U/x_2^U$ is equal to the ratio of observable Marshallian demands, $x_1/x_2$. That is, if preferences are homothetic, any ray through the origin cuts all of the indifference curves at points where the slope is the same (Deaton and Muellbauer 1991, pp. 143); hence, both Hicksian demand and Marshallian demand exist on the same ray through the origin (linear income-consumption path). Thus, the alternative econometric model would be (now $x_1^U/x_2^U$ is switched to $x_1/x_2$):

$$\frac{x_1}{x_2} = \beta_0 + \beta_1 t + \beta_2\left(\frac{p_1}{p_2}\right), \tag{22}$$

where:

$x_1/x_2$ = the ratio of the consumption of the higher-quality goods, $x_1$, to that of the lower-quality goods, $x_2$ (Marshallian demands);

$t$ = the unit cost of restaurant services; and

$p_1/p_2$ = the price ratio of the higher-quality goods, $x_1$ to the lower-quality goods, $x_2$.

To compare the validity of the competing formulations, the following tests can be employed.

Test 1:

$H_0$: $\beta_1 = 0$;

$H_A$: $\beta_1 > 0$.

Test 2:

$H_0$: $\beta_2 = 0$;

$H_A$: $\beta_2 < 0$.

The possible outcomes from above two tests and their implications are summarized in Table 2. Outcome 1 offers that Borcherding and Silberberg formulation is correct. Outcome 2 suggests that Umbeck formulation is right. Outcome 3 would propose that the consumers do not react to price at all. Finally, outcome 4 tells us that the result is indeterminate.

Equation (22) which captures all of the essential elements of equation (16) (Opaluch model) was chosen for the econometric investigation in this study.

Table 2. Possible Four Results from Two Tests

| Outcome | Test 1 | Test 2 | Implications |
|---|---|---|---|
| 1 | $\beta_1 > 0$ | $\beta_2 = 0$ | Borcherding and Silberberg formulation |
| 2 | $\beta_1 = 0$ | $\beta_2 < 0$ | Umbeck formulation |
| 3 | $\beta_1 = 0$ | $\beta_2 = 0$ | No price response |
| 4 | Other combinations | | Indeterminate |

# V. DATA

The data used in this study were collected from a Japanese restaurant in San Francisco. This restaurant is located in the financial district of downtown San Francisco. Most customers are business people and Caucasian Americans. The restaurant serves sea foods, beef, pork and chicken as the protein sources. There are 13 items on the lunch menu including sushi and those prices range from $8.95 to $13.50.

For this study, four menu items including the four main protein sources (salmon, beef, pork and chicken) were selected from the lunch menu: Salmon Teriyaki, New York Steak, Kotsuyaki (pork spare ribs) and Chicken Teriyaki. The average prices of these menu items were $10.50, $10.50, $9.25 and $8.95, respectively.

Then, for these four items, monthly data were collected for (1) the number of meals which were sold at lunch and (2) the input price of the protein source item for each meal, *i.e.*, the prices restaurant paid to its suppliers for salmon, beef, pork, and chicken. The data pertained to the period from May 1991 to December 1992, providing 20 observations.

Table 3 shows the monthly data for the number of each meal which was sold at lunch for the period from May 1991 to December 1992. From the table, Chicken Teriyaki was sold the most through the period, with the mean value of 415.3

Table 3. Monthly Data for the Number of the Meals Sold in the Study Restaurant, 1991/5 - 1992/12.

| Year/Month | Salmon Teriyaki | New York Steak | Kotsuyaki (pork) | Chicken Teriyaki |
|---|---|---|---|---|
| | (meals) | (meals) | (meals) | (meals) |
| 1991/ 5 | 114 | 93 | 126 | 411 |
| 6 | 98 | 87 | 106 | 388 |
| 7 | 77 | 101 | 98 | 453 |
| 8 | 97 | 103 | 140 | 460 |
| 9 | 106 | 77 | 96 | 369 |
| 10 | 83 | 118 | 118 | 447 |
| 11 | 81 | 80 | 104 | 381 |
| 12 | 94 | 100 | 115 | 465 |
| 1992/ 1 | 128 | 115 | 112 | 527 |
| 2 | 98 | 95 | 104 | 477 |
| 3 | 115 | 109 | 115 | 490 |
| 4 | 79 | 102 | 73 | 460 |
| 5 | 73 | 83 | 77 | 360 |
| 6 | 91 | 97 | 70 | 340 |
| 7 | 77 | 83 | 77 | 371 |
| 8 | 102 | 88 | 91 | 340 |
| 9 | 86 | 85 | 91 | 357 |
| 10 | 100 | 101 | 77 | 390 |
| 11 | 78 | 72 | 69 | 330 |
| 12 | 94 | 90 | 111 | 490 |
| Numbers | 20 | 20 | 20 | 20 |
| Mean | 93.55 | 93.95 | 98.50 | 415.3 |
| St. dev. | 14.763 | 12.407 | 20.127 | 59.867 |
| Variance | 217.94 | 153.94 | 405.11 | 3584.0 |
| Minimum | 73 | 72 | 69 | 330 |
| Maximum | 128 | 118 | 140 | 527 |

(meals per month) over four times higher than the others. The other three meals were almost sold even through the period, with the mean of 93.55 (meals per month) for Salmon Teriyaki, 93.95 (meals per month) for New York Steak and 98.50 (meals per month) for Kotsuyaki.

The input price data for the four protein sources are presented in Table 4. Prices are adjusted to yield per meal prices, taking into account the sizes of protein sources, as reported by the restaurant (the sizes of four protein sources in each meal were 7 oz. for salmon, 8 oz. for beef, 10 oz. for pork and 9 oz. for chicken). Salmon was the most expensive protein source costing $3.28125 per meal. Beef was the second, with the mean values of $1.9585 per meal. Pork and chicken had almost the same price, with mean prices of $0.94000 and $0.98438 per meal, respectively.

Unfortunately, the salmon and chicken prices were constant through the period. Because of these fixed prices, the combination of salmon and chicken cannot be used for the test. In addition, the menu prices of all four lunches were constant over the period. That is, for each protein source i, $p_i$ varied over the period of analysis (except salmon and chicken) but $p_i + t$ did not.

The econometric model used in this study, equation (22) in page 53, requires three variables: (1) the ratio of the consumption of the meal including the higher-quality protein source to that including the lower-quality protein source;

Table 4. Monthly Data for the Input Price of the Protein Sources in the Study Restaurant, 1991/5 - 1992/12.

| Year/Month | Salmon | Beef | Pork | Chicken |
|---|---|---|---|---|
| | ($/meal) | ($/meal) | ($/meal) | ($/meal) |
| 1991/ 5 | 3.28125 | 1.900 | 1.03750 | 0.98438 |
| 6 | 3.28125 | 1.885 | 0.96875 | 0.98438 |
| 7 | 3.28125 | 1.885 | 0.96875 | 0.98438 |
| 8 | 3.28125 | 1.840 | 0.96875 | 0.98438 |
| 9 | 3.28125 | 1.775 | 0.96875 | 0.98438 |
| 10 | 3.28125 | 1.830 | 0.87500 | 0.98438 |
| 11 | 3.28125 | 1.760 | 0.86250 | 0.98438 |
| 12 | 3.28125 | 1.680 | 0.81250 | 0.98438 |
| 1992/ 1 | 3.28125 | 1.935 | 0.84375 | 0.98438 |
| 2 | 3.28125 | 1.975 | 0.84375 | 0.98438 |
| 3 | 3.28125 | 1.975 | 0.93125 | 0.98438 |
| 4 | 3.28125 | 2.025 | 0.93125 | 0.98438 |
| 5 | 3.28125 | 2.395 | 1.01250 | 0.98438 |
| 6 | 3.28125 | 2.325 | 1.13125 | 0.98438 |
| 7 | 3.28125 | 2.195 | 0.94375 | 0.98438 |
| 8 | 3.28125 | 1.985 | 1.21875 | 0.98438 |
| 9 | 3.28125 | 1.925 | 0.90000 | 0.98438 |
| 10 | 3.28125 | 1.910 | 0.85625 | 0.98438 |
| 11 | 3.28125 | 1.975 | 0.85625 | 0.98438 |
| 12 | 3.28125 | 1.995 | 0.86875 | 0.98438 |
| Numbers | 20 | 20 | 20 | 20 |
| Mean | 3.28125 | 1.9585 | 0.94000 | 0.98438 |
| St. dev. | 0 | 0.17584 | 0.10214 | 0 |
| Variance | 0 | 0.030921 | 0.010433 | 0 |
| Minimum | 3.28125 | 1.6800 | 0.81250 | 0.98438 |
| Maximum | 3.28125 | 2.3950 | 1.2188 | 0.98438 |

(2) the price ratio of the higher-quality protein source to the lower-quality protein source; and (3) the unit cost of restaurant services.

The first two variables can be directly calculated from the collected data. For the third variable we need to assume that the restaurant service price is simply the difference between the menu price and the price of the protein source items which the restaurant purchases from a supplier. Under this assumption, the unit cost of the restaurant service, which now includes the other item in the meal, is calculated by subtracting the protein source item price from the menu price.

By this way, the three variables were calculated from the collected data and presented in table 5, 6 and 7. Salmon, beef, pork and chicken are symbolized by S, B, P and C, respectively in those tables. (They are explained in next Chapter in detail.)

In table 7, the unit costs of restaurant services for salmon and chicken were constant at $7.21875 per meal ($10.50 - $3.28125) and $7.96562 per meal ($8.95 - $0.98438), respectively. The average unit cost of restaurant services calculated for beef is $8.5415 per meal ($10.50 - $1.9585), and for pork is $8.31000 per meal ($9.25 - $0.94000). The average $t$ values are similar for all of the meals but Salmon Teriyaki.

Table 5. Calculated Monthly Data for Dependent Variable, the Ratio of the Consumption, $x_1/x_2$.

| Yr./Month | XSXB | XSXP | XBXC | XBXP | XCXP |
|---|---|---|---|---|---|
| 91/ 5 | 1.225806 | 0.9047619 | 0.2262774 | 0.7380952 | 3.261905 |
| 6 | 1.126437 | 0.9245283 | 0.2242268 | 0.8207547 | 3.660377 |
| 7 | 0.7623762 | 0.7857143 | 0.2229581 | 1.030612 | 4.622449 |
| 8 | 0.9417476 | 0.6928571 | 0.2239130 | 0.7357143 | 3.285714 |
| 9 | 1.376623 | 1.104167 | 0.2086721 | 0.8020833 | 3.843750 |
| 10 | 0.7033898 | 0.7033898 | 0.2639821 | 1.000000 | 3.788136 |
| 11 | 1.012500 | 0.7788462 | 0.2099738 | 0.7692308 | 3.663462 |
| 12 | 0.9400000 | 0.8173913 | 0.2150538 | 0.8695652 | 4.043478 |
| 92/ 1 | 1.113043 | 1.142857 | 0.2182163 | 1.026786 | 4.705357 |
| 2 | 1.031579 | 0.9423077 | 0.1991614 | 0.9134615 | 4.586538 |
| 3 | 1.055046 | 1.000000 | 0.2224490 | 0.9478261 | 4.260870 |
| 4 | 0.7745098 | 1.082192 | 0.2217391 | 1.397260 | 6.301370 |
| 5 | 0.8795181 | 0.9480519 | 0.2305556 | 1.077922 | 4.675325 |
| 6 | 0.9381443 | 1.300000 | 0.2852941 | 1.385714 | 4.857143 |
| 7 | 0.9277108 | 1.000000 | 0.2237197 | 1.077922 | 4.818182 |
| 8 | 1.159091 | 1.120879 | 0.2588235 | 0.9670330 | 3.736264 |
| 9 | 1.011765 | 0.9450549 | 0.2380952 | 0.9340659 | 3.923077 |
| 10 | 0.9900990 | 1.298701 | 0.2589744 | 1.311688 | 5.064935 |
| 11 | 1.083333 | 1.130435 | 0.2181818 | 1.043478 | 4.782609 |
| 12 | 1.044444 | 0.8468468 | 0.1836735 | 0.8108108 | 4.414414 |
| No. | 20 | 20 | 20 | 20 | 20 |
| Mean | 1.0049 | 0.97345 | 0.22770 | 0.98300 | 4.3148 |
| St.d. | 0.15987 | 0.17659 | 0.023615 | 0.19803 | 0.71894 |
| Var. | 0.025559 | 0.031185 | 0.0005577 | 0.039216 | 0.51687 |
| Min. | 0.70339 | 0.69286 | 0.18367 | 0.73571 | 3.2619 |
| Max. | 1.3766 | 1.3000 | 0.28529 | 1.3973 | 6.3014 |

Table 6. Calculated Monthly Data for Independent Variable, the Price Ratio of $x_1$ to $x_2$, $p_1/p_2$.

| Yr./Month | PSPB | PSPP | PBPC | PBPP | PCPP |
|---|---|---|---|---|---|
| 91/ 5 | 1.726974 | 3.162651 | 1.930149 | 1.831325 | 0.9488000 |
| 6 | 1.740716 | 3.387097 | 1.914911 | 1.945806 | 1.016124 |
| 7 | 1.740716 | 3.387097 | 1.914911 | 1.945806 | 1.016134 |
| 8 | 1.783288 | 3.387097 | 1.869197 | 1.899355 | 1.016134 |
| 9 | 1.848592 | 3.387097 | 1.803165 | 1.832258 | 1.016134 |
| 10 | 1.793033 | 3.750000 | 1.859038 | 2.091429 | 1.125006 |
| 11 | 1.864347 | 3.804348 | 1.787927 | 2.040580 | 1.141310 |
| 12 | 1.953125 | 4.038462 | 1.706658 | 2.067692 | 1.211545 |
| 92/ 1 | 1.695736 | 3.888889 | 1.965704 | 2.293333 | 1.166673 |
| 2 | 1.661392 | 3.888889 | 2.006339 | 2.340741 | 1.166673 |
| 3 | 1.661392 | 3.523490 | 2.006339 | 2.120805 | 1.057052 |
| 4 | 1.620370 | 3.523490 | 2.057132 | 2.174497 | 1.057052 |
| 5 | 1.370042 | 3.240741 | 2.433004 | 2.365432 | 0.9722272 |
| 6 | 1.411290 | 2.900552 | 2.361893 | 2.055249 | 0.8701702 |
| 7 | 1.494875 | 3.476821 | 2.229830 | 2.325828 | 1.043052 |
| 8 | 1.653023 | 2.692308 | 2.016498 | 1.628718 | 0.8076964 |
| 9 | 1.704545 | 3.645833 | 1.955546 | 2.138889 | 1.093756 |
| 10 | 1.717932 | 3.832117 | 1.940308 | 2.230657 | 1.149641 |
| 11 | 1.661392 | 3.832117 | 2.006339 | 2.306569 | 1.149641 |
| 12 | 1.644737 | 3.776978 | 2.026656 | 2.296403 | 1.133099 |
| No. | 20 | 20 | 20 | 20 | 20 |
| Mean | 1.6874 | 3.5263 | 1.9896 | 2.0966 | 1.0579 |
| St.d. | 0.14149 | 0.34775 | 0.17863 | 0.20298 | 0.10432 |
| Var. | 0.020018 | 0.12093 | 0.031910 | 0.041200 | 0.010884 |
| Min. | 1.3700 | 2.6923 | 1.7067 | 1.6287 | 0.80770 |
| Max. | 1.9531 | 4.0385 | 2.4330 | 2.3654 | 1.2115 |

Table 7. Calculated Monthly Data for Independent Variable, the Unit Cost of Restaurant Services, *t*.

| Yr./Month | TS | TB | TP | TC | TBTP |
|---|---|---|---|---|---|
| 91/ 5 | 7.21875 | 8.600000 | 8.212500 | 7.96562 | 1.047184 |
| 6 | 7.21875 | 8.615000 | 8.281250 | 7.96562 | 1.040302 |
| 7 | 7.21875 | 8.615000 | 8.281250 | 7.96562 | 1.040302 |
| 8 | 7.21875 | 8.660000 | 8.281250 | 7.96562 | 1.045736 |
| 9 | 7.21875 | 8.725000 | 8.281250 | 7.96562 | 1.053585 |
| 10 | 7.21875 | 8.670000 | 8.375000 | 7.96562 | 1.035224 |
| 11 | 7.21875 | 8.740000 | 8.387500 | 7.96562 | 1.042027 |
| 12 | 7.21875 | 8.820000 | 8.437500 | 7.96562 | 1.045333 |
| 92/ 1 | 7.21875 | 8.565000 | 8.406250 | 7.96562 | 1.018885 |
| 2 | 7.21875 | 8.525000 | 8.406250 | 7.96562 | 1.014126 |
| 3 | 7.21875 | 8.525000 | 8.318750 | 7.96562 | 1.024793 |
| 4 | 7.21875 | 8.475000 | 8.318750 | 7.96562 | 1.018783 |
| 5 | 7.21875 | 8.105000 | 8.237500 | 7.96562 | 0.9839150 |
| 6 | 7.21875 | 8.175000 | 8.118750 | 7.96562 | 1.006928 |
| 7 | 7.21875 | 8.305000 | 8.306250 | 7.96562 | 0.9998495 |
| 8 | 7.21875 | 8.515000 | 8.031250 | 7.96562 | 1.060233 |
| 9 | 7.21875 | 8.575000 | 8.350000 | 7.96562 | 1.026946 |
| 10 | 7.21875 | 8.590000 | 8.393750 | 7.96562 | 1.023380 |
| 11 | 7.21875 | 8.525000 | 8.393750 | 7.96562 | 1.015637 |
| 12 | 7.21875 | 8.505000 | 8.381250 | 7.96562 | 1.014765 |
| No. | 20 | 20 | 20 | 20 | 20 |
| Mean | 7.21875 | 8.5415 | 8.3100 | 7.96562 | 1.0279 |
| St.d. | 0 | 0.17584 | 0.10214 | 0 | 0.01937 |
| Var. | 0 | 0.030921 | 0.010433 | 0 | 0.00038 |
| Min. | 7.21875 | 8.1050 | 8.0313 | 7.96562 | 0.98392 |
| Max. | 7.21875 | 8.8200 | 8.4375 | 7.96562 | 1.0602 |

There is a variation in the monthly *t* values for beef and pork. This presents some difficulty for the analysis. However, the assumption of a constant *t* is not crucial to the Borcherding and Silberberg formulation of the argument, although it does provide some difficulty in calculating the true *t* values under the Umbeck formulation. In the latter case, while *t* can change over time, it is difficult to know which is the "correct" value for a given data. In this analysis only those *t* values showing variation over time were used.

# VI. ESTIMATION AND TEST RESULTS

There are five combinations of higher-quality and lower-quality protein sources. Because the salmon and chicken input prices are constant in the collected data set (this makes the prices ratio variable constant), the combination of salmon and chicken is excluded. The ratios considered are salmon to beef, salmon to pork, beef to chicken and beef to pork. The models for these five combinations are as follows:

I $XSXB_t = \gamma_0 + \gamma_1 TB_t + \gamma_2 PSPB_t$;

II $XSXP_t = \gamma_0 + \gamma_1 TP_t + \gamma_2 PSPP_t$;

III $XBXC_t = \gamma_0 + \gamma_1 TB_t + \gamma_2 PBPC_t$;

IV $XCXP_t = \gamma_0 + \gamma_1 TP_t + \gamma_2 PCPP_t$; and

V $XBXP_t = \gamma_0 + \gamma_1 TB_t$ (or $\gamma_1 TP_t$) $+ \gamma_2 PBPP_t$,

where:

$XSXB_t$ = the ratio of consumption of Salmon Teriyaki to that of New York Steak;

$XSXP_t$ = the ratio of consumption of Salmon Teriyaki to that of Kotsuyaki (pork);

$XBXC_t$ = the ratio of consumption of New York Steak to that of Chicken Teriyaki;

$XCXP_t$ = the ratio of consumption of Chicken Teriyaki to that of Kotsuyaki (pork);

$XBXP_t$ = the ratio of consumption of New York Steak to that of Kotsuyaki (pork);

$TB_t$ = the unit cost of restaurant services calculated by beef price (New York Steak price, $10.50 minus beef price);

$TP_t$ = the unit cost of restaurant services calculated by pork price (Kotsuyaki price, $9.25 minus pork price);

$PSPB_t$ = the input price ratio of salmon to beef;

$PSPP_t$ = the input price ratio of salmon to pork;

$PBPC_t$ = the input price ratio of beef to chicken;

$PCPP_t$ = the input price ratio of chicken to pork; and

$PBPP_t$ = the input price ratio of beef to pork.

In the model I, II, III and IV, however, the independent variables are highly correlated with each other. Table 8 presents the correlation matrix of variables for the four models. In the model I, II, III and IV, the correlation coefficient between the price ratio variable and the restaurant service variable is 0.99324, 0.99203, -1.0000 (perfect collinearity) and 0.99203, respectively. These values are extremely high, indicating that multicollinearity is a severe problem.

Since the salmon and chicken prices are constant through the period, the movement of the price ratio variable closely tracks changes in the beef and pork prices, which

Table 8. Correlation Matrix of Variables

Model I:

| | | | |
|---|---|---|---|
| XSXB | 1.0000 | | |
| TB | 0.21751 | 1.0000 | |
| PSPB | 0.20121 | 0.99324 | 1.0000 |
| | XSXB | TB | PSPB |

Model II:

| | | | |
|---|---|---|---|
| XSXP | 1.0000 | | |
| TP | -0.26788 | 1.0000 | |
| PSPP | -0.23562 | 0.99203 | 1.0000 |
| | XSXP | TP | PSPP |

Model III:

| | | | |
|---|---|---|---|
| XBXC | 1.0000 | | |
| TB | -0.31539 | 1.0000 | |
| PBPC | -0.23562 | -1.0000 | 1.0000 |
| | XBXC | TB | PBPC |

Model IV:

| | | | |
|---|---|---|---|
| XCXP | 1.0000 | | |
| TP | 0.17205 | 1.0000 | |
| PCPP | 0.16898 | 0.99203 | 1.0000 |
| | XCXP | TP | PCPP |

Model V:

| | | | | |
|---|---|---|---|---|
| XBXP | 1.0000 | | | |
| TB | -0.56429 | 1.0000 | | |
| TP | -0.13281 | 0.44543 | 1.0000 | |
| PBPP | 0.36068 | -0.41469 | 0.62319 | 1.0000 |
| | XBXP | TB | TP | PBPP |

are also used to calculate the values of the restaurant services variable. Because of this multicollinearity, the models I, II, III and IV can not be used for the hypothesis testing since their results are too unreliable.

On the other hand, in the model V, the correlation coefficient between TB and PBPP is -0.41469, and also that between TP and PBPP is 0.62319. These values indicates there is no serious multicollinearity problem. Hence, the model V is employed for the hypothesis testing in this study.

In the model V, there are two restaurant service variables TB and TP. These add some difficulty for the analysis. Since TB and TP are not the same, they violate the assumption of Alchian and Allen proposition (*t* is added equally to the price of both goods). That is, by adding *t*, the relative price of the higher-quality goods is reduced. From our assumption on the restaurant service variable (it is simply the difference between the menu price and the input price of the protein sources), when the relevant *t* is added equally to the price of beef and pork, the relative price of beef to pork becomes PB + TB / PP + TP, which can be further transformed as

$$\frac{PB + TB}{PP + TP} = \frac{PB + \left(\frac{TB}{TP}\right)TP}{PP + TP} = \frac{PB + TB}{PP + \left(\frac{TP}{TB}\right)TB}. \qquad (23)$$

Hence, if TP is used as the restaurant service variable, it should be added both to the price of beef (TB) and pork (TP). However, in this case, the numerator will be PB + (TB/TP)TP instead of PB + TB as in equation (23). However, the value of TB/TP is very much close to 1, with the mean value of 1.0279 (the minimum value of 0.98392 and the maximum value of 1.0602) so that (TB/TP)TP is almost equal to TP. Therefore, by adding TP, the relative price of beef to pork would be reduced as Alchian and Allen proposition predicted. The result is the same if TB is used instead of TP since TP/TB is just reciprocal of TB/TP.

Hence, two models to be used in hypothesis testing are as follows:

A $\quad XBXP_t = \delta_0 + \delta_1 TB_t + \delta_2 PBPP_t$; and

B $\quad XBXP_t + \delta_0 + \delta_1 TB_t + \delta_2 PBPP_t$.

The model A uses TB as the restaurant service variable and the model B employs TP.

The empirical estimates of the model V are presented in Table 9. Ordinary least squares is used for the estimation. In the first column of the Table (model A), TB is used as the variable of the unit cost of restaurant services, and the second column of the Table (model B) employs TP as the variable for the unit cost of restaurant services. The F-statistics of 4.362 in model A and 4.362 in model B, with 2

Table 9. Estimation Results by OLS

| XBXP | Model A | Model B |
|---|---|---|
| Constant | 5.4879 | 8.9188 |
| | (2.3796)* | (2.3707)* |
| TB | -0.56404 | — |
| | (-2.3092)* | — |
| TP | — | -1.1334 |
| | — | (-2.3190)* |
| PBPP | 0.14925 | 0.70734 |
| | (0.70532) | (2.8758)* |
| $R^2$ | 0.3378 | 0.3391 |
| F | 4.336* | 4.362* |
| s | 0.49340 | 0.49240 |
| DW | 2.5401 | 2.5021 |

t-statistics are in parentheses.

*Statistically significant at the 5 percent level.

and 17 degrees of freedom are statistically significant at the 5 percent level. This allows us to reject the null hypothesis that all explanatory variable coefficients are jointly 0.

The Durbin-Watson statistics, with values of 2.5401 and 2.5021, indicate that test for autocorreration is inconclusive (within the range of $4-d_u=2.46$ and $4-d_l=2.90$). However, plotting the residuals against the horizontal time axis, the graphical patterns indicates that negative serial correlation might be present in the estimated residuals.

To correct for this, the model is reestimated by using the Cochrane-Orcutt procedure. The estimation results are presented in Table 10. The Durbin-Watson statistics of 2.0510 and 2.0600 suggest that it is reasonable to accept the null hypothesis of no serial correlation. Also, all the t-statistics are greater than the original ones.

In the model A, the estimated coefficient of TB is statistically significant at the 1 percent level according to the t-test. This indicates that the null hypothesis of Test 1 ($\alpha_1 = 0$) can be rejected. However, the coefficient has negative sign ($\alpha_1 < 0$) which is inconsistent with Borcherding and Silberberg formulation. In the case of the coefficient of PBPP, the null hypothesis of Test 2 ($\alpha_2 = 0$) cannot be rejected at 5 percent level. This suggests that customers may not respond changes in the ratio of beef to pork prices.

Table 10. Estimation Results by Cochrane-Orcutt Procedure

| XBXP | Model A | Model B |
|---|---|---|
| Constant | 5.5001 | 9.1263 |
| | (3.6722)** | (3.5867)** |
| TB | -0.60012 | — |
| | (-3.8758)** | — |
| TP | — | -1.1971 |
| | — | (-3.6806)** |
| PBPP | 0.29357 | 0.86391 |
| | (1.8352) | (5.0462)** |
| $R^2$ | 0.4726 | 0.4570 |
| s | 0.39298 | 0.40458 |
| DW | 2.0510 | 2.0600 |

t-statistics are in parentheses.

*Statistically significant at the 5 percent level.

**Statistically significant at the 1 percent level.

In the model B, both coefficients are statistically significant at the 1 percent level for the t-test. Hence, the null hypothesis of both Test 1 ($\alpha_1 = 0$) and Test 2 ($\alpha_2 = 0$) can be rejected. However, the sign of both coefficients is inconsistent with prior expectation ($\alpha_1 < 0$ and $\alpha_2 > 0$).

Therefore, in the both model A and B, the test results can support neither Borcherding and Silberberg formulation nor Umbeck formulation, indicating an indeterminate result (outcome 4).

# VII. CONCLUSION AND SUPPLEMENT

## Summary and Conclusion

The question of whether the consumers purchase different bundles of food at restaurants than at homes was considered in this study. An approach to the question is provided by the "shipping the good apples out" proposition that higher-quality foods are consumed relatively more at restaurants than at homes (i.e., the higher-quality goods becomes relatively cheaper if the cost of services is added).

This hypothesis was formulated by two different, alternative assumptions about how consumers perceive prices. One is Borcherding and Silberberg formulation that consumers view the fixed per-unit charge as a change in the price ratio. The other is Umbeck formulation that consumers view the charge as a fixed lump-sum charge for a separate third good or service.

These two competing hypotheses were tested by using data from a Japanese restaurant in San Francisco. However, the test results could not support either Borcherding and Silberberg formulation or Umbeck formulation. In both cases, the signs of the coefficients were opposite as against both hypotheses had predicted.

This result may simply be a reflection of the weak data as Opaluch (1982) had stated. If weakness exists in our data, there are several reasons that can be considered.

First, in this study, the price data were collected from the restaurant (*i.e.*, the retail price data were not available). Hence, these were input prices of protein source items which the restaurant purchased from a supplier. These prices would be different from those which consumers face at retail store, since the input prices for restaurants are relatively more rigid than the prices at retail stores.

Second, the statistical test was conducted between beef and pork in this study because of the lack of data (*i.e.* salmon and chicken prices were not available for the test). However, these prices would be quite close each other, so that it is difficult to say which is the higher-quality food for customers.

Additional research to distinguish between the competing hypotheses is necessary with new data set. It is essential to collect the price data from the retail store around the restaurant, and especially, the price data for salmon which is obviously higher-cost food.

## Supplementary Consideration

Recently, a new data set was obtained from a family restaurant chain.[25] These were weekly data, providing four observations (each week ending 4/04/92, 8/02/92, 12/13/92 and 3/28/93). Those included the meal prices, the input price of the protein sources ( which also include the price of vegetables on the dish) and the number of meals sold per week at dinner. Protein sources obtained in this data were beef, chicken and fish (the name of fish was unknown).

Since there were only four observations, we could not perform regression analysis as usual. However, these data provided us some supplementary but important implications with our hypothesis testing for the competing formulations.

Table 11 and 12 show three variables which were calculated from the obtained data as in Chapter V. In those tables, (+), (0) and (-) show whether the quantity ratio moved in the same or in the opposite direction from the relevant independent variable between two dates. Thus, for example, between 4/04/92 and 8/02/92, both XBXC and TB fell in value. Because they both moved in the same direction, a (+) sign is assigned. However, because PBPC rose between the two dates, XBXC and PBPC moved in opposite directions and, thus, a (-) sign is assigned. $\alpha_1$, $\alpha_2$ and $\alpha_3$ are coefficients in the applied Opaluch econometric model for

[25]Management requested that name of the family restaurant chain be kept confidential.

Table 11. Analysis of the Obtained Weekly Data, the Combination of Beef and Chicken.

| Week ending | XBXC | TB | TC | PBPC | PBTPCT |
|---|---|---|---|---|---|
| 4/04/92 | 0.8462 | 5.96 | 5.98 | 2.1777 | 1.2893 |
| | | ↓ + | ↓ + | ↓ - | ↓ 0 |
| 8/02/92 | 0.4857 | 4.89 | 5.78 | 2.4700 | 1.2893 |
| | | ↓ + | ↓ + | ↓ - | ↓ - |
| 12/13/92 | 0.7714 | 5.37 ↓ + | 5.91 ↓ + | 2.1709 ↓ - | 1.2667 ↓ - |
| | | ↓ - | ↓ - | ↓ + | ↓ + |
| 3/28/93 | 0.7143 | 5.86 | 6.29 | 2.1637 | 1.2573 |
| Implications | | $\alpha_1 > 0$ | $\alpha_1 > 0$ | $\alpha_2 < 0$ | $\alpha_3 < 0$ |
| | | $\beta_1 > 0$ | $\beta_1 > 0$ | $\beta_2 < 0$ | —— |

Where: PBTPCT = (PB + TB)/(PC + TP).

Table 12. Analysis of the Obtained Weekly Data, the Combination of Beef and Fish.

| Week ending | XBXF | TB | TF | PBPF | PBTPFT |
|---|---|---|---|---|---|
| 4/04/92 | 1.5714 | 5.96 | 6.64 | 1.5267 | 1.0847 |
| | | ↓ + | ↓ - | ↓ - | ↓ + |
| 8/02/92 | 1.3077 | 4.89 | 7.40 | 2.1020 | 1.0302 |
| | | ↓ + (8/02/92 → 3/28/93: ↓ +) | ↓ - | ↓ - | ↓ + |
| 12/13/92 | 2.0769 | 5.37 | 6.83 | 1.6282 | 1.0503 |
| | | ↓ - | ↓ - | ↓ - | ↓ + |
| 3/28/93 | 1.7857 | 5.86 | 7.44 | 1.7402 | 1.0488 |
| Implications | | $\alpha_1 > 0$ | $\alpha_1 < 0$ | $\alpha_2 < 0$ | $\alpha_3 > 0$ |
| | | $\beta_1 > 0$ | $\beta_1 < 0$ | $\beta_2 < 0$ | —— |

Where: PBTPFT = (PB + TB)/(PF + TP).

the hypothesis testing (equation (16) in page 47). Also, $\beta_1$ and $\beta_2$ are coefficients in an alternative economic model (equation (22) in page 53).

Table 11 shows the combination of beef and chicken. The coefficients of input price ratio variable (PBPC) had negative sign, $\alpha_2 < 0$ and $\beta_2 < 0$, supporting Umbeck formulation. On the other hand, the coefficients of restaurant services variable (TB and TC) had positive sign, $\beta_1 > 0$ and the meal price ratio variable (PBTPCT) $\alpha_3 < 0$, implied Borcherding and Silberberg formulation.

Table 12 presents the case of the combination of beef and fish (which is symbolized by F). Again, the coefficient of input price ratio variable (PBPF) indicated negative sign, $\alpha_2 < 0$ and $\beta_2 < 0$, implying Umbeck formulation is correct. In this combination, however, Borcherding and Silberberg formulation could not be supported.

Hence, these consideration from obtained new data set, although it was roughly analyzed, implied that Umbeck formulation was more likely correct. Consumers chose higher-quality meals in the restaurant, viewing the difference between protein source price ratios, and also the restaurant service change as an entrance fee.

This will lead us to answer the question of the issue: the ratio of two protein source consumptions is not different in restaurants than in retail stores. However, four observations were not enough to provide strong evidence and to conclude the question of our interest. In future, if more data are to be obtained from this family restaurant chain, regression analysis will be possible so that we can conclude which formulation is correct through our hypothesis testing procedure.

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