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CHILD CARE SERVICES:
TWO STATISTICAL/ECONOMETRIC APPROACHES
TO HOUSEHOLD CHOICE AND DEMAND

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By
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*****
The Ohio State University
1995

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"I will praise you, O LORD, with all my heart;
I will tell of all your wonders.

I will be glad and rejoice in you;
I will sing praise to your name, O Most High.

I trust in your unfailing love;
My heart rejoices in your salvation.

I will sing to the LORD".

(Psalms 9:1-2 and 13:5-6)
To my husband, Dong-Hoon
ACKNOWLEDGEMENTS

I express sincere appreciation to Dr. Sherman Hanna, my advisor and dissertation committee chair, the editor of Financial Counseling and Planning, for his endless help and encouragement through this process. I would also like to confess that I am such a lucky person since Professor Sherman Hanna is the most gentle, kind, and intelligent man as an academic advisor, mentor and teacher that I ever met before.

I also would like to thank my other committee member, Dr. Sharon Seiling for her guidance and encouragement. As a research advisor, she has shown me warm and kind guidance during my graduate work.

Special thanks go to Professor Stephen Cosslett, graduate chair of the Economics Department, with whom I had Econometrics individual studies for more than two years. As my minor advisor and dissertation committee member, he has always been open and willing to help through the entire process.
I am especially grateful to the Department of Family Resource Management and Dr. Sherman Hanna for financial support through my years of graduate study at The Ohio State University. I also wish to extend my sincere thank to my friends HyounKyoung, YoonKyoung, Mona, Mohamed, and Jaimie for their encouragement and support.

Special gratitude also goes to my friends, SeungHee, HyoSook, YeonJoo, DeokSim and WhaYoung for their sincere prayers.

I wish to extend my sincere thanks to my best friend and handsome husband, Dong-Hoon(Don) for his love, prayers, patience, and academic help. I can never adequately express my gratitude. To my son, Kyle Moses (Seung-Jae) Oh, thanks for being a source of joy and inspiration to me.

Special thanks go to my parents (YoungJoon and JongHan), sister(SooYoung), brother(ChangKeun), MiJa and JoongHo, and parents-in-law (YongHan and JooSoon) for their prayers, support and encouragement.

I thank my Lord, Jesus Christ, for giving me all desires of my heart.
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CHAPTER I

INTRODUCTION

Child care is a necessity for a household with children, therefore household's decisions regarding the demand and choice for child care services is of great concern. Traditionally, a mother's major role in the family is child care but the traditional role as a primary child care giver has been changed since mothers' labor force participation has increased. Consequently, the family's role as a major provider of child care has been transferred to another place in which their children are taken care of. When mothers work outside of the home, someone else has to take care of their children so that every family has to either buy market child care services or substitute (hire) someone else for babysitting. Therefore, child care has become an important family issue as well as a public policy issue in the United States because women's labor force participation has greatly increased since 1950.

An increasing number of mothers have joined the labor force since World War II. In 1950, about 11 percent of
mothers with children under age six were in the labor force. The percentage of mothers with children under age six in the labor force increased to 42 percent in 1980 and to 58 percent in 1990 (Gray, 1992). Among husband-wife households with the oldest child under six years of age, about 21 percent had day care expenses in 1980 and this number rose to 33 percent in 1990; 34 percent and 36 percent allocated their household budget to babysitting in the same periods (Gray, 1992).

According to Goodman (1995), during 1990-1993 periods, $2.5 billion was expanded in the name of the Child Care and Development Block Grant for funding for the care of the children of poor families and for improving the quality of child care. Approximately $300 million has provided annually for the "At-Risk" Child Care Program since 1990. Thus, 5 billion of government funding in 1994 was allocated so that federal and local government supported billions dollars to not only for households with young children but also for child care industry (Goodman, 1995). Therefore, much attention on child care services primarily stems from the result of changes in employment patterns of mothers or women.

Furthermore, child care service is a necessary and important consideration, not only for the working households but also for all households with young children. In spite of the major interest in child care services for all types of households, there has not been research focusing on households with and without employed wives simultaneously. Therefore, this study will explore the issues of demand and choice for
child care services from the microeconomic perspectives in urban households. Household expenditure on child care in this study is defined as the sum of expenses for nursery school, day care, and babysitting and other home care. The major categories of variables expected to be related to expenditures on child care are: household's annual earned income and wealth, women's labor force participation measured by time spent working, age and education of the mother, number of children by the children's age categories, household type, ethnicity, and household's geographic location (region and size of metropolitan area). In addition, price of child care will be considered as an important factor in relation to child care demand and choice analysis.

This study uses Consumer Expenditure Survey data (CES) of the U. S. Bureau of Labor Statistics. The dataset created for this study includes consumer units who participated in the interview for four consecutive quarters during the three year period from 1990 to 1992. In order to adjust inflation between three different year periods, all dollar values used in this study will be fixed as dollar values in 1992. For the purpose of this analysis, only households with at least one child under the age of six would be included.

This study first will broadly review the child care related literatures in which the three major focused domain was classified as mother's labor force participation, choice and demand for child care services, and child care cost or expenditures. This study thereafter concentrates on the theory
of consumer behavior focusing on the demand and choice for child care services. Four major theoretical considerations will be employed where child care issues are explored. Neoclassical demand theory in which Marshallian, or uncompensated demand, and Hicksian, or compensated demand, will be discussed within the duality framework; Becker's household production theory with respect to the theory of allocation of time; Lancaster's characteristics theory; and Deacon and Firebaugh's management system theory will all be discussed. Theoretical approaches to demand and choice for child care will be widely discussed from those theories' perspectives.

This study attempts to bridge the gap between neoclassical demand theory and household's production function theory through empirical demand analysis. In the former theory, income and price are the major explanatory variables, whereas time at work or wage rate is of great interest in addition to price in the latter theory. Therefore, household income, price, and time variables will be incorporated into the model together. Furthermore, a household's wealth variable will be also considered in addition to income effect.

Statistical and econometric models for child care analysis in this study will be deeply considered, and discussion on the type I Tobit, the type II Tobit including the Probit selection equation, and the Linear Probability model will be employed. The type I Tobit by Amemiya (1984,1985) is the same as that of the one-stage Tobit by Maddala (1983,1992), which is the most
frequently used econometric model among Tobit-related research in the field of Consumer and Family Economics, and even Family Resource Management. However, it is true that most studies using the type I Tobit skip over the issues of the sample selectivity. The Type II Tobit on a basis of a bivariate normal distribution would also be considered as the appropriate statistical model for the households' demand and choice for child care services. In the first step, whether or not households purchase formal market child care or not will be decided and actual child care expenditures in the second step will be estimated using the result of the first step, producing a sample selectivity correction factor which will be incorporated as another regressor in the second step.

For the purpose of performing an analysis of the choice of child care (informal versus formal market child care) a Probit model shall be used. In the Probit model, the dependent variable is the choice of formal market child care versus informal child care; nursery, daycare, and babysitting and "other" types of home-based care belong to formal child care whereas informal child care, which is normally unpaid home-based child care by relatives, family, or a parent is classified as informal child care.

The most important result expected from the empirical analysis conducted in this study is income and price elasticities of demand. Income effect on child care would be directly related to the income elasticity of demand for child care services, while most consumption studies using CES data
only attempt income elasticities of expenditures. This relationship would explain whether the child care is a normal good or a luxury good within the various levels of household structure. The importance of income analysis would be found as follows. In the evaluation of the child care assistance program, policy makers may decide whether or not they consider the family income effect on child care expenditures, since each family’s demand for child care is constructed differently. That is, families with young children might show various income elasticities according to their income level.

A family or household financial counselor whose major concern is in diagnosing family financial situations may make a plan based on the result provided from child care analysis. From the model for child care choice in the type II Tobit, the result may show a household’s preference level for child care choice whether purchasing market services or not, and it may provide useful information on the market strategy for the child care industry.

Furthermore, the demand for child care may depend upon the price of child care as well. For the purpose of testing price effects, a price variable considering regional difference as well as city size was created from Consumer Expenditure Survey data using daycare and nursery CPI, and it was also adjusted by the Cost of Living Index by the American Chamber of Commerce Researchers Association that enables us to see regional variation. Fan (1993) tried to perform price incorporation using CES data and adjusting the CLI index in her dissertation. Park, Wasnich, and Fox (1995) also tested
the price effect for out-of-pocket health care expenditures using a similar procedure.

Therefore, this study will provide invaluable information in that it will adopt such price incorporation not only using the CPI for daycare and nursery school but also applying regional cost variance adjustment by the ACCRA. In this study, the income and price elasticities through both the type I Tobit and the type II Tobit for households with non-zero child care expenditures as well as households with zero child care expenditures would be calculated.

The other significant outcome from this study would be a mother's time effect on the demand and choice for child care, which is commonly disregarded by researchers on the basis of neoclassical demand theory. According to Becker's production theory, child care service is a time intensive commodity, so that a wife's working time directly affects the decision on the demand and choice for child care. Becker (1976) hypothesized that the value of a mother's time, measured by hourly wage rate, would negatively affect the amount of time spent in home production but positively influence the amount of time spent in market production which is a purchasing child care service. This study will therefore test household production theory through empirical analysis.

The empirical analysis on the demand and choice for child care in this study is unique in that both neoclassical demand theory and household production theory are considered at the
same time.

Basic descriptive statistical analyses will be shown, including frequencies, standard deviation and means by three categories of child care expenditure groups and socio-economic variables. This will provide the basic information on the overall household structure before conducting multivariate demand and choice analyses of child care.

This study will explore the effects of working mothers and family types on the level of child care expenditures. The interactive nature of those two variables will be examined. The author will analyze the relationship between household types with either a working or a non-working mother and the expenditure on child care. The results will provide insight into the family assistance program for either single-parent households or low-income households with working mothers.

The influence of ethnic difference on household spending patterns for child care will be examined for four available ethnic family groups: White (non-Hispanic), Black, Asian and pacific Islander, and Other. Other possible results related to child care expenditure are the mother’s curvilinear age effect and educational effect on child care.

In conclusion, this study is expected to provide several useful insights into the decisions about family or household analysis and public policy on child care assistance programs, which can be targeted for specific family types. Other
applications in the family resource management area may include designing educational programs about parenthood, setting guidelines for child support in divorce settlements, making decisions about a young mother's participation in the labor force, and financial counseling or planning for family financial problems.

The goals of this study are described as follows: first to bridge the gap between demand and choice theories in the neoclassical approach and the household production approach; second, to explore income, financial assets, the mother's working time, and other socio-demographic effects on the demand and choice for child care; third, to construct statistical and econometric models addressing the issue of statistical efficiency and unbiasedness as well as involving the sample selection bias correction problem, and modeling the type I and II Tobit; fourth, to show the simulation graphically using the results from the empirical analysis; and finally to provide invaluable insight for the consumer educator, financial planner, financial counselor and public policy maker.
CHAPTER II

LITERATURE REVIEW

1. Definition of Child Care

There has been much research on child care, but the research has had diverse goals. In the field of Family Studies and Child Development, child care study is more likely to involve the use of a child care service and its consequent impacts on children's social, emotional, and intellectual development. However, a somewhat different focus on child care has been employed in the fields of Consumer Economics, Family Economics, and Family Resource Management in which a subject topic is more likely to be associated with the aspects of well-being so as to maximize the satisfaction or utility of a household, a family, or a consumer unit. These preceding three terms are interchangeably used in this study.

Two general definitions of child care are widely accepted from the view point of Microeconomics. One is a child care payment denoting any kind of child care arrangements such as
a day care center, nursery school, babysitting, family day care, relative care, and non-relative care at provider's home or outside home.

Some studies consider that child care is a payment using such services only while mothers are working (Robins and Spiegelman, 1978; Hofferth, 1989; Blau and Robins, 1988; Mason and Kuhlthau, 1989; Folk and Beller, 1993; Camasso and Roche, 1991; Lehrer, 1983; Cain and Hofferth, 1989; Floge, 1985), however others regard child care as a payment regardless of the status of women's labor force participation. The latter includes all consumer units (Connelly, 1991; Lino, 1994; Sung, Park, and Hanna, 1994; Park and Mok, 1995). Hofferth et al. (1991) defined child care expenditure as the total amount for child care including all possible forms of child care such as parental, relative, and non-relative care while mothers are in the labor force.

A much broader meaning for child care expenditures includes not only day care, nursery, and babysitting but also other categories of goods and services required in child rearing such as food away from home, housing, transportation, and other personal care (Lino, 1990, 1991, 1992, and 1993). In this case, "child rearing expense" would fit better than calling it child care.
In fact, the usage of the former definition is widely prevalent throughout child care related research. Thus, "child care" in this study takes the former definition of child care.

Next, a review of child care related studies shall be employed in three major classifications as the topic of interest.

2. Three Streams of Child Care Research

There are three major streams of studies of child care expenditures or child care costs. One is encountered in the field of labor economics where three main topics such as women's work decision, women's fertility, and child care choice are interrelated to each other. Another subject in that field is the extent that the status of women's labor force participation and other socioeconomic variables impact on child care costs, choice, and demands for child care services. The other is explored by the field of consumption economics in which total child care expenditures are mainly viewed as a subcategory of total household expenditures.
Studies which have focused on the effect of child care expenditure or cost and price on women's labor force participation use a variety of econometric and statistical methods to estimate the mother's labor supply model. Women's labor force participation is a function of child care cost, household's income, women's wage rates and other sociodemographic variables and, hence, woman's labor supply is mainly explained by the cost of child care. Furthermore, most studies associated with women's labor supply hypothesized that women's employment decisions and child care for their children aged less than 6 are jointly involved.

Heckman (1974) is a forerunner in this field. Using the 1966 National Longitudinal Survey, he divided child care choice into either formal care or informal care with respect to the women's work status, and found that the mother's work decision and the decision to use paid child care are closely related to the price of child care and to other family members like teenagers and adults. Several other studies have focused on the issue of the effect of child care expenditures or child care costs on mother's employment status (Presser and Baldwin, 1980; Blau and Robins; 1988, 1989) and types of child care services (Blau, and Robins: 1988).
An earlier study of Presser and Baldwin (1980) examined child care as a constraint on a mother's labor force participation using data from the 1977 Current Population Survey, and also explored the relationship between a mother's labor force participation and fertility. In their results, it was found that minority mothers with young children aged less than six would work or seek to work more as long as child care services were provided at a reasonable cost. Also, mothers who are young, black, single, and with a lower level of education and income were more likely to have the problem that child care was a constraint on their employment.

They also found that a mother's fertility behavior is closely related not only to the intention or desire to work but also current employment status. In a similar context, the study of Blau and Robins (1989) was in line with the results of Presser and Baldwin who reported that child care cost influence both a mother's employment and fertility decisions so that increases in child care costs lead to an increase in the rate of those out of the labor force.

Leibowitz, Waite, and Witsberger (1988) estimated the mother's labor supply model and choice of child care separately, according to the age of youngest child between 0 to 2 and 3 to 5. In their study, major significant determinants of women's labor supply were substitute
availability, family resources, race, region, and education. Positive significant variables affecting child care choice for working women are the availability of substitute child care from family or friends, living in the South, being Hispanic or Black, and a higher level of education, whereas negative factors are number of children aged less than eighteen, Blacks living in South, husband's income, and a lower level of education.

Hill's empirical research (1989) on the female labor supply in Japan was explored considering women's hours of work and wage rates simultaneously. Significant results were that the husband's income and the presence of a young child aged under six reduced the likelihood of participating in the labor force participation for Japanese women, whereas previous labor market experience and education increased the propensity to work.

In later research, Leher (1992) explored the effects of race, mother's education, and the age of children on married women's labor supply using the data from the 1982 National Survey of Family Growth. In her research, the nonlinear number of children effect was tested according to the age of the youngest child. Multinomial Logit and ordered Probit estimations of a labor supply model were employed yielding the conclusion that the negative significant effect of children on
women’s work status by blacks is less striking in more highly educated groups.

2) Choice and Demand for Child Care Services

Another stream of research related to child care is extent to which mode of child care services are preferred while women are in the labor force. A good bit of attention has been paid to the effect of socioeconomic variables on the choice of child care parents are actually using, which is largely treated as dichotomous classifications in various ways: purchased care versus non-purchased care (Blau and Robins, 1988), informal care (unpaid) versus formal care (paid) (Mason and Kuhlthau, 1989; Ribar, 1992; Robins and Spiegelman, 1978; Leibowitz, Waite, and Witsberger, 1988), market care versus non-market care (Robins and Spiegelman, 1979; Blau and Robins, 1988; Folk and Beller, 1993), group care versus informal care (Camasso and Roche, 1991), organized care versus other care (Lehrer, 1983), self-care (parental care) versus other (non-parental) care (Cain and Hofferth, 1989), and relative care versus non-relative care (Floge, 1985; Leibowitz, Klerman, and Waite, 1992). Meanwhile, other studies’ modal choices mainly fell into four types of child care: center based care, family day care, in-home care, and relative care (Hofferth and Wissoker, 1992; Willer et al 1991).
According to Folk and Beller (1993), market care represented child care provided by family day care, a day care center, a nursery school, or babysitter, all of which are mainly paid care, whereas child care by a parent, older sibling, and other relatives is regarded as nonmarket unpaid care.

Major interests regarding child care in the above illustrated research are extended to which determinants significantly affect choice and demand for child care. Different sorts of price incorporation were executed. One is child care cost as a proxy of child care price (Blau and Robins, 1988; Camasso and Roche, 1991), the other is using another kind of proxy for child care price (Robins and Spiegelman, 1978). Price elasticity by region was estimated by Robins and Spiegelman (1978) in which average elasticities of child care were -1.36 in Denver and -2.86 in Seattle.

Robins and Spiegelman also calculated the informal and formal child care elasticities which are -0.85 and -2.40 for informal child care in Denver and Seattle, respectively, compared to -6.99 and -4.08 for formal child care in each region. Robins and Spielman (1978) also estimated that elasticity for both formal child care and informal child care were 2.5 and 0.73, respectively. On the other hand, the
estimated average price elasticities of purchased child care were -0.34 from the study of Blau and Robins (1988).

However, price incorporation in the demand or choice model seems to be very difficult because not only is there the problem of gathering price information, but also the fact that most child care is an aggregate commodity so that price information is very difficult to obtain. Thus, it is hard to find a true demand model for child care where child care quantity demanded is a function of own-price, cross-price, income, and other demographic variables. Most demand models for child care services are constructed through either the Engel function or modal choice where child care expenditure or mode is a function of income or modal choice.

The Choice model, therefore, is frequently used as a substitute for the demand model for child care using income and other sociodemographic variables. Various studies incorporated income model as a major determinant of child care in the choice model. Three different pieces of information on wages, namely, mother's earned income or wage rate, father's earned income, and other family's non-wage income, were used in order to explore the income effect on child care. Among those three source of income, women's earned income or wage rate, (when women's wage rate is not available, frequently a predicted wage rate for non-working
mothers is used) is of great concern. A common hypothesis of wage rate effect on the choice of either formal (market, purchased, and group) care or informal child care was that there is a positive effect of women’s earning or wage rate on purchasing market child care (Lehrer, 1983; Robins and Spiegelman, 1983; Blau and Robins, 1988, 1991; Folk and Beller, 1993), and the women’s wage rate impact is greater for market (formal) child care than non-market (informal) child care (Robins and Spiegelman, 1983; Folk and Beller, 1993).

Similar to women’s wage rate measure, mother’s working hours are used as a major determinant of choice of formal care or informal care. Several studies support that the increase in hours of women’s market work is more likely to involve purchasing formal child care (Leibowitz, Waite, and Witsberger, 1988; Lehrer, 1983, 1989; Hofferth and Wissoker, 1992; Ribar, 1992; Michalopoulos, Robins, and Garfinkel, 1992). Women’s employment status was also involved in the choice of child care, and as a result, women who are working either nonstandard hours such as evenings, weekends, or part-time are more likely to utilize informal child care (Presser, 1988).

Both the presence of children in different age groups and the age of the children or youngest child are also of interest. Some studies showed that households with young
children aged less than two were more likely to prefer informal care or nonmarket care. In addition to the ages of children or the youngest child, the number of children is an important determinant in child care choice (Lehrer, 1983). Older children are also considered as potential child care providers in the household, with the result that older children can take care of preschool siblings so that households are less likely to use paid care or market care (Heckman, 1974; Robins and Spiegelman, 1978; Lehrer, 1983; Leibowitz, Waite, and Witsberger, 1988; and Blau and Robins; 1991).

Mother's educational attainment was also considered to be an important explanatory variable in order to set a model of child care choice. The higher the women's level of education, the more likely they were to purchase market care (Blau and Robins, 1991).

Location variables such as residence in a Metropolitan Statistical Area is also important in the analysis of choice or mode of child care. Blau and Robins (1991) found that households living in SMSA were less likely to use nonrelative care service. However, the child care price index already contained regional variations as well as city sizes, so that multicollinearity among price, region, and city size would be highly expected. Thus, region and city size are only used in
basic descriptive analysis.

3) Child Care Cost and Child Care Expenditures


Bellante and Foster (1984) studied the relationship between working wives and expenditure on child care services using the Bureau of Labor Statistics' Consumer Expenditure Survey data from 1972-73. The labor force participation of the wife was one of the significant explanatory variables for child care service. A more specific later study of Weagley and Norum (1989) indicated that both the female's wage rate and hours of work were found to be positively related to the purchase of day care.
Moon (1986), using the 1972-73 Consumer Expenditure Survey, focused on the effects of the mother's employment status, including full-time employment, part-time employment, and unemployment on both the demand for formal child care services using the Logit model and formal child care expenditures using the linear probability model. She found that a mean value of the total formal child care expenditures was $235 for all households, but no other information on child care expenditures by women's work status was available.

Schwenk's study (1986) showed child care expenditures as combined day care and babysitting according to family composition as well as earner composition. The results reported that dual-earner families devoted 4 percent of the total family income as a mean child care expenditure of $1,439 based on 1985 dollar value, compared to 2 percent of two-parent households having one earner and a mean child care expenditure of $688, and the single-earner of one parent families allocated 9 percent of their family income as a mean expenditure of $1,549 to child care services.

In Schwenk's later study (1993), only households with working wives and positive child care expenditures were considered as a sample. Results showed that most children of employed mothers were cared for in both child care centers and family day care homes. She also showed the percentage of
child care expenditures out of family income according to five income groups using Wilier et al.'s results (1991). The cost of child care including center care, and family day care, family in-home care for the women who are in the labor force averaged $63 dollars per week in 1990 dollars, which is comparable to 10 percent of the family income among working wives who have positive child care expenditures. Higher income families with an annual income of $50,000 allocate their child care budget at about four times less than that of lower income families with an annual income of less than $15,000. The comparable budget shares between them were 6 percent and 23 percent.

The Multivariate Tobit model by Jacobs et al. (1989) was used to estimate the effects of women's employment status on child care cost as a combination of day care and babysitting where total expenditures were used as a proxy for income, holding a chance of simultaneous bias problem. Both families with wives working part-time and full-time were compared to the families with non-working wives, with a result that families with working wives spent more on work-related and time saving services like child care. These results were supported by Nickols and Fox (1983), and Yang and Magrabi (1989).
Jacobs et al.'s results are also supported by a study of Hanson and Ooms (1991). The Bureau of Labor Statistics' Consumer Expenditure Survey from 1980-83 was used in Hanson's study examining work-related expenses which revealed that child care as a combination of baby sitting and day care was one of the largest work-related costs, especially for dual-earner families. Two-earner families spent on average four times more on babysitting and day care than single-earner families across the levels of income.

Veum and Gleason (1991) reported that average expenditures on child care using 1988 National Longitudinal Surveys were around $62 per week and $1.56 per hour for women aged 23 to 31 and $45 per week and $1.80 per hour for women aged 29 to 39.

Cattan (1991) examined child care costs as a percent of weekly income. Results showed that families with working wives who are below the poverty level, using 1988 National Longitudinal Survey of Youth, reported that child care expenditure was $30 per week and 26.3 percent of weekly income compared to $40 which is 8.2 percent of weekly income for non poverty families.

Kisker and Maynard (1991) also reported average weekly expenditures on child care as a percent of both total family income and mother's income using the source from Hofferth's
study in 1988 with the result that all families spent 10 percent of their budget on child care whereas non-poor families spent 8 percent and poor families spent up to 22 percent. They also calculated child care expenditures as a percent of mother’s income and results showed that all families spent an average of 23 percent; non-poor families spent 21 percent; and poor families spent 32 percent of the mother’s income on child care while they are in the labor force.

Lino, using Consumer Expenditure Surveys, explored child care in two different ways: one is focused on child rearing expenses in which various budgetary components are combined, (1990, 1991, and 1993), the other estimated total child care expenses including day care, nursery, babysitting, and other home care only (1994).

In Lino’s 1990 study, he tried to estimate annual expenditures on a child for two-parent families, on the basis of six major budgetary components according to number of children as well as income groups, and yielded on estimation for family expenditures on child-rearing by children’s age, family income, and residence. The estimated child rearing cost based on 1989 dollars is $7,080 for a child aged 0 to 2; $13,180 for two children aged 0 to 16; and $15,670 for three children aged 0 to 16. In addition, he also projected the
future cost of rearing a child in three income groups with a 6 percent inflation rate until 2,006 year.

In 1993, Lino concluded that family expenditures on a child by husband-wife families in 1991 dollars are $4,520 to $5,700 for the income group below $31,200; $6,400 to $7,780 for the income group between 31,200 to $50,400; and $9,160 to $10,690 for the income group over $50,400. Such estimations from his 1990, 1991, and 1993 results would be useful to both the public and private sector for setting child support guidelines and foster care payments.

Unlike his previous studies, Lino’s latest study (1994) was conducted to estimate child care expenditures in which day care, nursery, babysitting and other home care are combined, comparing child care cost between single-mother households and two parent households. He found a single-parent household spent about $435 for those divorced or separated; $218 for those never married; and $312 for those widowed; whereas the two-parent household spent about $608. Those yearly child care expenditures are slightly underestimated because households having zero expenditures are included in the sample size. The households’ budgets for child care are 2.2 percent, 2.0 percent, 1.4 percent and 1.7 percent, respectively in the above order.
A more striking empirical report done by Marshall and Marx (1991) on the basis of the Massachusetts Child Care Survey data of 1987 was that annual child care payments per family were $4,200 for center-based child care; $5,350 for family day care; $4,800 for adult relative care at home; and even $11,000 for adult sitter in-home care, which resulted in the issue of the affordability of the child care services for both low-income families and moderate-income families with working mothers.

Kisker and Maynard (1991) conducted a similar study on the average fees paid by parents where approximately annual child care costs were $3,500 for full-time center-based care and $2,900 for full-time family day care but these estimations were much lower than those of Marshall and Marx. In the same context, more interesting research was done by Clifford and Russell (1989). They estimated child care cost by a different quality level of center-based care. Their annual estimation for child care per child is $2,900 for minimally adequate center-based care, whereas it is $5,000 for high quality center-based care. Michalopoulous, Robins and Garfinkel (1992) also reported the annual household’s expenditures on market child care was $2,128, which was 5.6 percent of the household’s total income.
The child care studies previously reviewed have used various ranges of children's age as a cut-off line for choosing households with young children. However, most studies generally adopted the age of six as a cut-off so that the age line, from which we choose proper sample sizes, includes child care expense of day care, nursery, and babysitting for the child aged less than six will be chosen in this study.

Indeed, most child care issues have focused on the households with working wives as well as households with positive child care costs. The thought that households with wives who are not in the labor force or households with non-employed parents are less likely to have or even unlikely to have the need of child care seems to remain. Thus, from this point of view, inclusion of households with both non-working wives and working wives would be more reasonable for consideration of the sample size in this study.

3. Government Regulation and Quality of Child Care Services

In this chapter, we can consider a regulation that increases costs but also increases the average quality of day care for children. Three major issues will be discussed.
1) Government Regulation and the Average Quality of a Product or Service

Historically, federal, state, and local governments have instituted regulations in the economy to serve particular social, economic, and public policy purpose.

What goals might a government have for regulation of child care? Government pursues a certain level of social and economic goals that satisfy consumer's need or public interest in the market place. Among six different goals illustrating government goals as well as consumer interests by Garman (1993), three issues may be related to the issues of the regulation for child care centers in the context of quality of service. These three goals are 1) the goal to promote public well-being and safety, 2) the goal to set uniform standards so that government encourage a fair market by setting standards, and 3) the goal to protect consumer from economic frauds.

Governments try to promote a fair market place by protecting consumers from economic frauds. Fraud can result in two bad things: problems for consumers and giving unfair advantage to particular sellers (child care centers.) Parents (buyers) often pay higher price for lower quality. In fact, consumers are unable to evaluate product or service because of either the fact that consumers are not fully informed, or the fact that sellers do not fully disclose
information. When a government creates regulations that require minimum standards for child care centers, the regulations may increase costs but also improve the average quality of child care for children.

Steinberg and Belsky (1991) state that the quality of day care is marked by many of the characteristics that define quality parenting, such as sensitivity, emotional support, and adequate physical and mental stimulation. They also found that such a quality can be enhanced when caregivers have some training in child development, for example, in group care whether family day care or center care, trained caregiver-child ratio are crucial.

On the other hand, according to the law of child care licensing and administrative rules by State of Ohio, there are certain minimum requirements for 13 categories: indoor floor space, outdoor play space, equipment for quiet and active play, health requirement, medical requirements for each child, staff-child ratios, staff qualification requirements, preadmission interview and visitation, records about child, safety, meals and snacks, space used only for child day care, and care of infants. In addition, there are requirements for consulting services and training programs.
All the above mentioned categories are closely related to the quality of child day care, but require higher costs by the operators of child care centers. If a child care center already meets new requirements, it may not face increased costs, but its competitors which did not meet the requirements might have to increase prices, which might allow a center already in compliance with the new regulations to increase its prices. Licensure of child care center itself is an example of government regulation, which may increase the quality of a child care compared to an unlicensed child care center.

2) Government Regulation and Net Benefit for Consumers

There are four different possible cases when the demand and/or supply curves shift upward due to regulations which increase costs and quality of child care.

Case 1: flat marginal cost curve with increased quantity demand
Case 2: flat marginal cost curve with decreased quantity demand
Case 3: upward sloping marginal cost curve with increased quantity demand
Case 4: upward sloping marginal cost curve with decreased quantity demand
Only cases 1 and 3 will be discussed in this section because cases 2 and 4 will be analyzed in following section.

We assume that child care center in the market is currently unregulated with condition that marginal cost equals to average cost. This is an unrealistic assumption, which would only hold with zero fixed costs. On the other hand, it simplifies the analysis. In equilibrium in a competitive market, the price that consumers pay for child care equals to $p_1$ dollars per hour. The quantity demanded, on the average is $q_1$ children in child care center under initial demand curve $D_1$. Now assume that the government implements a new regulation which would cause the average cost curve to shift to $p_2$ dollars per hour. The price for child care increases to $p_2$ dollar per hour. If the demand curve does not change, the quantity demanded will decrease. The decrease in quantity will depend on the price elasticity of demand. If the price elasticity is high (e.g, less than -1) there will be a fairly substantial decrease in quantity. If the price elasticity is zero (vertical demand curve) the quantity will not change. The more negative the price elasticity, the lower the loss in consumer surplus. The elasticity of demand may reflect the availability of substitutes for market child care.

It is possible that the higher quality induced by the regulation will cause consumers to demand more child care at
any given price, which can be represented by an upward rotation of the demand curve to D2. As shown in the graph on the next page in Figure 2.1, the new equilibrium quantity would increase to q2. Would the demand curve rotate or shift in response to regulation? If consumers were well informed and a range of quality levels were available, it is unlikely that the demand curve would change because of regulation. On the other hand, if consumers were not well informed, such a rotation or shift might be possible.
Figure 2.1

Effects of the Government Regulation on the Household's Demand for Child Care Services, For the Case of Simple Exposition, When Flat Marginal Cost Curve with Increased Quantity Demand is Assumed
Under the flat marginal cost curve, consumer surplus equals social surplus (ignoring the possibility of social benefits not valued by consumers.) Before regulation, consumer surplus is the area of $ACp_1$, and the area $p_1Cq_10$ is the expenditure for day care. After regulation which increases the price for child care from $p_1$ to $p_2$, consumer surplus is the area of $ADp_2$. Thus, the area of trapezoid, $p_2BCp_1$ is the cost (loss) for consumers due to the regulations, whereas the area of triangle $ADB$ is the benefit from higher quality. If the area $ADB$ is greater than that of $p_2BCp_1$, then consumers would be better off, on the average, with the regulation, which indicates regulation produces a net benefit for consumers. On the contrary, if the area, $ADB$ is smaller than that of $p_2BCp_1$, the regulation does not produce a net benefit for consumers.

Next, Figure 2.2 shows case 3 with an upward sloping marginal cost curve.
Figure 2.2

Effects of the Government Regulation on the Household's Demand for Child Care Services, For the Case of Simple Exposition, When Upward Sloping Marginal Cost Curve with Increased Quantity Demand
Before regulation in Figure 2.2, consumer surplus is the area of DoDp1, and the area p1Dq10 is the total expenditure for child day care. After regulation, consumer surplus is the area of DoBp2. To compare between those two areas, if area of p2ADp1 is greater than that of triangle DoBA, then regulation does not produce a net benefit for consumers, while the area of p2ADp1 is smaller than that of DoBA, then regulation produces a net benefit for consumers.

3) Government Regulation and Net Loss for Society

Next Figure 3.3 shows flat marginal cost curve which is case 2. In this case, the difference of consumer surplus between before regulation and after regulation will decide whether there is a net loss for society or not. Since producer surplus is zero under flat marginal cost curve, social surplus equals consumer surplus.
Figure 2.3

Effects of the Government Regulation on the Household's Demand for Child Care Services, For the Case of Simple Exposition, When Flat Marginal Cost Curve with Decreased Quantity Demand
Figure 2.3 indicates case 2 where marginal cost equals average cost curve. Before regulation, consumer surplus is the area of \( AE_1p_1 \) compared to the area of \( AE_2p_2 \) after regulation, and producer surplus is zero, thus if the area of \( p_2D_2E_1p_1 \) is greater than the area of triangle \( AE_2D \), then regulation produce a net loss for society. The shape of demand curve affects the result if there will be a net loss for society or not. Here, the demand curve doesn't look like a upward parallel shifted, so that the area of \( AE_2D \) looks smaller than that of \( p_2D_2E_1p_1 \). However, we also need to consider parallel shift of demand curve, which is the reason why we should compare between those two areas.
Figure 2.4

Effects of the Government Regulation on the Household's Demand for Child Care Services, For the Case of Simple Exposition, When Upward Sloping Marginal Cost Curve with Decreased Quantity Demand
On the other hand, Figure 2.4 indicates the case 4 where marginal cost is an upward sloping curve. With no regulation, consumer surplus is the area of $D_1E_1p_1$ compared to the area of $D_2E_2p_2$ after regulation, and producer surplus with no regulation is the area of $p_1E_1s_1$ compared to the area of $p_2E_2s_2$ after regulation. Social surplus is the sum of consumer surplus and producer surplus, which will be the area of $D_1E_1s_1$ before regulation, whereas the social surplus after regulation is the area of $D_2E_2s_2$. Therefore, if the area of $s_2A_1s_1$ is greater than the area of $D_2E_2AD_1$, then regulation produce a net loss for society.

In conclusion, the result of price effect (price elasticity) on the child care quantity demanded is very important to policy makers. When government regulation aims at increasing the quality of child care, the cost of regulation and the benefit from the higher quality to consumers will be compared based on price elasticities. This is the reason why price information is very crucial to policy makers. If the price variations observed in the dataset analyzed are partly due to regulatory differences and there is a high price elasticity, it is likely that there are not large shifts in demand due to regulation. However, there is no definitive way to judge this from the analysis in this dissertation.
CHAPTER III
THEORETICAL FRAMEWORKS

This chapter describes four possible theoretical models to use as a basis for empirical analysis of child care choice: Neoclassical demand theory, Becker's household production theory, Lancaster's modern consumer theory, and Deacon and Firebaugh's management system theory. After consideration of the features of the models and the variables available in the dataset, neoclassical demand theory and household production theory are chosen for use in considering the empirical analysis.

1. Neoclassical Theory of Consumer Behavior

In the neoclassical theory of consumer behavior, consumers either maximize their utilities subject to their budget constraint, or minimize their outlays. Marshallian or uncompensated demand theory and Hicksian or uncompensated demand
theory, which are the two representative conventional demand theories, will be described and compared in this section.

1) Utility Maximization and Demand

According to Marshallian demand theory, households maximize their utilities using child care which may be divided into day care, nursery, babysitting and other types of home care, and other goods and services within their income constraints. The theory can be displayed in equation form as follows:

\[
\begin{align*}
\text{Max } & u(q_1, q_2, q_3, q_4) = u(q_i) = f(q_i) \\
\text{subject to } & \sum p_i q_i = I
\end{align*}
\]

Where \( \sum p_i q_i \) = total child care expenditures, \( i=1,2,3 \)

\( \sum p_i q_i = I = \text{total household income or total expenditure where } i=1,2,3,4 \)

\( q_1 \) : Day Care
\( q_2 \) : Nursery
\( q_3 \) : Baby Sittting & Other types of home care
\( q_4 \) : Other goods and services

Clearly, solution of equation (3.1) is the system of Marshallian demand functions. In order to solve the problem of utility maximization, we need to form a Lagrangean function for the equation (3.1).
\[ L = L ( \mathbf{q}, \lambda ) = f(\mathbf{q}) + \lambda \cdot g ( \mathbf{q} ) \]
\[ = u ( \mathbf{q} ) + \lambda ( \sum p_i q_i - I) \]  
\[ (3.2) \]

where \( \lambda \) is a Lagrangean multiplier which is the marginal utility of total expenditure,
\[ g ( \mathbf{q}, x ) = \sum p_i q_i + p_x x - I \quad i=1,2,3,4. \]

First order conditions are used in order to derive Marshallian uncompensated demand functions.

\[ \frac{\partial L}{\partial q_1} = \frac{\partial u}{\partial q_1} - \lambda p_1 = 0 \]  
\[ (3.3) \]
\[ \frac{\partial L}{\partial q_2} = \frac{\partial u}{\partial q_2} - \lambda p_2 = 0 \]  
\[ (3.4) \]
\[ \frac{\partial L}{\partial q_3} = \frac{\partial u}{\partial q_3} - \lambda p_3 = 0 \]  
\[ (3.5) \]
\[ \frac{\partial L}{\partial q_4} = \frac{\partial u}{\partial q_4} - \lambda p_4 = 0 \]  
\[ (3.6) \]
\[ \frac{\partial L}{\partial \lambda} + \sum p_i q_i - I = 0 \quad \text{where } i=1,2,3,4 \]  
\[ (3.7) \]

The above equations (3.3) through (3.7) comprise a set of five equations and five unknowns. Using Cramer's Rule, the equations can be solved for the values of the unknowns when \( L(\cdot) \) is at its maximum. Solution for the five unknowns. \((q_1, q_2, q_3, q_4, \text{ and } \lambda)\) in the above five equations is the uncompensated Marshallian demand function, which is noted as:
\[ q_i = g_i (I, p_i) \]  \hspace{1cm} (3.8)

where \( i = 1, 2, 3, 4 \).

On the other hand, the Hicksian compensated demand function is the new cost-minimizing demand, that is,

Minimize \[ I = \Sigma p_i \cdot q_i = \text{Cost} = C \] \hspace{1cm} (3.9)

subject to \( u (q_1, q_2, q_3, q_4) = u \).

The Hicksian’s model tells us how \( q_i \) and \( x \) are affected by the prices of \( q_i \) and \( x \) holding utility constant. Minimum attainable cost is the matter of the Hicksian’s demand function. Hence,

\[ c (u, p) = \min (\Sigma p_i \cdot q_i ; v(q_i) = u) \] \hspace{1cm} (3.10)

where \( I = \Sigma p_i \cdot q_i \), \( i = 1, 2, 3, 4 \).

The maximum attainable utility function, \( u(\cdot) \), is also known as the indirect utility function which is noted as:

\[ U = v(q_i) = v[q_1(I, p_1), q_2(I, p_2), \ldots q_4(I, p_4)] \] \hspace{1cm} (3.11)

\[ = \varphi (I, p_i) \] \hspace{1cm} (3.12)

\[ = \max [v(q_i) ; \Sigma p_i q_i] \text{ where } i=1,2,3,4. \] \hspace{1cm} (3.13)

Meanwhile, two different demand functions, both Marshallian and Hicksian, are ultimately related to each other.
within the context of duality. The Hicksian compensated
demand function is a result from the partial derivative of the
cost function with respect to prices, which is called
Shephard’s Lemma:
\[
\frac{\partial c}{\partial p_i} = h_i (u, p_i) = q_i (p_i, I)
\]
where \(i = 1, 2, 3, 4\). \(3.14\)

We can rearrange the indirect utility function as a
function of total expenditure (or income), \(I\) and prices \(p_i\).
It forms as:
\[
u = \phi (I, p_i)
\]
(3.15)

In a similar way, the inversion of the indirect utility
function will give us a cost function,
\[
C = c (u, p_i) = I \quad \text{where } i = 1, 2, 3, 4.
\]
(3.17)

Now, the cost and indirect utility functions are inverse and
we have the following identity substituting (3.17) into
(3.15),
\[
\phi [c (u, p_i), p_i] = u.
\]
(3.17a)

Differentiating (3.18) with respect to price, \(p_i\), holding
utility constant, then we have
\[
[(\partial \phi/\partial I) \cdot (\partial c/\partial p_i)] + (\partial \phi/\partial p_i) = 0
\]
(3.17b)
Rearranging (3.17b) with respect to \( \partial c/\partial p_i \),
\[
(\partial c/\partial p_i) = - (\partial \phi/\partial p_i)/(\partial \phi/\partial I)
\]
(3.17c)

Using Shephard's Lemma in (3.14), and substituting (3.14) into (3.17c), so that
\[
q_i = q_i (p_i, I) = - (\partial \phi/\partial p_i)/(\partial \phi/\partial I)
\]
(3.17d)
is called Roy's identity.

Deaton and Muellbauer (1980) illustrated the above relationship between the Marshallian demand function and the Hicksian's demand function in the frames of duality and inversion. The following diagram, Figure (3.1), based on Deaton and Muellbauer's (1980) for child care shows the relationship between utility maximization and cost minimization.
Figure 3.1

Relationship between Utility Maximization and Cost Minimization based on Duality and Inversion, when $x$ stands for household income by Deaton and Muellbauer (1980)
2) Properties of Cost function

The cost function as a substitute for Hicksian demands has five general properties. The five general properties of cost function substituting for Hicksian demand for child care and "other" good and services are as follows:

Property 1: The child care cost function is homogeneous of degree one in prices. This means that twofold expenditure (cost) is required to maintain the household's indifference curve if prices doubled.

\[ c(\mathbf{u}, \theta \mathbf{p}_i) = \theta c(\mathbf{u}, \mathbf{p}_i), \quad i=1,2,3,4, \]

where a scalar \( \theta > 0 \). (3.18)

Property 2: In order to increase the household's utility, the consumer has to spend more holding price constant, and the expenditure should be required to be as much when prices increase. Cost function is increasing in utility, nondecreasing in price, and increasing in at least one price. This property indicates that households have to spend more to be better off at given prices, and increases in prices requires more expenditure to maintain the same level of being better off.
Property 3: The cost function is concave to the origin. Deaton and Muellbauer (1980) denote this property using a scalar function $f(z)$, which is concave if for $0 \leq \theta \leq 1$, that is,

$$f \{ \theta z^2 + (1-\theta)z^2 \} \geq \theta f(z^2) + (1-\theta)f(z^2) \quad (3.19)$$

where strict concavity of cost function occurs only when the left-hand side of the inequality (3.19) is greater than the right-hand side.

Property 4: This property indicates the continuity in price. Both first derivative and second derivative with respect to price exist within the possible range of price vectors.

Property 5: This property can be explained by Shephard’s Lemma. Hicksian demand functions as the partial derivative of the cost function with respect to price which is the continuity of Property 4. Equation (3.14) already indicated this relationship. Deaton and Muellbauer’s (1980) summarization gives us a clear picture of the relationships among demand, cost, and indirect utility functions. Figure 3.2 shows the relationship among Demand, cost, and indirect utility functions by Deaton and Muellbauer (1980).
Figure 3.2

The Relationship among Demand, Cost, and Indirect Utility Function when $x$ stands for household income by Deaton and Muellbauer (1980)
3) Properties of both Marshallian and Hicksian Demand

General characterization of the four restrictions of the demand function is discussed: adding-up, homogeneity, symmetry, and negativity.

**Property 1 : Adding-up Restriction.** This property refers to the fact that total expenditures for both Marshallian and Hicksian demands are the total value of both demands.

\[
\sum p_k h_k(u, p) = \sum p_k g_k(I, p) = I \\
i=1,2,3,4.
\]  
\[
\sum p_i h_k(u, p_i) = \sum p_i g_k(I, p_i) = I \\
i=1,2,3,4.
\]  

**Property 2 : Homogeneity Restriction.** It indicates that Marshallian (uncompensated) demand functions are homogeneous of degree zero in prices and total expenditure, whereas Hicksian's demands are only in prices.

\[
h_i(u, \theta p_i) = h_i(u, p_i) = g_i(\theta, \theta p_i) = g_i(y, p_i)
\]
where a scalar \( \theta > 0 \).

**Property 3 : Symmetry Restriction.** This property shows that the cross price derivatives in Hicksian (compensated) demands are symmetric for all \( i \neq j \), that is,
\[ \frac{\partial h_i(u, p_i)}{\partial p_j} = \frac{\partial h_i(u, p_j)}{\partial p_j} \] (3.23)

denoting \[ \frac{\partial^2 c}{\partial p_j \partial p_i} = \frac{\partial^2 c}{\partial p_i \partial p_j} \]
or,
\[ s_{ij} = s_{ji} \] for all \( i \neq j \), when \( s_{ij} = \frac{\partial h_i}{\partial p_j} \). (3.24)

**Property 4: Negativity Restriction.** This indicates that the \( n \)-by-\( n \) matrix is negative semidefinite, which is formed by the elements of \( s_{ij} = \frac{\partial h_i}{\partial p_j} \) in which \( S \) is the substitution matrix or Slutsky matrix of compensated price responses.

\[ \sum \sum s_{ij} \frac{\partial h_i}{\partial p_j} \leq 0 \] (3.25)
or,
\[ s_{ii} \leq 0 \] for all \( i \).

In the neoclassical theory of consumer household behavior, demand for child care services can be established as a function of own price, cross price, income, other forms of socio-demographic variables, and expected other proxies for tastes. Results are income, own-price, and cross-price elasticities. Through this study, own price, financial asset, income, and other variables will be incorporated in the demand model. Thus, price and income are main factors to be considered, thus the neoclassical framework will be feasible to test through empirical analysis.
2. Modern Theory of Consumer Behavior

In modern theory of consumer behavior by Lancaster (1966a, 1966b, and 1991), the primary objective interest of consumer or household choice is characteristics of the commodities and services, from which direct utility is obtained.

The following graphical representation, Figure (3.3), shows a characteristic space called C-space where three goods or services and two characteristics are given.

Ray OX gives the proportion of characteristics between both \( C_1 \) and \( C_2 \) in commodity X. The slope of OX is \( c_1/c_2 \) which represents a ratio between the quantities of characteristics \( C_1 \) and \( C_2 \). Thus, utility is a function of the characteristics of the commodities.

\[
U = u(\ c_1, \ c_2, \ ) \quad (3.26)
\]

where \( c_1, c_2 \) stand for the amount of characteristics of day care, nursery, babysitting and "other" home care services, respectively.
Figure 3.3

Characteristic Model for Child Care
In Figure 3.3, \(C_1\) and \(C_2\) are the names of the characteristics, e.g., the number of teachers and the education level of the teachers in the child care center; \(X\), \(Y\), and \(Z\) are the names of child care services purchasing characteristics: day care, nursery, and baby sitting; \(c_1\) and \(c_2\) are the quantities of characteristics; and \(x\), \(y\), and \(z\) are the quantities of child care services.

According to Ladd and Suvannunt (1976), utility maximization can be reformulated as follows:

\[
U = u \left( c_{t1}, c_{t2}, \ldots, c_{tm} \right) \tag{3.27}
\]

\[
C_{tj} = f_i \left( q_1, \ldots, q_n, c_{t1}, \ldots, c_{nj} \right) \tag{3.28}
\]

where there are \(m\) characteristics and \(n\) goods, \(q_i\) stands for the quantities of market goods, \(c_{tj}\) represents total amount of \(j\)th characteristics so that \(c_{nj}\) represents parameters. The parameters indicate the quantities of the characteristics which provided by units of \(n\) goods. Thus, rearranged the consumer's utility functions is:

\[
U = f_i \left( q_1, \ldots, q_n, c_{11}, \ldots, c_{mm} \right) \tag{3.29}
\]

the consumer's choice problem can thus be solved in the context of utility maximization subject to income.
Max \( U = f_i (q_1, \ldots, q_n, c_{11}, \ldots, c_{nm}) \)

subject to \( \sum p_i q_i = I \)  \hspace{1cm} (3.30)

The Lagrangean function follows:

\[
\mathcal{L} (c_{t1}, c_{t2}, \ldots, c_{tn}, \lambda) = u(c_{t1}, c_{t2}, \ldots, c_{tn}) - \lambda (\sum p_i q_i - I)
\]

where \( \lambda = \partial U / \partial I \) is the marginal utility of income.  \hspace{1cm} (3.31)

The first order conditions are:

\[
\mathcal{L}_{ct1} = \frac{\partial \mathcal{L}}{\partial q_1} = (\frac{\partial u}{\partial c_1})(\frac{\partial c_{t1}}{\partial q_1}) - \lambda p_1 = 0 \hspace{1cm} (3.32)
\]

\[
\mathcal{L}_{ct2} = \frac{\partial \mathcal{L}}{\partial q_2} = (\frac{\partial u}{\partial c_2})(\frac{\partial c_{t2}}{\partial q_2}) - \lambda p_2 = 0 \hspace{1cm} (3.33)
\]

\[
\mathcal{L}_{ct3} = \frac{\partial \mathcal{L}}{\partial q_3} = (\frac{\partial u}{\partial c_3})(\frac{\partial c_{t3}}{\partial q_3}) - \lambda p_3 = 0 \hspace{1cm} (3.34)
\]

\ldots

\[
\mathcal{L}_{ctn} = \frac{\partial \mathcal{L}}{\partial q_n} = (\frac{\partial u}{\partial c_n})(\frac{\partial c_{tn}}{\partial q_n}) - \lambda p_n = 0 \hspace{1cm} (3.35)
\]

\[
\mathcal{L}_\lambda = \sum p_i q_i - I = 0 \hspace{1cm} (3.36)
\]

The solutions for the equations (3.32) to (3.36) are consumer demands for child care services on the basis of Lancaster's characteristic theory. Such a solution is

\[
q_i = f(p_1, \ldots, p_n, c_{11}, \ldots, c_{nm}, I) \hspace{1cm} (3.37)
\]
1) Hedonic Price

Hedonic price is directly associated with the characteristics of commodities. Ladd and Suvannunt (1976) noted hedonic price as a functional form called hedonic price equation. Based on two equations, (3.30) and (3.31), hedonic price equation is as follows:

\[ p_i = \sum \left\{ \left( \frac{\partial c_{o_j}}{\partial q_i} \right) \left( \frac{\partial U}{\partial c_{o_j}} \right) \right\} \]

\[ = \sum \left( \frac{\partial c_{o_j}}{\partial q_i} \right) \left( \frac{\partial E}{\partial c_{o_j}} \right) \]

(3.38)

(3.39)

where \( c_{ij} = \frac{\partial c_{o_j}}{\partial q_i} \),
\[ \frac{\partial I}{\partial c_{o_j}} = \frac{\partial E}{\partial c_{o_j}} = \left( \frac{\partial U}{\partial c_{o_j}} \right) \right\} \left( \frac{\partial U}{\partial I} \right) \),
\( E_j = \frac{\partial E}{\partial c_{o_j}} \), called hedonic price, and
\( E \) stands for a household's total expenditures, a proxy of income.

Thus, \( p_i = \sum c_{ij} E_j \)

(3.40)

where \( E_j \) stands for the marginal expenditure of characteristic \( j \).

The main object of the hedonic price equation is to estimate the marginal implicit price, \( E_j \), which also indicates willingness to pay for the commodities. The Hedonic price
equation can be easily estimated using the multiple regression method where the parameters of the regression coefficient will be the implicit marginal prices of the characteristics. In a child care study, possible characteristics of child care from which a household can obtain direct utilities are the staff’s time spent with children, staff turnover, staff qualification (such as level of education), facilities and teaching materials, child-staff ratio, and age-mix. Since the data set this study uses does not include above-mentioned characteristics, a theoretical approach to Lancaster’s theory of consumer behavior will be impossible to implement.

3. Household Production Theory

From the neoclassical demand theory, consumers do not receive utility when goods and services (e.g., TV or watching TV) are purchased. However, household production theory explained that utilities can be obtained from the commodities produced from goods and time. In the household production theory constructed by Becker (1976), the primary object of consumer or household choice is commodities, from which direct utility is derived (Becker, 1976). These commodities are produced by the consumer unit or household itself by combining some of the household’s own time with purchased market goods and services such as child care.
In his model, all market goods are inputs which are used in the process of utility-yielding production of the nonmarket sector. The household production model describes the technology by which purchased child care services and other goods and services are used in combination with owned durables and inputs of the household's time in order to produce a commodity that households consume (Mok, Park, and Chern, 1995).

The household preferences are represented by a utility function, which can be expressed as:

\[ U = u (z_1, z_2, z_3, z_4) \]  

where \( z_1 \), \( z_2 \), and \( z_3 \) stand inclusively for day care, nursery, babysitting and other home care services produced and the quantities consumed by a household, and \( z_4 \) stands for both "other" types of goods and services except child care produced and consumed. These commodities identify the quantity of a commodity that can be produced per unit of time with specific combinations of inputs. It can be also expressed as:

\[ Z = Z_i (x_i, t_i ; E) \]  

where 1) \( x_i \) stands for a vector of market goods and services purchased for and used in the production of the commodities \( z_1 \), \( z_2 \), \( z_3 \), \( z_4 \), 2) \( t_i \) represents a vector of quantities of its own time in producing \( Z_i \), and 3) \( E \) is a vector of
environmental variables which reflect the level of technology and other socio-demographic environmental factors affecting the production process. There are four key components in this commodity model: \( x_i, t_i, w_i \), (wage rate) and \( E \).

The utility function (3.41) is maximized subject to both money income and time constraints:

\[
I = \sum p_i x_i \tag{3.43}
\]

\[
T = t_w + \sum t_i \tag{3.44}
\]

where \( t_w \) stands for the household's time spent in the labor market, \( t_i \) represents the household's time spent in producing \( Z_i \), and \( p_i \) and \( x_i \) are the price and quantity of the market good input used in the production of \( Z_i \).

In the time constraint model, wealthy households tend to have higher time costs and working households have less time available and more income so that households substitute \( x_i \) for \( t_i \). Furthermore, such time and money income constraints can be composed of a single full income constraint, \( S' \):

\[
S' = wT + V = \sum (wt_i + p_i x_i) \tag{3.45}
\]

where \( w \) stands for the wage rate, and \( V \) represents the household's non-labor income.
Increases in wages \((w)\) tends to decrease time spent on \(Z_i\), given \(x_i\) since \(x_i\) will substitute for \(t_i\) which can be seen from total income constraint in household production function. Decreases in wages \((w)\) also tends to decrease production of time-intensive commodities or earning-intensive commodities relative to good-intensive commodities.

The utility function (3.41) is then maximized subject both to the production function constraint (3.42) and full income constraint (3.45).

The Lagrangean function from Becker(1976) is constructed as:

\[
\mathcal{L}(z_1, z_2, z_3, z_0, \lambda) = u(z_1, z_2, z_3, z_0) - \lambda (\Sigma (w t_i + p_i x_i) - S')
\]

First order conditions are used to derive demand for commodities (goods) and time.

\[
\begin{align*}
\mathcal{L}_{z_1} &= \partial \mathcal{L} / \partial z_1 = \partial u / \partial z_1 - \lambda \pi_1 = 0 \\
\mathcal{L}_{z_2} &= \partial \mathcal{L} / \partial z_2 = \partial u / \partial z_2 - \lambda \pi_2 = 0 \\
\mathcal{L}_{z_3} &= \partial \mathcal{L} / \partial z_3 = \partial u / \partial z_3 - \lambda \pi_3 = 0 \\
\mathcal{L}_{z_0} &= \partial \mathcal{L} / \partial z_0 = \partial u / \partial z_0 - \lambda \pi_0 = 0 \\
\mathcal{L}_\lambda &= \Sigma (w t_i + p_i x_i) - S' = 0
\end{align*}
\]

where \([w (\partial t_i / \partial z_i) + p_i (\partial x_i / \partial z_i)] = \pi_i\).
The solutions for the equations (3.47) to (3.51) will be the demand for goods and time.

\[ Z_i = (w, p, S') \]  

(3.52)

On the other hand, demand for goods and time can also be derived using cost minimization problem. This cost minimization problem may be easier to solve than the utility maximization problem. In the utility maximization function, demand for goods and time depends upon the price of commodity \( \pi_i \), whereas the price of commodity \( \pi_i \) depends upon the demand for \( Z_i \) in cost minimization function.

According to Deaton and Muellbauer’s (1980) expression,

\[
\text{Min } S' = \sum (w t_i + p_i x_i) \\
\text{Subject to } U = u(z_1, z_2, z_3, z_0).
\]

(3.52)

The solution will give us as follows:

\[ C = c(p, w, U) \]  

(3.57)

Furthermore, based on duality, the derived input demand for goods is:

\[ x_j = \frac{\partial C}{\partial p_j} = x_j (p, w, U), \]  

(3.58)
demand for time is:

\[ t_k = \frac{\partial C}{\partial w_k} = t_k( p, w, U), \]  

(3.59)

and shadow price or an index of all commodity prices is:

\[ \pi_i = \frac{\partial C}{\partial Z_i} = \pi_i( p, w, U). \]  

(3.60)

1) Income and Substitution Effect

In the neoclassical demand model, the wage rate does not affect market price. However, higher wages yield higher price for the commodity \( \pi_i \) in household production theory. Thus, the higher wage rate results in a more earning intensive commodity which has a higher value of time. An increase in the value of a home producer's time, e.g., increase in spouse's wage rate, may induce her or him to spend less time in child care at home and increase purchasing child care services from the market sector. Therefore, households have alternatives in the combination of time and goods when performing the household production.

Pollack's (1969) decomposition of conditional demand functions may be useful for the analysis of the demand for child care services. Household's demand for child care services expressed as household production according to the change of the household production time can be formed as:
\[ \frac{\partial p_i x_i}{\partial t_w} = \left[ \frac{\partial p_i x_i}{\partial I} \right] \cdot \left[ \frac{\partial I}{\partial t_w} \right] + \left[ \frac{\partial p_i x_i}{\partial t_w} \right] \mid_I \]  
(3.61)

where \( t_w \) stands for the household's time spent in the labor market, and \( I \) represents the household's money income.

The first term, \( \left[ \frac{\partial p_i x_i}{\partial I} \right] \cdot \left[ \frac{\partial I}{\partial t_w} \right] \), in the right hand side of the equation (3.61) stands for the money expenditure effect, and second term, \( \left[ \frac{\partial p_i x_i}{\partial t_w} \right] \mid_I \), represents the pure substitution effect in which child care is either substituted or complemented with respect to time. The substitution effect may exist in purchased child care services for household production due to a time constraint, and complementarity may exist between time spent on market work (in the labor force) and purchased child care. The total effect on the expenditure on child care services, \( p_i x_i \), is the sum of the money expenditure effect and the pure substitution effect.

Therefore, demand for child care services is explained in the context of household production theory. The value of the wife’s or mother’s time will negatively affect the amount of time spent in home production so that there is a substitution effect between time spent in women’s labor force participation and time spent in home production called self-care at home. The value of the wife’s or mother’s time will positively
influence the amount of time spent in market production, purchasing child care services from either the formal or informal market sector so that the wife’s or mother’s time in market labor will be complemented with the purchase of child care services.

Another major interest in child care study in household production theory is the income effect with respect to the number of children. In household production theory, a child is an inferior good since the price of children as a commodity increases as household’s income or wage rate increases, whereas the number of children is more likely to be a normal good in traditional neoclassical theory. In this study, both mother’s weekly employment hours and the amount purchased of child care services are available. Thus, household production theory will be another possible theoretical consideration for the empirical analysis.

4. Management System Theory

All families with children may face a situation in which they need to make a decision concerning child care choice for their children. There are multidimensional factors and process with respect to their choice of child care. The
family process related to their decision making on child care choice is not a simple matter. Not every family has the same values, attitudes, opinions, and preference levels towards their child care services or choices. During the entire family life cycle, most families with children will face decision making on child care choice.

Deacon and Firebaugh's (1981) management process related to household decision making on child care would be appropriate to emphasize because they remark that "decision making is essentially a process of evaluation in the choice or resolution of alternatives." It is of course generally recognized that Deacon and Firebaugh’s management framework is one of the most widely used models for family or household decision making.

In Deacon and Firebaugh’s model (1981), there are three major processes: input, throughput and output. Input, which affects throughput process, has two major components called demand and resources. Throughput transforms a system from input to output. Throughput consists of two subsystems, personal subsystem and the managerial subsystem. The personal subsystem involves developing an individual’s capacities and evolving values, whereas the managerial subsystem includes planning and implementing. Demand responses and resource changes are output from managerial actions.
Throughout the entire system in the model of Deacon and Firebaugh, the household or family decision making process about their child care involves in all of these three stages. For example, in the input phase, households have to identify the available resources as well as decide what their goal priorities in relation to child care choices.

In the throughput phase, households need both to weigh alternative qualities or quantities of child care and determine alternative standards for their child care. In the output phase, households finally determine if the results of the child care they already have chosen is consistent with the households’ desired goals or demands. Therefore, the household’s satisfaction through the child’s development using selected child care services would not only involve their satisfaction regarding child care services but also the output of child care demands or choices.

To be more specific, the following diagram in Figure 3.4 will demonstrate the components of Deacon and Firebaugh’s system model associated with child care choice or demand for child care.
Figure 3.4

Management System Model of Demand and Choice for Child Care
Modified from the Management System Framework by Deacon and Firebaugh, 1981
When a child is born, a household needs to make a decision on child care choice. The different demands for child care result in different output of child development as well as households' satisfaction. The selection of type of child care among family day care, home based care, center based care, relative care, and spouse care may be a very important process in household or family decision making. If a family prefers or pursues the knowledge, skill, and ability of others outside of the family, those things may be obtained for children by a family's consumption behavior, and finally the family's satisfaction is a result of such behavior. Therefore, Deacon and Firebaugh's model displaying the input, throughput and output stages is important in terms of explaining family decision making for child care choice.

Heck (1983) and Jang (1995) expressed Deacon and Firebaugh's management system framework as:

\[ Q = q \left[ X_i; r_t(V_{i,b}), r_j \right] \]  \hspace{1cm} (3.61)

where \( Q \) stands for outputs; \( X_i \) for household’s managerial elements; a goal as an input; \( r \) for the fixed input levels; and \( V \) for characteristics of the \( t \)-th household’s member of \( s \) relevant members.

In the model (3.61), \( Q \) represents the household’s satisfaction which is a function of a set of household’s
managerial activities, and a set of inputs, i.e., $r_i$ and $r_j$. Within a set of inputs, a goal, $r_i$ is a function of the household's socioeconomic and demographic characteristics, $V_{t,b}$. Value-laden goals, $r_j$ are fixed or given inputs into the household's managerial system. Therefore, the household's satisfaction pursuing the household's goal to enhance its children's well-being can be obtained through the household's managerial activity, i.e., the throughput of the household's need to decide how to allocate their resources to child care expenditures, and how to make child care choices.

However, factors indicating output phase, i.e., levels of satisfaction, are not available. Thus, using this framework as a theoretical consideration for this study is not feasible empirically.
CHAPTER IV
STATISTICAL AND ECONOMETRIC MODELS

There are several stages in reaching a final model of demand and choice for child care services. First of all, we need to set up the demand function where price, quantity, the wife’s time at work, a household's earned income, financial assets, and other socio-demographic variables are entered into a model. Prior to setting up the empirical demand and choice model, several issues with respect to statistic and econometric models will appear in this chapter.

Estimation methods including the Ordinary Least Square and Maximum Likelihood Estimation will be introduced. Mean marginal effects of income, price and other sociodemographic variables will be described. With respect to income and price elasticities of quantity demanded, the calculation process of income and price elasticities will be shown. Finally, the log-likelihood ratio test and the empirical model will be described at the end of the chapter.
1. Tobit Model

The Tobit model represents a regression model in which the dependent variable is observed in only some of the ranges. The pioneering work in Tobit models was done by Tobin (1958). In his work, he estimated household expenditure on durable goods using a regression model but he considered the fact that the value of the dependent variable could not be negative. He called his specific case of regression model the limited dependent variable method. This Tobit model is also known as a censored normal regression model (Maddala, 1983;1992). In Amemiya’s 1984 article entitled “Tobit Models: A Survey”, he classified the diverse types of the Tobit. In this section, the two types of Tobit models introduced by Amemiya (1984,1985) will be introduced since the demand model for child care services falls into those two types.

1) Standard Tobit Model : Type I Tobit : $p(y<0)p(y)$

According to Amemiya (1984,1985), a household is assumed to maximize the utility, subject to budget constraint, which is described as follows.
Max $U(y, z)$
subject to $y + z \leq x$
\[ y \geq 0 \]

where $y$ is a household's actual child care expenditures
$z$ is all other expenditures
$x$ is income
$y + z \leq x$ stands for budget constraints, and
$y \geq 0$ stands for boundary constraint.

Also, suppose $y^*$ is the solution of the unconstrained optimization (the utility maximization subject to income constraint only), which is denoted by

\[ y_i^* = \beta' x_i + \mu_i, \] \hspace{1cm} (4.1)

where $x_i$ are the income and other variables and
$\mu_i$ indicates all the unobservable variables affecting the household's utility.

We can also define $y_i^*$ as desired expenditures or potential expenditures. Thus, we can rewrite equation (4.1) as

\[ y_i = y_i^* \text{ if } y_i^* > 0 \] \hspace{1cm} (4.1.1)
\[ y_i = 0 \text{ if } y_i^* \leq 0 \] \hspace{1cm} (4.1.2)

where $y_i$ are observed if a household's potential expenditures are greater than zero ($y_i^* > 0$), $y_i^*$ are unobserved if a household's potential expenditures is less
than zero \((y_i^* \leq 0)\), \(x_i\) are observed variables, and \(u_i \sim iid N(0, \sigma^2)\).

Therefore, \(y_i\) stands for the actual child care expenditures, and \(x\) stands for annual earned income, price of child care, financial assets, age of mother, education of mother, mother's working hours, and other variables.

The likelihood function of the standard Tobit model is given by

\[
L = \prod_0^1 \left[1 - \Phi(\beta'x_i / \sigma)\right] \prod_i \sigma^{-1} \phi \left[ (y_i - \beta'x_i / \sigma) \right]
\] (4.2)

where \(\Phi\) and \(\phi\) stand for the cumulative distribution function and density function, respectively, of the standard normal distribution; \(\prod\) stands for the product over those \(i\) for which \(y_i = 0 (y_i^* \leq 0)\); and \(\Pi\) means the product over those \(i\) for which \(y_i = 1 (y_i^* > 0)\).

Maddala (1983, 1992) also described the likelihood function for the type I Tobit model which is the same as in description (4.2), and it takes the following form as:

\[
L = \prod_{y_i > 0} \frac{1}{\sigma} f \left[ (y_i - \beta'x_i) / \sigma \right] \prod_{y_i \leq 0} F \left( -\beta'x_i / \sigma \right)
\] (4.3)
where \( f(t) = \frac{1}{\sqrt{2\pi}} \exp\left(-t^2/2\right) \)

\[
F(\beta'x_i/\sigma) = \int_{-\infty}^{\beta'x_i/\sigma} f(t)\,dt
\]

The description of the likelihood function is very important because of the maximum value of the function with respect to \( \beta \) and \( \sigma^2 \), yielding consistent and efficient estimators. Numerous studies about consumers' purchase of durable goods using the Tobit model use this type of Tobit. Sung, Park, and Hanna (1994) used the type I Tobit model for the determinant of child care.

2) **Type II Tobit**: \( p(y_i < 0) \cdot p(y_i > 0, y_i) \)

The previous type 1 Tobit model, \( p(y_i < 0) \cdot p(y_i) \) is another expression for \( \prod_0 p(y_i < 0) \cdot \prod_1 f_i(y_i) \), where \( f_i \) is the density function of \( N(\beta'x_i, \sigma^2) \). Here, the type II Tobit is defined as \( p(y_i < 0) \cdot p(y_i > 0, y_i) \) and follows:

\[
y_{1i}^* = \beta_1'x_{1i} + \mu_{1i} \quad (4.4)
\]

\[
y_{2i}^* = \beta_2'x_{2i} + \mu_{2i} \quad (4.5)
\]
where \( \mu_{i1}, \mu_{i2} \) are i.i.d bivariate normal distribution with a mean of zero, variances \( \sigma_1^2, \sigma_2^2 \), and covariance \( \sigma_{12} = \rho \sigma_1 \sigma_2 \).

and,

\[
y_{i1} = 1 \text{ if } y_{i1}^* > 0 \\
0 \text{ otherwise } \tag{4.6}
\]

\[
y_{i2} = y_{i2}^* \text{ if } y_{i1} = 1 \\
0 \text{ if } y_{i1} = 0 \tag{4.7}
\]

where \( y_{i1}^* \) is the household’s decision on whether to purchase market child care or not, and \( y_{i1} \) is observed only when \( y_{i1}^* > 0 \) indicating that \( y_{i1}^* \) is the utility difference between purchasing of market child care and non-purchasing market child care, and \( y_{i1} \) and \( y_{i2} \) are the observed variables.

When a household has a child care expense, then \( y_{i1} \) takes the value of 1, which means there was a child care expense, otherwise it takes zero, which means there was no expense. \( y_{i2}^* \) is only observed when there is a child care cost, thus, \( y_{i2} \) stands for actual child care expenditures only when a household has a child care expense.

Equations (4.4) and (4.6) are the Probit selection equation, and equations (4.5) and (4.7) are the regression model. Unlike the type I Tobit, \( y_{i2} \) in the type II Tobit can take negative values.
The likelihood function of type II Tobit is given by

\[ L = \prod_{i=0}^{1} p(y_{i*} \leq 0) \prod_{i=1}^{y_{i*} > 0} f(y_{2*} | y_{i*} > 0) p(y_{i*} > 0). \] (4.8)

where \( \prod \) and \( \prod \) stand for the product over these \( i \) for which \( y_{2i}=0 \) and \( y_{2i} \neq 0 \), and \( f(y_{2i} | y_{i*} > 0) \) stands for the conditional density of \( y_{2i} \) given \( y_{i*} > 0 \).

The first part of equation (4.8) is rewritten as

\[ p(y_{i*} \leq 0) = \int_{0}^{\Phi(0-x_i \beta_1)} dy_{i*} \int f(y_{1*}, y_{2*}) dy_{2*} \]

\[ = \int f(y_{1*}) dy_{1*} \]

\[ = \Phi(0-x_i \beta_1) \] (4.9)

where \( f(y_{1*}, y_{2*}) = f(y_{2*} | y_{1*}) f(y_{1*}) \)

and \( y_{1*} \sim N(x_i \beta_1, \sigma_1^2) \),

and the second part of equation (4.8) is

\[ f(y_{2i} | y_{i*} > 0) p(y_{i*} > 0) \]
\[ f(y_1^*, y_2^*) = \int_0 f(y_1^*, y_2^*) \, dy_1^* \]
\[ = f(y_2) \int_0 f(y_1^* | y_2^*) \, dy_1^* \]  
\[ = \frac{1}{\sigma_2} \phi \left( \frac{y_2 - x_2 \beta_2}{\sigma_2} \right) \Phi \left[ \frac{x_{ii} + \frac{\rho \sigma_1}{\sigma_2} (y_{ii} - x_{ii} \beta_2)}{\sigma_1 \sqrt{1 - \rho^2}} \right] \]

where
\[ f(y_2) = \frac{1}{\sigma_2} \phi \left( \frac{y_2 - x_2 \beta_2}{\sigma_2} \right) \]
\[ f(y_1^* | y_2) = \frac{1}{\sigma_1 \sqrt{1 - \rho^2}} \phi \left[ \frac{y_{ii} - x_{ii} \beta_1 - \frac{\rho \sigma_1}{\sigma_2} (y_{ii} - x_{ii} \beta_2)}{\sigma_1 \sqrt{1 - \rho^2}} \right] \]

Therefore, substituting equations (4.9) and (4.10) into equation (4.8), the final likelihood function can be produced as follows:

\[ L = \prod_0 [\phi \left( \frac{x_{ii} \beta_1}{\sigma_1} \right)] \prod_i \left[ \frac{1}{\sigma_2} \phi \left( \frac{y_{2i} - x_{2i} \beta_2}{\sigma_2} \right) \right] \]
\[ \times \frac{x_{ii} \beta_1 + \frac{\rho \sigma_1}{\sigma_2} (y_{ii} - x_{ii} \beta_2)}{\sigma_1 \sqrt{1 - \rho^2}} \Phi \left[ \frac{x_{ii} \beta_1 + \frac{\rho \sigma_1}{\sigma_2} (y_{ii} - x_{ii} \beta_2)}{\sigma_1 \sqrt{1 - \rho^2}} \right] \]  
\[ = \prod_0 [\phi \left( \frac{x_{ii} \beta_1}{\sigma_1} \right)] \prod_i \left[ \frac{1}{\sigma_2} \phi \left( \frac{y_{2i} - x_{2i} \beta_2}{\sigma_2} \right) \right] \]

where \( \prod_0 \) and \( \prod_i \) stand for the product over these \( i \) for which \( y_{2i} = 0 \) and \( y_{2i} \neq 0 \), and \( f(y_{2i} | y_{ii} > 0) \) stands for the conditional density of \( y_{2i} * \) given \( y_{ii} > 0 \).
a) Heckman's Two-Step Estimation Method

On the basis of models (4.4) to (4.7), Heckman's two-step method will be used for the estimation. According to Amemiya (1984, 1985), Maddala (1983) and Cosslett (1994), referring to the models (4.4) to (4.7) again, when we have $E(u_{2i}|x_{1i}) = 0$, then the regression method does not have any statistical problem. However, there is a high chance of self selection bias which is explained by

$$E[u_{2i}|x_{1i}, y_{1i}<0] = E[u_{2i}|x_{2i}, u_{2i}>-\beta_2'x_{1i}]$$

(4.12)

where $\rho = 0$ if $\rho \neq 0$

In order to correct the sample selection bias,

$$y_{2i} = \beta_2'x_{2i} + E[u_{2i}|u_{1i}>-\beta_1'x_{1i}] + v_{2i}$$

(4.13)

where $v_{2i} = u_{2i} - E[u_{2i}|u_{1i}>-\beta_1'x_{1i}]$.

Assume $u_{1i}$ and $u_{2i}$ are bivariate normal with
\begin{align}
E[u_{2i}|u_{1i} > -\beta_1'x_{1i}] &= \rho \sigma_2 \frac{\phi_i}{1-\Phi_i} \\
\text{where } \phi_i &= \phi(-\beta_1'x_{1i}) \\
\Phi_i &= \Phi(-\beta_1'x_{1i}).
\end{align}

In order to get consistent \( \tilde{\beta}_1 \), we need to estimate the selection equation by Probit in first step, and Cosslett (1984) noted as follows from (4.15) to (4.18):

\begin{align}
\hat{w}_i &= \frac{\hat{\phi}_i}{1-\Phi_i} \\
\text{where } \hat{\phi}_i &= \phi(1-\tilde{\beta}_1 x_{1i}) \\
\hat{\Phi}_i &= \Phi(-\tilde{\beta}_1 x_{1i}).
\end{align}

Substitute equation (4.15) into equation (4.5), then we get

\begin{align}
y_{2i} &= \beta_2' x_{2i} + \gamma \hat{w}_i + \epsilon_{2i} \\
\text{where } \gamma &\text{ will estimate } \rho \sigma_2.
\end{align}

In the second step, equation (4.16) will be estimated by using OLS or GLS where the correct term \( \hat{w}_i \) is used for a regressor. The rewritten equation (4.16) is as follows:

\begin{align}
y_{2i} &= \beta_2' x_{2i} + \gamma \hat{w}_i + [\nu_{2i} + \gamma (w_i - \hat{w}_i)]
\end{align}

In equation (4.16), standard error need to be corrected.
\[ \hat{w}_i - w_i = \frac{\partial w_i}{\partial \hat{\beta}_i} (\hat{\beta}_i - \beta_i) \]  
\hspace{1cm} (4.18)

where the term of \( \hat{\beta}_i - \beta_i \) will depend on \( \mu_i \)'s

If \( \gamma \) is statistically significant, it indicates that there was a sample selection bias. Further information on sample selectivity correction is available from Maddala (1983) and Amemiya (1984 and 1985).

3) Three Mean Marginal Effects For the Type I Tobit

With limited dependent variables, Maddala (1983) noted three mean marginal effects in the Type I Tobit model:

**Total mean marginal effect for overall samples**

\[ \frac{\partial E(y)}{\partial x_i} = \Phi(z) \beta_i \]  
\hspace{1cm} (4.19)

**Mean marginal effect for latent variables, desired expenditures**

\[ \frac{\partial E(y^*)}{\partial x_i} = \beta_i \]  
\hspace{1cm} (4.20)

**Mean marginal effect for the households that had positive expenditures**
\[
\frac{\partial \mathbb{E}(y | y^* > 0)}{\partial x_i} = \beta_i \left[ -z \left( \frac{\phi(z)}{\Phi(z)} \right) - \left( \frac{\phi(z)}{\Phi(z)} \right)^2 \right]
\]

(4.21)

where \( \phi(z) \) is the density function of the standard normal distribution, \( \Phi(z) \) is the cumulative distribution function of the standard normal distribution, and \( z = x_i' \beta \).

4) Mean Marginal Effect For the Type II Tobit

In the Ordinary Least Square Method, an estimation in the second step of the Type II Tobit, marginal effects are only the same as the estimated parameters themselves in linear functional form when the same variables appear in the first step. Since Limdep gives us the unbiased parameters in which standard errors in the second step are already corrected, the calculation process of the marginal effect would be omitted. We can apply several functional forms of regression in the type II Tobit model. Commonly used functional forms are the linear form, quadratic form, semi-logarithmic form, double-log form, and inverse semi-logarithmic form.
Next, the Box-Cox transformation method will be introduced which includes all of the above functional forms.

5) Box-Cox Transformation

The extent to which functional form should be employed is a major interest in demand analysis as well as in this study. In the type II Tobit model, Heckman's two-step estimation method will be used in which proper functional form should be employed. The Box-Cox transformation procedure gives us the answer.

Pindyck and Rubinfeld (1991) described a simplified two-variable model by the following equation:

\[
\frac{y_i^\lambda - 1}{\lambda} = \beta_0 + \beta_1 \left( \frac{x_i^\lambda - 1}{\lambda} \right) + \epsilon_i
\]

When \( \lambda = 1 \), this equation (4.22) will be reduced to linear form. Similarly, when \( \lambda = 0 \), this functional form will be more complicated because \( \frac{y_i^\lambda - 1}{\lambda} \) will be hard to determine.
Because $y_i^\lambda = \exp(\lambda \cdot \log y_i)$

$$= 1 + \lambda \cdot \log y_i + \frac{1}{2}(\lambda \cdot \log y_i)^2 + \ldots$$  \hspace{1cm} (4.23)

it follows that

$$y_i^\lambda - 1 = \lambda \cdot \log y_i + \frac{\lambda}{2}(\log y_i)^2 + \ldots$$  \hspace{1cm} (4.24)

divided both sides into $\lambda$ then,

$$\frac{y_i^\lambda - 1}{\lambda} = \log y_i + \frac{\lambda}{2}(\log y_i)^2 + \ldots$$  \hspace{1cm} (4.25)

Thus, when $\lambda = 0$, we obtain

$$\frac{y_i^\lambda - 1}{\lambda} = \log y_i$$  \hspace{1cm} (4.26)

The Box-Cox transformation yields the log-linear model,

$$\log y_i = \beta_0 + \beta_1 \log x_i + \epsilon_i,$$  \hspace{1cm} when we substitute equation (4.26) into (4.22).

Pindyck and Rubinfeld (1991), Amemiya (1985), and Neter et al. (1990) described the Log-likelihood estimation of equation (4.27) as:

$$\text{LogL} = (\lambda - 1) \sum \log y_i - \frac{N}{2} \log(2\pi) - \frac{N}{2} \log(\sigma^2)$$
Thus, we need to compare the various values of Log-likelihood from \( \lambda=0 \) to \( \lambda=1 \), which determines the model that best fits the data.

Statistically, the finding of the most appropriate value of transformation in the Box-Cox approach is to find the value which minimizes the error some of squares, SSE (Neter at al., 1990). One of the statistical packages, Minitab, gives us the graphical transformation. When we choose the value of \( \lambda \) from 0 to 1, the fitted regression line moves so that the best fitted regression can be easily selected as the value of \( \lambda \) changes.

In this study, semi-log functional form will be chosen. Thus the described semi-log form follows:

\[
Y = \beta_0 + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \log X_3 \tag{4.28}
\]

where \( Y \) = predicted child care quantity demanded
\( X_1 \) = income,
\( X_2 \) = price,
\( X_3 \) = other socio-demographic variables
6) Income and Price Elasticities in the Type I Tobit Model

There are two different methods to calculate income and price elasticity when the double-log form is executed.

Method (1): \( \eta = \frac{\partial \log EXP}{\partial \log I} = \frac{1}{EXP} \cdot \left( \frac{\partial EXP}{\partial \log I} \right) \) (4.29)

Method (2): \( \eta = \frac{1}{N} \sum \left( \frac{1}{EXP_i} \right) \cdot \left( \frac{\partial EXP_i}{\partial \log I} \right) \) (4.30)

Where I stands for income or price and EXP stands for child care expenditures.

Method (1) is usually easier to calculate than method (2) because of the procedure of taking the sample mean. Method (1) simply takes sample mean value of total expenditure, whereas method (2) first takes each household's expenditure and then takes sample means. The next procedure shows the proof of the calculation for method (1), which will be used for the calculation of the elasticities in this study.

From method (1),

\( \frac{\partial \log EXP}{\partial \log I} = \frac{1}{EXP} \cdot \left( \frac{\partial EXP}{\partial \log I} \right) \) (4.29)
Step 1

In order to calculate \( \partial \text{e[EXP]} / \partial \log I \), where \( \text{e[EXP]} \) stands for the "expected" value of child care "expenditures," the following equation for the child care expenditures should be firstly considered:

\[
\text{EXP} = X\beta + \mu \quad \text{if } \mu > -X\beta \\
0 \quad \text{otherwise}
\]  

(4.31)

Step 2

\[
e[\text{EXP}] = \int_{-\infty}^{\infty} du (X\beta + u) \frac{1}{\sigma} \phi \left( \frac{u}{\sigma} \right) \\
= X\beta \frac{1}{\sigma} \int_{-\infty}^{\infty} \phi \left( \frac{u}{\sigma} \right) du + \frac{1}{\sigma} \int_{-\infty}^{\infty} u \phi \left( \frac{u}{\sigma} \right) du \\
= X\beta \cdot \Phi (X\beta / \sigma) + \sigma \phi (X\beta / \sigma) 
\]  

(4.32)

Step 3

Now let \( \log I = X_i \)

\[
\frac{\partial}{\partial x_i} [X\beta \Phi (X\beta / \sigma) + \sigma \phi (X\beta / \sigma)] \\
= \frac{\partial \text{e[EXP]}}{\partial \log I} \\
= \beta_i [\Phi (X\beta / \sigma) + (X\beta / \sigma) \phi (X\beta / \sigma) + \Phi' (X\beta / \sigma)] \\
\quad \text{where } \Phi' (X\beta / \sigma) = (X\beta / \sigma) \phi (X\beta / \sigma) \\
= \beta_i [\Phi (X\beta / \sigma) + (X\beta / \sigma) \phi (X\beta / \sigma) - (X\beta / \sigma) \phi (X\beta / \sigma)] \\
= \beta_i \Phi (X\beta / \sigma) 
\]  

(4.33)
Step 4

Substituting the result from step 3 for method (1), then income or price elasticity would be as follows.

\[
\frac{1}{\text{EXP}} \frac{\partial \text{EXP}}{\partial \log I} = \frac{\beta_i \cdot \Phi(\bar{X} \beta / \sigma)}{\text{EXP} \text{(case. with positive expenditure only)}}
\]  

(4.34)

where \( x \) takes the sample mean value.

Step 5

Therefore, income and price elasticities for both population only with non-zero child care expenditures and with zero child care expenditures are described as follows.

(a) \( \eta_i = \text{income and price elasticity for the population with non-zero expenditures, where the mean expenditure was considered only by the non-zero cases.} \)

\[
\frac{1}{\text{EXP}} \frac{\partial \text{EXP}}{\partial \log I} = \frac{\beta_i \cdot \Phi(\bar{X} \beta / \sigma)}{\text{EXP} \text{(case. with. positive. expenditure. only)}}
\]  

(4.35)

(b) \( \eta_i = \text{income and price elasticity for the population including zero expenditures, where the mean expenditure was considered only by the total sample size.} \)

\[
\frac{1}{\text{EXP}} \frac{\partial \text{EXP}}{\partial \log I} = \frac{\beta_i \cdot \Phi(\bar{X} \beta / \sigma)}{\text{EXP} \text{(all. cases. including. zero. expenditure)}}
\]  

(4.36)
Finally, income elasticities of child care quantity demanded are the same as income elasticities of child care expenditures, and price elasticities of child care quantity demanded equal price elasticities of child care quantity demanded minus 1. (Please refer to Chapter VI)

2. The Probit and Logit Models

In addition to demand analysis, there will be an alternative possible common approach for demand analysis called choice of child care. If a researcher is not interested in economic analysis of demand for child care, then choice of child care will be another substitute for demand analysis.

In Amemiya's type II Tobit, the Probit selection equation in the first step was mentioned. Here, a household's binary choice of child care services whether purchasing market child care or not will be main focus. The Probit and Logit models represent another type of widely used statistical and econometric model for child care studies with binomial distribution. Furthermore the Probit model is involved in selection equation in the type II Tobit model.
Green (1990), Maddala (1983, 1992), Amemiya (1985), Liao (1994), Hosmer and Lemeshow (1989), and Demaris (1992) described the Probit and Logit model as follows:

\[ y_{i*} = \beta' x_i + \mu_i \] \hspace{1cm} (4.37)

where \( y_{i*} \) is the latent variable which defines the potentiality or ability of purchasing child care services.

The meaning of the latent variable \( (y_{i*}) \) is the utility difference between the household’s purchase of market child care and non-purchase of market child care. Thus, \( y_{i*} \geq 0 \) indicates that the utility of purchasing child care is greater than that of the household’s utility from non-purchasing market child care services so that \( p_i \) stands for the probability of purchasing child care services, whereas \( (1-p_i) \) stands for the probability of the non-event of purchasing child care services.

The following expressions are choice of child care model,

\[ y_i = 1 \text{ if } y_{i*} \geq 0 \]
\[ y_i = 0 \text{ otherwise} \] \hspace{1cm} (4.38)

Likewise,

\[ p_i = p(y_i=1) = \text{Prob}[\mu_i \geq -\beta' x_i] \]
\[ = 1 - F[-\beta' x_i] \]
\[ = F(\beta' x_i) = \Phi(\beta' x_i) \] \hspace{1cm} (4.39)

where \( F \) indicates a form of the standard cumulative distribution function, \( \Phi \).
Since the observed $y_i$ are the real value of a binomial process with probabilities given by equation (4.39), the described maximum likelihood estimation in the Probit for this binary choice is

$$L = \prod p_i \prod (1 - p_i) = \prod F(\beta' x_i) \prod (1 - F(\beta' x_i))$$  \hspace{1cm} (4.40)

when we set up $1 - F(-\beta' x_i) = F(\beta' x_i)$.

On the other hand, if the cumulative distribution of $\mu_i$ is logistic, then we call it a Logit model.

In a Logit model,

$$F(\beta' x_i) = \frac{\exp(\beta' x_i)}{1 + \exp(\beta' x_i)} \hspace{1cm} (4.41)$$

$$\beta' x_i = \log \frac{F(\beta' x_i)}{1 - F(\beta' x_i)} \hspace{1cm} (4.42)$$

From equation (4.32), $p_i$ stands for $F(\beta' x_i)$ and when we substitute this into equation (4.35), we will get

$$\beta' x_i = \log \frac{p_i}{1 - p_i} \hspace{1cm} (4.43)$$

where $\log \frac{p_i}{1 - p_i}$ is called the log-odds ratio which is a linear function of the socio-economic variables.
Likelihood in Logit follows

\[ L = \prod_{i=1}^{n} \left[ 1 + e^{-\beta x_i} \right] \prod_{j=0}^{n} \left[ 1 + e^{\beta x_j} \right] \]  

(4.44)

where \[ \frac{e^{-\beta x_i}}{1 + e^{-\beta x_i}} = \frac{1}{1 + e^{\beta x_j}} \]

On the other hand, if the error term \((u_i)\) in equation (4.39) has the normal distribution, we call it a Probit model or Normit model, which is

\[ F(\beta x_i) = \int_{-\infty}^{\frac{\beta x_i}{\sqrt{2}\pi}} \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{t^2}{2}\right) dt \]  

(4.45)

Therefore, the likelihood estimation in equation (4.40) will be executed for the Probit and Logit models in order for maximization.

Empirically, parameters in both the Probit and Logit are comparable. The variance of Logit has \(\frac{\sqrt{3}}{\pi}\) compared to 1 in Probit. Maddala (1992) noted the transformation as follows:

\[ \hat{\beta}_L(\text{Logit}) \cdot \frac{\sqrt{3}}{\pi} = \hat{\beta}_P(\text{Probit}) \]  

(4.46)
Amemiya (1985) also estimated this relationship as follows:

\[ \hat{\beta}_L (\text{Logit}) \cdot 0.625 = \hat{\beta}_P (\text{Probit}) \] (4.47)

The advantage of using both models is mainly that socioeconomic and demographic effects will be explained by the probability changes related to choice of child care. If a researcher is interested in how much probability a household has, on the average, of purchasing child care, this model will provide a very specific probability. Consequently, the description of the marginal effect should be a required discussion in the following section.

1) Mean Marginal Effects

In this section, the focus turns to the marginal effects, which means the effect of one unit of \( x_i \) on the probability of purchasing market child care services.

a) Probit Model

From the equation (4.39)

\[ P_i = F(\beta'x_i) = \Phi(\beta'x_i) \]

\[ \frac{\partial P_i}{\partial x_j} = \phi(\beta'x_i)\beta_j \] (4.48)

where \( \phi(\cdot) \) is the standard normal probability density function, which has the distribution of \( \frac{1}{\sqrt{2\pi}}\exp\left(-\frac{t^2}{2}\right) \).
b) **Logit Model**

From the equation (4.36),

\[
\frac{\partial p_i}{\partial x_j} = \frac{\partial}{\partial x} \frac{e^{\beta x_i}}{1 + e^{\beta x_i}} \\
= \frac{(1 + e^{\beta x_i}) \beta \cdot e^{\beta x_i} - e^{\beta x_i} \beta \cdot e^{\beta x_i}}{(1 + e^{\beta x_i})^2} \\
= \frac{\beta \cdot e^{\beta x_i}}{(1 + e^{\beta x_i})^2} \beta_j \frac{e^{\beta x_i}}{(1 + e^{\beta x_i})^2}
\]

(4.49)

In empirical analysis, the marginal effect on the probability is evaluated at the sample mean value of all \( x \), thus,

\[
\frac{\partial p_i}{\partial x_j} = \hat{\beta}_j \frac{e^{\hat{\beta} x_i}}{(1 + e^{\hat{\beta} x_i})^2}
\]

(4.50)

### 3. The Log-likelihood Ratio Test

The Final model between an unrestricted model and restricted model will be chosen through the Log-likelihood ratio test. According to Pindyck and Rubinfeld (1990), the Log-likelihood ratio test is described as follows:

\[
-2 \left[ L(\hat{\beta}_n) - L(\hat{\beta}_m) \right] \sim \chi^2_m
\]

(4.51)

when \( L(\hat{\beta}_n) \) is the maximum value of the log-likelihood function when the restriction applies,
L(\beta_m) is the maximum value of the log-likelihood function when the restriction does not apply, \( m \) is the number of restrictions as a degree of freedom.

The hypotheses for the Log-likelihood ratio test are

\[ H_0: \text{some of } \beta \text{'s are equal to 0} \]
\[ H_a: \text{some of } \beta \text{'s are not equal to 0} \]

Regarding the \( \chi^2 \) distribution with \( m \) degree of freedom, if the null hypothesis is rejected, then it means \( \beta \text{'s} \) are not zero, so the restrictions do not apply and vice versa. Thus, when the null hypothesis is rejeucted, the unrestricted one-stage Tobit model would be preferred for the estimation of child care expenditure.

Both estimated equations are as follows:

\[
Y^{UR} = \beta_0 + \sum_{i=1}^{i=n_1} \beta_i x_i + \epsilon_i \quad (4.52)
\]
\[
Y^R = \beta_0 + \sum_{i=1}^{i=n_2} \beta_i x_i + \mu_i \quad (4.53)
\]

where \( n_1 > n_2 \)
4. The Empirical Ad-hoc Model

An ad-hoc empirical specification modelling the demand for consumer goods and services is a function of income, price, wife's working time and other demographic variables. On the basis of demand theory from both neoclassical demand theory and household production theory, the statistical and econometric models, a suggested empirical ad-hoc model of demand and choice for child care is described.

The Type I Tobit: Maximum Likelihood Estimation

\[ y_i^* = f(x) \text{ (price of child care, earned annual income, financial assets, mother's time spent at work, mother's age, age-squared, age cubic, mother's education, number of children less than 2, number of children aged 3 to 5, number of children aged 6 to 11, number of children aged 12 to 17, family type, ethnicity, and MSA status)} \]  (4.54)
\[ y_i^* = f^m(\text{price of child care, earned annual income, financial assets, mother's time spent at work, mother's age, age-squared, age cubic, mother's education, number of children less than 2, number of children aged 3 to 5, number of children aged 6 to 11, and number of children aged 12 to 17}) \]  

\[ \text{(4.55)} \]

where \( f^m \) denotes unrestricted model, and \( f^s \) stands for restricted model.

**The Type II Tobit: Maximum Likelihood Estimation in the first step, and Ordinary Least Square Method in the second step**

**Probit selection estimation in first step**

\[ y_i^* = f^1(\text{price of child care, earned annual income, financial assets, mother's time spent at work, mother's age, age-squared, age cubic, mother's education, number of children less than 2, number of children aged 3 to 5, number of children aged 6 to 11, and number of children aged 12 to 17}). \]

\[ \text{(4.56)} \]
OLS estimation in the second step

\[ y_i^* = f_2(\text{price of child care, earned annual income, financial assets, mother's time spent at work, mother's age, age-squared, age cubic, mother's education, number of children less than 2, number of children aged 3 to 5, number of children aged 6 to 11, and number of children aged 12 to 17}). \]

\[(4.57)\]

In conclusion, for the purpose of accomplishing the estimation of both the demand model and the choice model, the Consumer Expenditure Survey data set from the Bureau of Labor Statistics will be used since this data set provides us with some available variables such as price of child care (CPI will be used as a proxy for child care price), choice of child care arrangement, and the other socioeconomic and demographic information. Furthermore, child care expenditures in three arrangements for child care such as nursery, daycare and combined in-home care and outside-home care are available too.
CHAPTER V
DATA AND DESCRIPTIVE STATISTICS

1. Data Source

The most commonly used household spending data in the U.S.A. is the Consumer Expenditure Survey (CES). The data source in this study was the 1990-1992 CES data. These data have been published by the Bureau of Labor Statistics (BLS). The BLS has been collecting data on the living expenditures and spending patterns of U.S. households for many years. The Consumer Expenditure Survey is a well designed survey where the primary focus is on gathering data related to household expenditures for goods and services purchased and used in our daily lives.

On a regular basis, new households are included since the BLS has a 20% sample rotating system in order to make the data
collection more efficient. That is, every quarter, a new sample regularly replaces 20% of the existing samples.

The BLS data have been collected from nationwide probability samples representing the total civilian, noninstitutional population of the United States. Therefore, each quarter holds a nationally representative sample (BLS Handbook of Methods, Chapter 18. Consumer Expenditures and Income, Bulletin 2285).

The data have samples of four regions including the urban Northeast, urban Midwest, urban South, and urban West. The four regions represent the following states belonging to one of the four regions (1990 EXPN public-use tape documentation: Interview Survey, Dec. 16, 1991, p.181):


**Midwest**: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.

**South**: Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and
West Virginia.


The data also have samples of five city population sizes as follows:

- Size 1 : More than 4 million
- Size 2 : 1.20-4 million
- Size 3 : 0.33-1.19 million
- Size 4 : 75-329.9 thousand
- Size 5 : Less than 75 thousand

2. Sample Selection

For the purpose of preparing the data set in this study, data for households who were interviewed for any four consecutive quarters during the period from 1990 to 1992 were retrieved and their expenditures were summed to get the total expenditures of each consumer unit. This enables one to study each household's actual annual expenditures about every consumption categories. Rural households in the sample were

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1 Since cities having more than a 4 million population were quite few, Size 1 and Size 2 were merged when considering city size population variation.
not used because the Consumer Price Index does not provide price index information for households in rural areas. Furthermore, consumer units which did not report their income or did not have positive income were also excluded from this study.

The Consumer Expenditure Survey provides detailed information on expenditures and demographic characteristics of U.S. households. The data used for this study included only consumer units who participated in the interview for four consecutive quarters during 1990 and 1992. In order to adjust dollar value between three different year periods, all of the dollar values used in this study were adjusted to equal the dollar's value in 1992. Price data from the Consumer Price Index (CPI) were used for adjusting for inflation in each dollar value in the data.

For the purpose of this study, only households with children aged less than seventeen years were included. The sample size was 971 urban households for those whom have at least one child under age six in the 1990-1992 period. Households with positive child care expenditures were 365 consumer units, whereas 606 households had zero child care expense which implicitly indicates that those households use either self-care or unpaid informal child care.
3. Definitions and Measurement of Variables

1) Dependent Variable

In the estimation of the demand for child care services, the dependent variable is expressed as TOTEXPN, indicating annual total child care expenditure including nursery school, day care, babysitting and "other" types of homecare. In the Consumer Expenditure Survey data set, expenditures on nursery and daycare are included with the education expenditure section, and babysitting and other home care are in the miscellaneous expenditure section. Thus, a new aggregated variable, total child care expenditures, is the sum of total household expenses on nursery, daycare, babysitting and other types of home care. The one-stage Tobit and the second step in the two-step Tobit model contain this value as a dependent variable.

In the analysis of choice of child care in which the issue of whether a household purchases market child care (formal child care) or not, the dependent variable is dichotomous, coded 1 if a household has positive child care expenditures and coded 0 if a household has zero child care expenditure. In the two-step Tobit analysis, the dependent variable in the first stage will take this value where a coding of 1 indicates the utility difference between purchasing market child care
and nonpurchasing child care is positive.

2) Independent Variables

The variables listed below will be used not only for basic descriptive statistics but also as independent variables in the further statistical analysis of the demand and choice for child care.

Price of child care

The Consumer Price Index for child care was incorporated as a proxy for child care prices. As a supplement, the American Chamber of Commerce Researchers Association's (ACCRA) Cost of Living Index was used in the process of determining Child Care Price. The American Chamber of Commerce Researchers Association (ACCRA) quarterly provides the Cost of Living Index in order to provide "a useful and reasonably accurate measure of living cost differences among urban areas" (ACCRA, 1992). This index is for measuring the differences in living costs in the United States.

The BLS documentation does not report child care price index officially; however, the Consumer Price Index of child care is a component of the index of personal and educational
expenses which is published in the lowest level of details under the other goods and services categories. That is, the child care expenses item under the personal and educational expenses are not available in CPI publications by the Bureau of the Census. Therefore, the author had to obtain the index for child care expenses directly from the Division of Consumer Price Index under the BLS.

In this study, without considering price variation by both region and city population, only nine\(^2\) Child Care Price Indexes of three years’ merged data set were available in the usage of the CES data set. Even though CPI has four regional price indexes, we cannot use those indexes for mutual regional comparisons because CPI does not provide data on relative cost variations among the four regions. Therefore, the author tried to incorporate the ACCRA cost of living index into the Child Care Index in order to make regional and city size comparisons possible in this study.

Thus, the American Chamber of Commerce Researchers Association Cost of Living Index was used to adjust for the regional price variation. It was possible to consider four

different city (population) size variations of regions except in the Western region because the BLS suppressed city size information on the Western region due to their confidentiality policy. Therefore, consideration for thirteen price variations was available. Consequently, the nine price variations from the CPI index as well as the thirteen variations adjusted by both region and city size using the ACCRA’s Cost of Living Index resulted in a total of 117 price variations during the 1990-1992 period. That is, 117 (= 9*4*3 + 9*1)^3 price variations were obtained from the above procedure. In the empirical analysis, logarithmic price will be incorporated into the model.

Household income and financial assets

There were two different variables considered: household annual after-tax income and total financial assets. The household income variable was an after-tax feature and was adjusted by retirement pensions. In the empirical analysis in this study, natural logarithmic income, noted as LNINCOME will be used. The household’s financial assets variable, represented by financial assets was also created, which consists of amounts invested in their own farm or business; amounts in checking accounts, brokerage accounts and other

\(^3\) The nine CPIs of child care expenses \times 4\) city population \times 3\) (NE, MW, & S) regions \plus 9\) CPIs of child care expenses \times 1\) region (West)
similar accounts; amounts in savings accounts at banks, savings and loans, and credit unions; estimated market value of all stocks, bonds, mutual funds and other such securities; amount of money owned; and amounts in U.S. Saving Bonds.

**Mother's Employment Characteristics**

In the CES data set, information on both wife's work status and hours of work per week and year was available but hours of work measured by time spent in the labor force will be chosen for the characteristics of mother's employment status. For those who were not in the labor force, zero value of time will be coded. In basic statistics, the wife's work status by child expenditure groups was given.

Next, numerous variables with respect to the household's preference will be also incorporated into the demand and choice for child care.

**Mother's age, age squared, and age cubic**

Mother's age was measured as the actual reported age of the respondent. Age squared and age cubic was used for the demand and choice model to explore a possible curvilinear relationship between mother's age and household's total child care expenses. The age squared variable was the squared age divided by 100 and the age cubic variable was the cubed age divided by 10,000. AGE, AGESQ, and AGECUB will be the
abbreviation for those variables.

**Mother’s education**

Mother’s education was coded as a set of dummy variables. The CES data set gives us several categories of education levels. The following categories will be used for the analysis:

- **LESHIGH** coded 1 if mothers completed less than high school; else =0, omitted category
- **HIGHSCH** coded 1 if mothers completed high school or some college; else=0
- **COLLEGE** coded 1 if mother completed college; else=0
- **MORECOL** coded 1 if mother completed more than an undergraduate college degree; else=0.

**Number of children**

Number of children was coded as a continuous variable according to age categories of children. Those age categories are:

- **KIDS02** number of children aged less than 2
- **KIDS0305** number of children aged 3 to 5
- **KIDS0611** number of children aged 6 to 11
- **KIDS1217** number of children aged 12 to 17
**Household Type**

The CES data set originally gave nine different categories of family types. Among those categories, there were four different groups of household types that were used in the descriptive analysis: husband and wife with children only, oldest child less than six; husband and wife with children only, oldest child greater than five and less than or equal to 17; husband and wife families, oldest child greater than 17; female single-parent household with own children at least one aged less than 18; and other types of households. However, in order to conduct further statistical analysis, the single parent-household denoted by SINGLE and the two-parent household denoted as PARENT will be used as dummy variables. This study will test the wife’s or mother’s time effect so that sample will be restricted within all households with a wife or mother.

**Ethnicity**

This variable was coded as the reference person’s race which was categorized into four dummy variables as follows:

- **WHITE** coded 1 if race of a reference person is white; else=0, omitted category
- **BLACK** coded 1 if race of a reference person is Black; else=0
ASIAN coded 1 if race of a reference person is Asian; else=0
OTHER coded 1 if race of a reference person is Other; else=0

Status of metropolitan statistical area (MSA)
This MSA residency was coded as 1 if a household lives inside of a metropolitan statistical area, and was coded 0 if not.

City size
In CES data, originally five categories of city size are given according to the population size. However, this study attempts price adjustment by the Cost of Living Index of ACCRA so that four different city sizes which is matching the population size from CES to ACCRA. Since price index in this study have this city size information, this variable will be used only for the basic descriptive not for statistic modeling. This variable categorized as follows:

CITY1 coded 1 if population size is greater than 1.2 million; else=0,
CITY2 coded 1 if population size is between 0.33 million and 1.19 million; else=0,
CITY3 coded 1 if population size is between 75
thousand and 329.9 thousand; else=0,
CITY4 coded 1 if population size is less than 74 thousand; else=0.

Region
Region was coded as four dummy variables, which were only used for descriptive analysis because the child care price variable already comprises this component.

MIDWEST coded 1 if a household lives in the urban Midwest; else=0;
NEAST coded 1 if a household lives in the urban Northeast; else=0
SOUTH coded 1 if a household lives in the urban South; else=0
WEST coded 1 if a household lives in the Urban West; else=0.

4. Basic Descriptive Statistics

791 urban households with at least one child under age six were used for the analysis. Among the total sample (N=971, sample C), about 37.60 percent of the households (N=365, sample A) had child care expenditures compared to 62.41
percent of households (N=606, sample B) that did not have child care expenditures. Three basic descriptive statistics are shown in Tables 5.1, 5.2, and 5.3.

The mean child care expenditures including daycare, nursery school, and babysitting or other home care were $2,008.91 for households with positive expenditures, compared to $755.15 for pooled samples, respectively. The average total child care expenditure per child was $611.70 for all households (pooled sample) and $1627.10 for households which had only positive child care expenditures.

Household average annual income was $41,683 for positive expenditure households; $30,952 for zero expenditure groups; and $34,986 for pooled households. Average household financial assets were $11,795 for positive expenditure households; $7,444 for zero expenditure groups; and $9,080 for pooled households.

About 78.1 percent of households had wives or mothers who were in the labor force for the positive expenditure groups compared to 58.8 percent for the zero expenditure group. For the employed mothers, the average time at work was for the former group of households was 27.01 hours per week compared to 19.74 hours per week for latter group of households. The mean age of wife or mother was 31.6 years and 31.0 years for
households with positive expenditures and zero expenditure, respectively. Among mothers in positive expenditure groups, about 9.31 percent had less than a high school education; 56.71 percent had a high school diploma, 19.19 percent had a college degree, and 14.79 percent had more than an undergraduate college degree. Among mothers in the zero expenditure groups, about 19.31 percent had less than a high school education; roughly 63.00 percent had a high school diploma, 17.55 percent had a college degree, and 0.60 percent had more than an undergraduate college degree.

Among households with zero and positive child care expenditures, the average number of children aged less than eighteen per household was 2.1 and ranged from 1 to 7. Among households with zero child care expenditures, the average number of children aged less than eighteen per household was 2.1 compared to 1.9 for positive expenditure households.

Among households for those who have positive child care expenditures, about 90 percent of the households were a husband-wife family, whereas 8 percent were a female-headed family. Among households for those who did not have child care expenditures, about 84 percent of the households were a husband-wife family, whereas 16 percent were a female-headed family.
Approximately 93 percent of the households studied lived inside of a metropolitan statistical area across the three expenditure groups. About 91 percent of the positive expenditure groups were White compared to 5.5 percent Black. Of the zero expenditure households, about 22 percent lived in the urban Northeast area, whereas 27 percent lived in the urban Midwest region; 25 percent lived in the urban South region; and 26.1 percent lived in the Western region.

Table 5.3 shows overall information on the households with positive child care expenditures as well as no-expenditure groups (pooled sample).
Table 5.1.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean or Standard Frequencies</th>
<th>Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Annual Child Care Expenditure*</td>
<td>$2,008.91</td>
<td>$2,547.00</td>
</tr>
<tr>
<td>Expenditure per child</td>
<td>$1,627.1</td>
<td>$1,884.15</td>
</tr>
<tr>
<td>Annual Income</td>
<td>$41,683.01</td>
<td>$21,982.32</td>
</tr>
<tr>
<td>Total Financial Assets</td>
<td>$11,795.00</td>
<td>$23,501.40</td>
</tr>
<tr>
<td>Wife’s Labor Force Participation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No work</td>
<td>21.9%</td>
<td></td>
</tr>
<tr>
<td>Part time</td>
<td>25.5%</td>
<td></td>
</tr>
<tr>
<td>Full time</td>
<td>52.6%</td>
<td></td>
</tr>
<tr>
<td>Time per week (if work)</td>
<td>27.01 17.55</td>
<td></td>
</tr>
<tr>
<td>Age of Mother or Wife</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;20</td>
<td>0.5%</td>
<td></td>
</tr>
<tr>
<td>21-30</td>
<td>44.7%</td>
<td></td>
</tr>
<tr>
<td>31-40</td>
<td>51.5%</td>
<td></td>
</tr>
<tr>
<td>&gt;40</td>
<td>3.3%</td>
<td></td>
</tr>
<tr>
<td>Education of mother</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less high school</td>
<td>9.31%</td>
<td></td>
</tr>
<tr>
<td>High school grad</td>
<td>56.71%</td>
<td></td>
</tr>
<tr>
<td>Some college</td>
<td>19.15%</td>
<td></td>
</tr>
<tr>
<td>More college</td>
<td>14.79%</td>
<td></td>
</tr>
<tr>
<td>Number of Children</td>
<td>1.9</td>
<td>0.9</td>
</tr>
<tr>
<td>Household Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H/W, own children only, oldest child &lt; 6</td>
<td>54.0%</td>
<td></td>
</tr>
<tr>
<td>H/W, own children only, oldest child 6-17</td>
<td>36.7%</td>
<td></td>
</tr>
<tr>
<td>H/W, own children only, oldest child &gt; 17</td>
<td>1.1%</td>
<td></td>
</tr>
<tr>
<td>Female-Headed household, at least one child &lt;18</td>
<td>8.2%</td>
<td></td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>90.68%</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>5.48%</td>
<td></td>
</tr>
<tr>
<td>Asian and Pacific Islander</td>
<td>3.83%</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0.01%</td>
<td></td>
</tr>
<tr>
<td>Metropolitan Statistical Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inside</td>
<td>93.15%</td>
<td></td>
</tr>
<tr>
<td>City Size(Population size)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 1.20 million</td>
<td>62.5%</td>
<td></td>
</tr>
<tr>
<td>0.33-1.19 million</td>
<td>18.3%</td>
<td></td>
</tr>
<tr>
<td>75-329.9 thousand</td>
<td>11.4%</td>
<td></td>
</tr>
<tr>
<td>&lt; 75 thousand</td>
<td>6.8%</td>
<td></td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban Northeast</td>
<td>17.81%</td>
<td></td>
</tr>
<tr>
<td>Urban Midwest</td>
<td>26.31%</td>
<td></td>
</tr>
<tr>
<td>Urban South</td>
<td>27.94%</td>
<td></td>
</tr>
<tr>
<td>Urban West</td>
<td>27.94%</td>
<td></td>
</tr>
</tbody>
</table>

Family income was adjusted by retirement pension. Thus,
Family Income =After tax-Income - Retirement Pension

*Total child care expenditures = Nursery + Daycare + Babysitting and other home care
### Table 5.2.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean or Frequencies</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Annual Child Care Expenditure(^5)</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
<tr>
<td>Expenditure per child</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
<tr>
<td>Annual income</td>
<td>$30,952.35</td>
<td>$19,380.86</td>
</tr>
<tr>
<td>Total Financial asset</td>
<td>$7,444.20</td>
<td>$18,217.50</td>
</tr>
<tr>
<td>Wife's Labor Force Participation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No work</td>
<td>41.3%</td>
<td></td>
</tr>
<tr>
<td>Part-time</td>
<td>21.8%</td>
<td></td>
</tr>
<tr>
<td>Full-time</td>
<td>37.0%</td>
<td></td>
</tr>
<tr>
<td>Time per week(if work)</td>
<td>19.7%</td>
<td>19.13</td>
</tr>
<tr>
<td>Age of Mother or Wife</td>
<td>31.0%</td>
<td>5.64</td>
</tr>
<tr>
<td>&lt; 20</td>
<td>2.1%</td>
<td></td>
</tr>
<tr>
<td>21-30</td>
<td>46.8%</td>
<td></td>
</tr>
<tr>
<td>31-40</td>
<td>46.5%</td>
<td></td>
</tr>
<tr>
<td>&gt; 41</td>
<td>5.3%</td>
<td></td>
</tr>
<tr>
<td>Education of mother</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less high school</td>
<td>19.3%</td>
<td></td>
</tr>
<tr>
<td>High school grad</td>
<td>62.5%</td>
<td></td>
</tr>
<tr>
<td>Some college</td>
<td>17.5%</td>
<td></td>
</tr>
<tr>
<td>More college</td>
<td>0.6%</td>
<td></td>
</tr>
<tr>
<td>Number of Child</td>
<td>2.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Household Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H/W, own children only, oldest child &lt; 6</td>
<td>42.6%</td>
<td></td>
</tr>
<tr>
<td>H/W, own children only, oldest child 6-17</td>
<td>39.1%</td>
<td></td>
</tr>
<tr>
<td>H/W, own children only, oldest child &gt; 17</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>Female-Headed household, at least one child &lt;16</td>
<td>16.2</td>
<td></td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>83.0%</td>
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</tr>
<tr>
<td>Black</td>
<td>11.5%</td>
<td></td>
</tr>
<tr>
<td>Asian and Pacific Islander</td>
<td>4.9%</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0.5%</td>
<td></td>
</tr>
<tr>
<td>Metropolitan Statistical Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inside</td>
<td>92.4%</td>
<td></td>
</tr>
<tr>
<td>City Size(Population size)</td>
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<td></td>
</tr>
<tr>
<td>&gt; 1.20 million</td>
<td>60.5%</td>
<td></td>
</tr>
<tr>
<td>0.33-1.19 million</td>
<td>15.8%</td>
<td></td>
</tr>
<tr>
<td>75-329.9 thousand</td>
<td>15.6%</td>
<td></td>
</tr>
<tr>
<td>&lt; 75 thousand</td>
<td>8.0%</td>
<td></td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban Northeast</td>
<td>21.9%</td>
<td></td>
</tr>
<tr>
<td>Urban Midwest</td>
<td>27.0%</td>
<td></td>
</tr>
<tr>
<td>Urban South</td>
<td>24.9%</td>
<td></td>
</tr>
<tr>
<td>Urban West</td>
<td>26.0%</td>
<td></td>
</tr>
</tbody>
</table>

Family income was adjusted by retirement pension. Thus, 
Family Income =After tax income - Retirement pension

\(^5\)Total child care expenditures = Nursery + Daycare + Babysitting and other home care
Table 5.3.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean or Frequencies</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Annual Child Care Expenditure*</td>
<td>$755.15</td>
<td>$1,839.18</td>
</tr>
<tr>
<td>Expenditure per child</td>
<td>$611.70</td>
<td>$1,397.88</td>
</tr>
<tr>
<td>Annual Income</td>
<td>$34,986.02</td>
<td>$21,039.28</td>
</tr>
<tr>
<td>Total Financial asset</td>
<td>$9,079.67</td>
<td>$20,462.20</td>
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<tr>
<td>Wife's Labor Force Participation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Work</td>
<td>34.0%</td>
<td></td>
</tr>
<tr>
<td>Part-time</td>
<td>23.2%</td>
<td></td>
</tr>
<tr>
<td>Full-time</td>
<td>42.8%</td>
<td></td>
</tr>
<tr>
<td>Time per week (if work)</td>
<td>22.47</td>
<td>18.88</td>
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<tr>
<td>Age of Mother or Wife</td>
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<tr>
<td>&lt;20</td>
<td>1.5%</td>
<td></td>
</tr>
<tr>
<td>21-30</td>
<td>45.5%</td>
<td></td>
</tr>
<tr>
<td>31-40</td>
<td>48.8%</td>
<td></td>
</tr>
<tr>
<td>&gt;41</td>
<td>4.5%</td>
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</tr>
<tr>
<td>Education of Mother</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less high school</td>
<td>15.55%</td>
<td></td>
</tr>
<tr>
<td>High school grad</td>
<td>60.35%</td>
<td></td>
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<tr>
<td>Some college</td>
<td>14.42%</td>
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</tr>
<tr>
<td>More college</td>
<td>9.68%</td>
<td></td>
</tr>
<tr>
<td>Number of Children</td>
<td>2.1</td>
<td>1.0</td>
</tr>
<tr>
<td>Household Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H/W, own children only, oldest child &lt; 6</td>
<td>46.9%</td>
<td></td>
</tr>
<tr>
<td>H/W, own children only, oldest child 6-17</td>
<td>38.2%</td>
<td></td>
</tr>
<tr>
<td>H/W, own children only, oldest child &gt; 17</td>
<td>1.8%</td>
<td></td>
</tr>
<tr>
<td>Female-Headed household, at least one child &lt;18</td>
<td>13.2%</td>
<td></td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>85.89%</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>9.27%</td>
<td></td>
</tr>
<tr>
<td>Asian and Pacific Islander</td>
<td>4.53%</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0.31%</td>
<td></td>
</tr>
<tr>
<td>Metropolitan Statistical Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inside</td>
<td>92.68%</td>
<td></td>
</tr>
<tr>
<td>City Size (Population size)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 1.20 million</td>
<td>61.6%</td>
<td></td>
</tr>
<tr>
<td>0.33-1.19 million</td>
<td>16.7%</td>
<td></td>
</tr>
<tr>
<td>75-329.9 thousand</td>
<td>14.1%</td>
<td></td>
</tr>
<tr>
<td>&lt; 75 thousand</td>
<td>7.6%</td>
<td></td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban Northeast</td>
<td>20.39%</td>
<td></td>
</tr>
<tr>
<td>Urban Midwest</td>
<td>26.78%</td>
<td></td>
</tr>
<tr>
<td>Urban South</td>
<td>26.05%</td>
<td></td>
</tr>
<tr>
<td>Urban West</td>
<td>26.78%</td>
<td></td>
</tr>
</tbody>
</table>

Family income was adjusted by retirement pension. Thus, Family Income = After tax income - Retirement pension.

*Total child care expenditures = Nursery + Daycare + Babysitting and other home care
5. Budget Allocation on Child Care

Among the total sample of 971, about 37.6 percent of the households had child care expenditures. The mean expenditures for daycare, nursery school, and babysitting or other home care are shown in Table 5.4. The mean expenditure for all households was about $756, for which $113 was for nursery school; $280 was for day care school; and $327 was for babysitting and other home care. The mean expenditure for households with any expenditures on any type of child care was $2,009. The mean expenditure for households with any expenditure on nursery school was $813. The mean expenditure for households with any expenditure for day care was $1,916. The mean expenditure for households with any expenditure for babysitting and other home care was $868 (Table 5.4).

For all households with young children, the mean budget share for child care was 2.46 percent, whereas for households with young children with positive child care expenditures the mean budget share was 5.61 percent (Table 5.5.1).

For households with positive child care expenditures, 25 percent spent 8.33 percent or more of their budgets on child care, and 25 percent spent 7.57 percent or more of their
incomes on child care (Table 5.5.2). The median level of the budget share was 3.78 percent for households with positive expenditures, and the median percent of income spent on child care was 3.43 percent.
Table 5.4.

<table>
<thead>
<tr>
<th>Categories</th>
<th>All Households Mean</th>
<th>Households with Positive Expenditures Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daycare</td>
<td>280.42</td>
<td>1915.51 (N=142)</td>
</tr>
<tr>
<td>Nursery</td>
<td>113.15</td>
<td>812.97 (N=135)</td>
</tr>
<tr>
<td>Baby Sitting &amp; Homecare</td>
<td>326.50</td>
<td>867.70 (N=365)</td>
</tr>
<tr>
<td>Total Child care Expenditure</td>
<td>755.93</td>
<td>2008.91 (N=365)</td>
</tr>
<tr>
<td></td>
<td>N=970</td>
<td>N=365</td>
</tr>
<tr>
<td>Categories</td>
<td>All Households (N=971)</td>
<td>Households with Positive Expenditures (N=365)</td>
</tr>
<tr>
<td>------------------------</td>
<td>------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Daycare</td>
<td>0.91</td>
<td>5.35</td>
</tr>
<tr>
<td>Nursery</td>
<td>0.37</td>
<td>2.27</td>
</tr>
<tr>
<td>Baby Sitting &amp; Homecare</td>
<td>1.06</td>
<td>2.42</td>
</tr>
<tr>
<td><strong>Total Expenditure</strong></td>
<td><strong>2.46</strong></td>
<td><strong>5.61</strong></td>
</tr>
</tbody>
</table>

Samples of Daycare, Nursery, and Babysitter and other home care are not mutually exclusive. Mean value of total expenditures for all households was $30,702.62. Mean value of total expenditures for households with positive childcare expenditures was $35,835.21.
Table 5.5.2
Household Budget Shares on Child Care Services with Children under Six, Positive Expenses Only, 1990-1992.

<table>
<thead>
<tr>
<th></th>
<th>Percent to Total Exp. (N=361)</th>
<th>Percent to Income (N=365)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>5.61</td>
<td>6.38</td>
</tr>
<tr>
<td>90th Percentile</td>
<td>13.40</td>
<td>13.02</td>
</tr>
<tr>
<td>Upper Quartile (75%)</td>
<td>8.33</td>
<td>7.57</td>
</tr>
<tr>
<td>Median (50%)</td>
<td>3.78</td>
<td>3.43</td>
</tr>
<tr>
<td>Lower Quartile (25%)</td>
<td>1.08</td>
<td>0.94</td>
</tr>
<tr>
<td>10th Percentile</td>
<td>0.31</td>
<td>0.27</td>
</tr>
</tbody>
</table>

Samples of Daycare, Nursery, and Babysitting and other home care are not mutually exclusive. Mean value of household income with positive child care expenditures was $41,683.01. Mean value of total expenditures for households with positive expenditures only was $35,835.21.
CHAPTER VI

ANALYSIS AND RESULTS

1. Demand for Child Care Services: Type I Tobit

In this section, results from two different types of Tobit models are discussed. Results from the unrestricted and restricted type I Tobit models are presented, and the final model is chosen based on the log-likelihood ratio test. Then, empirical results from the type II Tobit model, where Heckman’s two-step method is employed, are discussed.

The mean marginal effects in Tobit models are also presented using LIMDEP and SAS. The Simulation results based on the estimated parameters are graphically illustrated using spreadsheet. As noted earlier in Chapter IV, Tobit analysis produces three mean marginal effects: the potential child care expenditures for all households; the actual child care
expenditures for all households; and the actual child care expenditures for households with positive child care expenditures.

The marginal effects of Tobit models are twofold: one is based on constrained optimization and the other is based on unconstrained optimization. The mean marginal effects of a latent variable are the solution of unconstrained optimization where only the income constraint is restricted (expenditure can be negative or greater than or equal to zero). On the other hand, marginal effects for both households with and without child care expenditures are the solution of constrained optimization where both income and boundary constraints are restricted (expenditure is greater than or equal to zero).

Thus, since an expected value of the latent variables gives us information on the potential allocation of the child care budget, marginal effects of the latent (unobserved) variables indicate the marginal change of the household's potential pay for child care expenditures (latent variable) with respect to the changes of other independent variables, holding preferences and relative prices constant.

The mean marginal effects of actual child care expenditures of all the households with young children are
also given. Similarly, the mean marginal effects of actual child care expenditures of households for those who already have positive child care expenses are also discussed.

In addition, the effects of independent variables which show the statistical significance (income, price, mother's working time, and mother's age) on the demand for child care services are graphically compared through simulation results. The expected values of child care expenditures for all households based on the Tobit results are given based on the following equations by Maddala (1983):

\[
E(y_i) = \Phi_i (\beta' x_i + \sigma \frac{\phi_i}{\phi_i} + \sigma \phi_i) = \Phi_i \beta' x_i + \sigma \phi_i
\]  
\( (6.1) \)

\[
E(y_i | y_i > 0) = \beta' x_i + E(u_i | u_i > \beta' x_i) = \beta' x_i + \sigma \frac{\phi_i}{\phi_i}
\]  
\( (6.2) \)

1) The Unrestricted Model versus the Restricted Model

Tables 6.1 and 6.2 show the results of unrestricted and restricted type I Tobit analyses. Since the null hypothesis was not rejected at \( \alpha = 0.1 \) level, the restricted type I Tobit model would be preferred.\(^7\) Thus, some of the \( \beta \)'s are equal to

\(^7\) \(-2[\ln(\beta_{LR}) - \ln(\beta_{UR})]\) \( \sim \chi^2_m \)

\(-2[-3739.2 - (-3736.3)] = -2(-2.9) = 5.8 \) with \( d.f = 5 \). Since the calculated value of \( \chi^2 \) was not greater than the table value of \( \chi^2 \), the null hypothesis, \( H_0 \), was not rejected at the 0.1 level.
zero, so that adding five more variables including household type, wife's race (which consists of four dummy variables, with White as an omitted category), and household's status in MSA would not increase statistical efficiency for the child care demand model.

Table 6.1 shows the estimates in which three mean marginal effects on the demand for child care are from the Unrestricted type I Tobit with total child care expenditures as the dependent variable. Finally, the restricted type I Tobit model resulting from the log-likelihood ratio test is chosen in Table 6.2 for the purpose of calculating of income and price elasticities, and the effects of other factors affecting demand for child care services. Table 6.2 also represents three mean marginal effects of Tobit model where marginal effects of potential expenditures, actual expenditures within the total sample, and actual expenditures within the sample with positive child care expenditures are given.

**Income Effects and Income Elasticities**

In Table 6.2, income is revealed to be a significant factor at the 0.0001 level. The mean marginal effects of the log of income on total child care expenditures are $304.87 for entire sample and $258.50 for households with positive
expenditures, respectively, whereas potential pay for child care based on the unconstrained optimization was $936.27.

The effect of a 1 percent increase in income on total child care expenditures is a $3.05 increase in total child care expenditures per year. For those who already had positive child care expenditures (N=365), the predicted increase is $2.60. Table 6.3 shows the income elasticities of demand for child care, which are 0.47 for households with positive child care expenditures, and 1.24 for all households including those with zero expenses. Thus, child care is a normal good in which child care is a luxury good for total households with young children compared to a necessity for the households with positive expenditure groups.

Figure 6.1 shows the simulation result of income effect on demand for child care, with potential and actual child care expenditures estimated for various income levels. As indicated by the simulation results, when a household’s income is greater than $110,000, estimated potential expenditure on the basis of the unconstrained optimization starts to change from zero expenditures to positive expenses. The simulation results also indicate that households’ estimated expenditures

\[ \Delta y / \Delta \text{log} X = \partial y / \partial \text{log} X = \beta \ast (\partial X / X) = 3.05 \]

because 1% increase in X equals to \( \partial X / X \).

\[ \partial y / \partial X = [\partial y / \partial \text{log} X] \ast [\partial \text{log} X / \partial X] = \beta \ast [1/X] = 2.59 \]
for households within positive expenditure groups, holding other things constant, are about $2,000 for households with $30,000 income; $2,700 for households with $60,000 income; and $3,500 for households with $115,000 income.

The simulation analysis also shows that the average household with young children aged less than six (including households with zero child care expenditures) spends $500 if income is $30,000; $950 if income is $60,000; and $1,050 if income is $115,000.

**Price Effects and Price Elasticities**

This study attempts to incorporate price information into the model. Logarithmic price is only statistically significant at the 0.08 level. However, it is very important to see the price effect because one of the main purposes of this study was to calculate the price elasticities of the demand for child care. The price adjusted by the Consumer Price Index of the BLS as well as the ACCRA's Cost of Living Index has a range of 93 to 185 during the 1990-1992 period. As mentioned before, both indexes not only enable this study to examine the city size variation in child care prices, but also allow this study to explore regional variations. Average child care price during 1990-1992 in the United States was 117 when the 4th quarter of 1990 was coded as 100. The simulation
of the price effect is illustrated in Figure 6.2. According to simulation, if the child care price doubles (i.e., from a child care index of 100 to 200), the households' expected child care expenditures would decrease from $2,350 to $1,200 for households with positive child care expenditures, whereas for all households, the expenditures would decrease from $900 to $400. Thus, price effects are greater in higher expenditure groups, holding everything else constant. Also, the price effect is expected to be the greatest under the unconstrained optimization.

Based on the empirical demand model from the type I Tobit and Table 6.3, the own price elasticity of quantity demanded for child care is -1.65 for all households (N=971) and -1.26 for households with positive expenditures (N=365). This implies that own price effects can be considered as the evidence of the law of demand which would be the part of the consumer decision making process.

This study tried to estimate the effect of financial assets on the demand for child care but it did not show a significant effect. Thus, a household's demand for child care is greatly influenced by earned income but not by financial assets.

10 Please refer to the footnote of Table 6.3.
Table 6.1
Estimates on Demand for Child Care Services, Represented by Potential, Actual Child Care Expenditures and Mean Marginal Effects, Unrestricted Type I Tobit Model.

| Variables \( X_i \) | \( \beta^{11} \) | \( \partial E(y)/\partial X^{12}_i \) | \( \partial E(y|y>0)/\partial X^{13}_i \) | P-value |
|---------------------|----------------|----------------|----------------|---------|
| Intercept           | -18535.49      | -5960.35       | -4670.97       | .0151   |
| Lnincome            | 1001.20        | 321.95         | 252.30         | .0001   |
| LnPrice             | -1513.35       | -486.64        | -381.36        | .0876   |
| LnFA*               | 40.82          | 13.13          | 10.29          | .1602   |
| Hours/week          | 56.63          | 18.21          | 14.27          | .0001   |
| Age                 | 940.73         | 302.51         | 237.07         | .0708   |
| Agesq               | -2404.92       | -773.34        | -606.05        | .0697   |
| Agecub              | 1950.66        | 627.27         | 491.57         | .0650   |
| Education (High school omitted) |                |                |                |         |
| High                | 70.41          | 22.64          | 17.74          | .8649   |
| College             | 923.34         | 296.91         | 232.68         | .0692   |
| Morecol             | 1525.82        | 490.64         | 384.51         | .0065   |
| Number of Child     |                |                |                |         |
| Age <2              | 496.62         | 159.69         | 125.15         | .0528   |
| Age 3-5             | 631.57         | 203.09         | 159.16         | .0096   |
| Age 6-11            | -342.06        | -109.99        | -86.20         | .0733   |
| Age 12-17           | -772.22        | -248.32        | -194.60        | .0228   |
| Household Type (H/W household omitted) |                |                |                |         |
| Single-Head         | 659.46         | 212.06         | 166.18         | .1687   |
| Ethnicity (White omitted) |            |                |                |         |
| Black               | -768.70        | -247.19        | -193.71        | .1417   |
| Asian               | -361.30        | -116.18        | -91.05         | .5569   |
| Other               | -17306.07      | -3973.95       | -3114.29       | .9977   |
| MSA                 |                |                |                |         |
| Inside              | 127.16         | 40.89          | 32.04          | .7973   |
| Sigma               | 3084.30        |                |                |         |
| Log-L               | -3736.28       |                |                |         |

LIMDEP was used for calculating three mean marginal effects.
a: Z score=-0.46, \( \Phi(z)=0.32, \phi(z)=0.36 \)
*: FA indicates Financial Asset

\( \beta^{11} \) Desired, Potential Expenditures: \( \partial E(y^*)/\partial X_i = \beta_j \)

\( \partial E(y)/\partial X_i = \Phi(z)\beta_j \)

\( \partial E(y|y>0)/\partial X_i = \beta_j[1-z(\phi(z)/\Phi(z))-(\phi(z)/\Phi(z))^2] \)

\( \Phi(z) = (\frac{1}{\sqrt{2\pi}})\int^{-z}_{-\infty} e^{-\frac{1}{2}x^2} dx \)

\( \phi(z) = (\frac{1}{\sqrt{2\pi}}) e^{-\frac{1}{2}z^2} \)
| Variables ($X_i$) | $\beta$ | $\delta E(y)/\delta X_i$ | $\delta E(y|y>0)/\delta X_i$ | P-value |
|------------------|---------|--------------------------|-----------------------------|---------|
| Intercept        | -18515.65 | -6029.14 | -5112.24 | .0151 |
| Lnincome         | 936.27 | 304.87 | 258.50 | .0001 |
| LnPrice          | -1540.62 | -501.66 | -425.37 | .0788 |
| LnFA*            | 40.90 | 13.32 | 11.29 | .1490 |
| Hours/week       | 56.13 | 18.28 | 15.50 | .0001 |
| Age              | 1020.43 | 332.28 | 281.74 | .0504 |
| Agesq            | -2615.91 | -851.81 | -722.27 | .0489 |
| Agecub           | 2130.91 | 693.88 | 588.35 | .0441 |
| Education        |         |         |         |         |
| High             | 68.69 | 22.37 | 18.97 | .8682 |
| College          | 900.40 | 293.19 | 248.60 | .0766 |
| Morecol          | 1539.93 | 501.43 | 425.17 | .0061 |
| Number of Child  |         |         |         |         |
| Age <2           | 441.21 | 143.67 | 121.82 | .0834 |
| Age 3-5          | 596.13 | 194.11 | 164.59 | .0142 |
| Age 6-11         | -349.28 | -113.73 | -96.44 | .0661 |
| Age 12-17        | -822.84 | -267.94 | -227.19 | .0156 |
| Sigma            | 3097.10 |         |         |         |
| Log-L            | -3157.00 |         |         |         |

LIMDEP was used for calculating three mean marginal effects.

a: $Z$ score = -0.45, $\Phi(z) = 0.33$, $\phi(z) = 0.36$

*: FA indicates Financial Assets

From Maddala(1983, p158-159), expected values of child care expenditure for the households with and without expenditures are as follows. Simulation will be based on following equations using spreadsheet.

$$E(y_i) = \Phi_i (\beta' x_i + \sigma \frac{\phi_i}{\Phi_i}) + \sigma \phi_i \cdot 0 = \Phi_i \beta' x_i + \sigma \phi_i$$

$$E(y_i|y_i>0) = \beta' x_i + E(u_i|u_i>0) = \beta' x_i + \sigma \frac{\phi_i}{\Phi_i}$$
Wife’s or Mother’s working time in the Labor Force

For all households, an one hour increase in the mother’s weekly working time would cost $18.30 more per year. For households with positive child care expenditures, an one hour increase in the mother’s weekly working time would increase child care expenditure by $15.50 per year. Thus, if a non-working mother enters the labor force as a full-time worker, it is expected that the family’s annual budget on child care would be increased, on average, by $732 for all households and $620 for households with positive child care expenditures.

Figure 6.3 shows the simulation result of a wife’s working time on the market child care demand. When mothers’ working hours are 45 per week, estimated child care spendings are about zero under the unconstrained optimization result, $1,000 for households with and without expense groups, and roughly more than $3,300 for households with only positive expenditure groups. If a mother who is not currently in the labor force (i.e., a mother’s working hours equal zero) but would like to work as a part-time worker (e.g. working hours are 20 hours per week), the simulation projects that the estimated child care expenditures range from $300 to $600 for households including zero expenditure groups compared to $800 to $1,800 for households with positive expenditure groups.
The estimated child care expenditures of full-time working mothers (40 hour per week) are $1,000 for the all households including the zero expenditure group (N=971) and $3,000 for the households with positive expense groups (N=365), respectively. Therefore, empirical result shows that mother’s time at market production was positively associated with the purchase of market child care so that mother’s time at market work is complemented with the purchase of market child care services, and also is substituted for mother’s time spent in home production (self-care).

Curvilinear Mother’s Age Effect

Age of the mother had a curvilinear effect on child care expenditure, holding all other factors constant. Figure 6.4 illustrates the curvilinear age effect on child care expenditures where potential and actual expenditures are estimated. Child care expenditures increase from mother’s age 18 until age 33. At age 33, the estimated child care expenditures reach a peak of $2,200 and $700 for households with positive expense groups and for all households including the zero expenditure groups, respectively. The curvilinear age effects are bigger in the former group compared to the latter group. The upswing trend after mother’s age at 50 may partly indicate that the mothers start spending on their grandchildren. The estimated spending level for the
households under the condition of the unconstrained optimization shows below zero expenditure across all age groups.
Table 6.3  
Income and Price Elasticities of Quantity Demanded for Child Care Services, using MLE based on Type I Tobit Model

<table>
<thead>
<tr>
<th>Elasticity</th>
<th>$\varepsilon_1(\exp &gt; 0)$</th>
<th>$\varepsilon_2(\exp \geq 0)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>0.47</td>
<td>1.24</td>
</tr>
<tr>
<td>Price</td>
<td>-1.26</td>
<td>-1.65</td>
</tr>
</tbody>
</table>

The calculation procedure is in Appendix 1.
Simulation Results Based on Tobit Estimates in Table 5.2: Effect of Household Income on the Potential, Actual Child Care Expenditure, Holding Preferences and Relative Prices constant, Measured at Sample Mean Level
Figure 6.2
Simulation Results Based on Tobit Estimates in Table 5.2: Effect of Child Care Price on the Potential, Actual Child Care Expenditure, Holding Incomes and Preferences Constant, Measured at Sample Mean Level
Figure 6.3

Simulation Results Based on Tobit Estimates in Table 5.2: Effect of Mother's time at work on the Potential, Actual Child Care Expenditure, Holding Income, Other Prices, and Preferences constant, Measured at Sample Mean Level
Figure 6.4

Simulation Results Based on Tobit Estimates in Table 5.2: Effect of Mother's Age on the Potential, Actual Child Care Expenditure, Holding Income, Other Prices, and Preferences Constant, Measured at sample mean level
Mother’s Education

Households with wives or mothers who had a college degree are likely to spend $293 more on child care than would those with less than a high school diploma. For households with positive child care expenditures (N=365), households where the mother’s level of education was college level spend $249 more on child care expenditures than would comparison households. The suggested potential expenses for child care services, which is associated with household’s unconstrained utility maximization, are $900 more for households where the mother’s level of education was more than an undergraduate college degree, compared to households in which mother’s education was less than a high school diploma.

Similarly, the empirical result shows that a wife’s (mother’s) educational effect is much greater in the higher education group. In the case of households where the wives or mothers had more than an undergraduate college degree, households’ annual child care expenses are $501 more than those with less than a high school diploma. For households with positive child care expenditures (N=365), households’ child care expenses where the mother’s level of education is more than an undergraduate college degree is $425 more than their counterpart households. From the viewpoint of
the household's utility maximization, estimated annual desired
cild care expenditure is $1,540 more for households where the
mother's level of education is more than an undergraduate
college degree, compared to households where mother's
education is less than a high school diploma.

**Number of Children**

The range of total number of children aged less than
eighteen was 1 to 7. A household with children aged less than
two or between 3 and 5 would increase child care expenses,
whereas households with older children lowered child care
expenses. For all samples, one more child aged less than two
leads to $144 more expenditures than their counterparts
without the oldest child aged less than two. For households
with some child care spending (N=365), one additional child
aged less than two would spend $122 more than their
counterpart household without the oldest child aged less than
two.

Conversely, one additional child aged between 6 and 11
lowers annual child care expenditure by $114 for all
households and $96 for households with positive expenses,
compared to households without children belonging to those age
categories, respectively. An increase of one more child aged
between 12 and 17 decreases annual child care expenses by $268
and $227 for all households and positive expenditure groups, respectively. The positive relationship between annual child care expenditures and the number of minor children aged less than six, and the negative relationship between child care expenditures and the number of older children aged 6 to 17 may be partly due to the fact that child care expenditures only regards child care expenses for those aged less than six, and older children may be possible caregivers for younger siblings (minor children) within a household.

2. Demand and Choice for Child Care Service: Type II Tobit

1) Probit Selection Model

In this chapter, choices for market (purchased) child care services will be determined by the income, price, financial assets, mother’s working hours, age of mother, education of mother, and number of children. Table 6.4 shows the results of the Probit selection equation for a household’s choice for child care services. Logarithmic income, logarithmic price, wife’s weekly working hours, wife’s educational dummy variable which is categorized as more than an undergraduate college degree, and the number of children aged 12 to 17 are statistically significant variables affecting the probability of purchasing of child care at the
0.05 level. Results indicate that an one unit change in 
natural logarithmic income leads to a 9 percent greater 
likelihood of purchasing market child care services. For 
instance, a household's income increases from $25,000 
(Log25,000=10.12) to $68,000 (Log68,000=11.12), on average, 
leads to a 9 percent increase in the purchase of more market 
child care services. Similarly, the marginal effect of the 
natural logarithmic price on the probability of purchasing 
market child care services was -0.2623, which indicates that 
if the child care price index increases from 122 (Log122=4.8) 
to 330 (Log330=5.8), then a household is 26 percent less 
likely to purchase market child care services.

The mother's status in the labor force participation was 
found to be a significant factor affecting the probability of 
purchasing market child care services at the 0.0001 level. 
The mean marginal effect of working hours is, on average, 
.0036 indicating that a mother who increases her weekly 
working hours by one is 0.36 percent more likely to buy market 
child care services. For instance, if a mother who is not 
currently in the labor force enters the labor force as a full-
time worker (40 hours-base work per week), that household 
would experience an increase of 14.4 percent of the likelihood 
of purchasing child care services compared to when the mother 
was not in the labor force.
Curvilinear age effect was also found to be significant in affecting the choice of market child care but it is difficult to calculate the marginal effect. Mother's education had a positive effect on purchasing market child care services. A household with a mother who had a high school diploma is 3.3 percent more likely to purchase child care services than a household with wife who had less than a high school diploma. A household with a mother who had a college degree is 11.54 percent more likely to purchase child care than comparison households. The educational marginal effects are the biggest in the households with mothers who had more than an undergraduate college degree among comparison households.

One additional child aged between 6 and 11 decreases the probability of purchasing child care services by 12.6 percent. Furthermore, for a household with a child aged between 12 and 17, the probability of purchasing market child care services decreases by 25.3 percent. This may be evidence that older children are a possible source of babysitting services at home, so that the presence of an older sibling lowers the child care expenses for young children.
<table>
<thead>
<tr>
<th>Variables ($X_j$)</th>
<th>$\beta$</th>
<th>S.E</th>
<th>$\frac{\partial P(y=1)}{\partial X_j}$</th>
<th>P-value</th>
</tr>
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<td>N.A.</td>
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<tr>
<td>Lnincome</td>
<td>.24282</td>
<td>.07050</td>
<td>.0902</td>
<td>.0006</td>
</tr>
<tr>
<td>LnPrice</td>
<td>-.70607</td>
<td>.30550</td>
<td>-.2623</td>
<td>.0208</td>
</tr>
<tr>
<td>LnFA*</td>
<td>.01025</td>
<td>.00978</td>
<td>.0038</td>
<td>.2942</td>
</tr>
<tr>
<td>Hours/week</td>
<td>.00973</td>
<td>.00242</td>
<td>.0036</td>
<td>.0001</td>
</tr>
<tr>
<td>Age</td>
<td>.67349</td>
<td>.33720</td>
<td>.2502</td>
<td>.0458</td>
</tr>
<tr>
<td>AgeSq</td>
<td>-1.8538</td>
<td>.99900</td>
<td>-.6886</td>
<td>.0635</td>
</tr>
<tr>
<td>AgeCub</td>
<td>1.6253</td>
<td>.96490</td>
<td>.6037</td>
<td>.0921</td>
</tr>
<tr>
<td>Education (LessHigh school omitted)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>.08889</td>
<td>.13890</td>
<td>.0330</td>
<td>.5222</td>
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<td>College</td>
<td>.31067</td>
<td>.17730</td>
<td>.1154</td>
<td>.0797</td>
</tr>
<tr>
<td>Morecol</td>
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<td>.20180</td>
<td>.1737</td>
<td>.0205</td>
</tr>
<tr>
<td>Number of Child</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age &lt;2</td>
<td>-.02800</td>
<td>.09027</td>
<td>-.0104</td>
<td>.7564</td>
</tr>
<tr>
<td>Age 3-5</td>
<td>.10304</td>
<td>.08498</td>
<td>.0383</td>
<td>.2253</td>
</tr>
<tr>
<td>Age 6-11</td>
<td>-.12635</td>
<td>.06512</td>
<td>-.0469</td>
<td>.0523</td>
</tr>
<tr>
<td>Age 12-17</td>
<td>-.25329</td>
<td>.11390</td>
<td>-.0941</td>
<td>.0262</td>
</tr>
</tbody>
</table>

Log-L -584.48
Chi-square 116.69

* : FA indicates Financial Asset

Marginal effects of independent variables on the probability of purchasing market child care are $
\frac{\partial P(y=1)}{\partial X_j} = \phi(\beta^T x_j) \beta_j$, where $\phi(\cdot)$ is the standard normal probability density function.
2) Ordinary Least Square Method with Sample Selectivity Correction Factor

According to Heckman’s two-step method, the second step may be estimated by the Ordinary Least Square method using only the positive child care expenditure households where the sample selection bias correction factor is entered as another regressor. Table 6.5 shows the result of the second step of type II Tobit analysis. As noted by Amemiya (1985), the Ordinary Least Square method is not statistically efficient compared to Maximum Likelihood Estimation; even the Generalized Least Square method is not as fully efficient as the Maximum Likelihood Estimation. Furthermore, the explanatory variables between step 1 and step 2 are the same since the regressors of both the choice and demand models are not expected to be different from each other. Thus, lambda (sample selectivity correction factor or inverse Mills ratio) already contains all the factors of the estimation in step 1, and the OLS estimates on the second step yield statistically insignificant results. Even the explanatory variables in the first step could be constructed in a different way, but the expected results would be similar since the decision in both cases is not different.
Table 6.5
Ordinary Least Squares Estimates on the Demand for Child Care Services, Second Step, Type II Tobit.

<table>
<thead>
<tr>
<th>Variables (X_j)</th>
<th>β</th>
<th>S.E</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
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<td>115200.00</td>
<td>.4153</td>
</tr>
<tr>
<td>LnIncome</td>
<td>3822.30</td>
<td>3929.00</td>
<td>.3306</td>
</tr>
<tr>
<td>LnPrice</td>
<td>-8224.70</td>
<td>11400.00</td>
<td>.4705</td>
</tr>
<tr>
<td>LnFA*</td>
<td>170.37</td>
<td>227.20</td>
<td>.4534</td>
</tr>
<tr>
<td>Hours/week</td>
<td>183.92</td>
<td>145.60</td>
<td>.2065</td>
</tr>
<tr>
<td>Age</td>
<td>5710.40</td>
<td>7977.00</td>
<td>.4714</td>
</tr>
<tr>
<td>Age Squared</td>
<td>-15055.00</td>
<td>20800.00</td>
<td>.4692</td>
</tr>
<tr>
<td>Age Cubed</td>
<td>12511.00</td>
<td>17010.00</td>
<td>.4619</td>
</tr>
<tr>
<td>(Less than High school omitted)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>High</td>
<td>1158.20</td>
<td>2722.00</td>
<td>.6705</td>
</tr>
<tr>
<td>College</td>
<td>4234.50</td>
<td>5088.00</td>
<td>.4053</td>
</tr>
<tr>
<td>More Col</td>
<td>6284.2</td>
<td>6887.00</td>
<td>.3615</td>
</tr>
<tr>
<td>Number of Child</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Age &lt; 2</td>
<td>505.45</td>
<td>1535.00</td>
<td>.7419</td>
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<tr>
<td>Age 3-5</td>
<td>1930.20</td>
<td>2023.00</td>
<td>.3398</td>
</tr>
<tr>
<td>Age 6-11</td>
<td>-1645.5</td>
<td>2160.00</td>
<td>.4462</td>
</tr>
<tr>
<td>Age 12-17</td>
<td>-3607.9</td>
<td>4402.00</td>
<td>.4125</td>
</tr>
<tr>
<td>Lambda</td>
<td>18450.00</td>
<td></td>
<td>.3920</td>
</tr>
</tbody>
</table>

* : FA indicates Financial Asset
3. Discussion of the Results

1) Comparison Between the Type I and the Type II Tobit Results

Table 6.6 shows the comparison between MLE (Type I Tobit) and OLS (Type II Tobit) results where type I Tobit gives us more statistical efficiency, whereas type II Tobit provides us unbiased results but none of them are significant. Therefore, in the discussion below of the amount of child care expenditure demanded, type I results will be used. There will be also some discussion of the results of the choice model (Table 6.4).

2) The Effect of Price on the Demand for Child Care

Based on the empirical demand model from the type I Tobit and Table 6.3, the own price elasticity of quantity demanded for child care is -1.65 for all households and -1.26 both for households with positive expenditures. The large elasticities, even if it is only significant at the 0.08 level, have implications for government tax policy, child care subsidies targeted at low income families, and for regulation of the quality of child care.
The large and statistically significant effect of price on the choice of purchasing child care services in the market (Table 6.4) also has important implications for these issues.

One government program that may affect the choices of most households with young children is the child care tax credit. This credit can reduce a household's federal income tax liability by from 20 to 30 percent of the expenditures on child care, yet many low income households may not benefit because they do not file income tax returns or their total federal income tax liability is less than their child care expenditures (Garfinkel, Meyer and Wong, 1990). Making the tax credit refundable, that is, having the government send a check to households whose child care tax credit exceeds their income tax liability, might improve the child care quality and quantity purchased by low income households (Robins, 1990; Garfinkel, et al., 1990) by substantially lowering the price. For households receiving benefits from the credit, the effect on price is higher for moderate income households than for middle and higher income households. For instance, in 1994, the 30 percent credit was available only for households whose lower paid parent earned no more than $10,000, and the credit was 20 percent for households whose lower paid parent earned $28,000 or more (Internal Revenue Service, 1994, Form 2441).
<table>
<thead>
<tr>
<th>Variables ($X_j$)</th>
<th>$\beta_{MLE}$</th>
<th>$\beta_{HECKMAN}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-18515.00**</td>
<td>-93856.00</td>
</tr>
<tr>
<td>Lnincome</td>
<td>936.27***</td>
<td>3822.30</td>
</tr>
<tr>
<td>LnPrice</td>
<td>-1540.62*</td>
<td>-8224.70</td>
</tr>
<tr>
<td>LnFinancial asset</td>
<td>40.90</td>
<td>170.37</td>
</tr>
<tr>
<td>Hours/week</td>
<td>56.13***</td>
<td>183.92</td>
</tr>
<tr>
<td>Age</td>
<td>1020.43*</td>
<td>5710.40</td>
</tr>
<tr>
<td>AgeSq</td>
<td>-2615.91**</td>
<td>-15055.00</td>
</tr>
<tr>
<td>AgeCub</td>
<td>2130.91***</td>
<td>12411.00</td>
</tr>
<tr>
<td>Education</td>
<td>(&lt;High school omitted)</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>68.69</td>
<td>1158.20</td>
</tr>
<tr>
<td>College</td>
<td>900.40*</td>
<td>4234.50</td>
</tr>
<tr>
<td>Morecol</td>
<td>1539.93***</td>
<td>6284.2</td>
</tr>
<tr>
<td>Number of Child</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age &lt;2</td>
<td>441.21*</td>
<td>505.4</td>
</tr>
<tr>
<td>Age 3-5</td>
<td>596.13**</td>
<td>1930.70</td>
</tr>
<tr>
<td>Age 6-11</td>
<td>-349.28*</td>
<td>-1645.50</td>
</tr>
<tr>
<td>Age 12-17</td>
<td>-822.84**</td>
<td>4402.00</td>
</tr>
</tbody>
</table>

* ; p < .1,  ** ; P < .05,  *** ; P < .01
The structure of the tax credit might help explain the relative size of the elasticities from the Type I Tobit (-1.65 for all households and -1.26 for households with positive expenditure,) as the effective price reduction from the tax credit was only available for those making some expenditure, and was probably not relevant to households considering a small level.

Subsidized child care centers typically have a graduated payment system, so that low income households face a lower price than high income households. The fact that income has a significant, positive effect implies that the combined effect of the tax credit system and any subsidy programs do not have a very large effect. On the other hand, the relatively low size of the income elasticity for households with positive child care expenditure (Table 6.3) may be related to implicit price effects.

Government regulation aimed at increasing the quality of child care, if not accompanied by increased tax credits or subsidies, might lead to a substantial decrease in household purchases of child care. The price elasticities estimated with the Type I Tobit Model (Table 6.3) imply that a regulation resulting in a 10 percent increase in price would cause a 12.6 percent decrease in the quantity of child care purchased (among those already spending money on child care)
and 16.5 percent decrease in the quantity of child care among all households with young children. The Probit analysis for the Type II Tobit Model (Table 6.4) implies that an increase in the price index from 100 to 120 would result in a 2.5 percent decrease in the choice of child care.

The price effects estimated in this study are consistent with the estimates in Blau and Robins (1988), but are in contrast to the estimates in Robins and Spielman (1978). The price elasticity of child care quantity demanded estimated in this study indicates that a 1 percent increase in the price of child care results in a 1.65 percent and 1.26 percent decrease in the quantity of child care services demanded. Therefore, child care for both samples appears to be price elastic since a 1 percent change of price results in a decrease in the quantity demanded of child care of more than 1 percent.

The child care industry might consider the price effects found in this study in planning pricing strategies. There appear to be economies of scale in child care services (Powell and Cosgrove, 1992). If child care were provided by large corporations, the high price elasticities would provide considerable incentives for cost-cutting, although the impact on quality might be uncertain (Waite, Leibowitz and Witsberger, 1991).
3) The Effect of Income on the Demand for Child Care

The income elasticities estimated with the Type I Tobit Model (Table 6.3) imply that a 10 percent income increase would cause a 4.7 percent increase in the quantity of child care purchased (among those already spending money on child care) and 12.4 percent increase in the quantity of child care among all households with young children. The effect of income obtained in the Probit analysis for the Type II Tobit Model (Table 6.4) implies that an increase in income from $10,000 to $11,000 would cause an one percent income increase in the choice of child care.

It is possible that differences in the effective price paid by households because of the federal income tax credits and subsidized programs distort the income effects obtained in these estimates. On the other hand, in absence of any subsidies, obviously low income households who need child care will obtain much lower quality than will high income households. The findings of Waite, Leibowitz and Witsberger, (1991) that higher income families do not obtain higher quality must be carefully considered, however. It is possible that much more consumer education is needed to improve the ability of parents to select high quality child care.
4) The Effect of Wife’s Working Hours on the Demand for Child Care

According to Becker’s household production theory, the value of a mother’s time will positively influence the amount of time spent in market production, resulting in greater purchases of child care services. Therefore, the empirical results (Tables 6.2 and 6.4) suggest that as more time is spent at work, households tend to spend more on child care services, indicating the mother’s time at work and market child care services are complements (mother’s time at work and self care are substitutes). Even though a wife’s wage rate was not used in this study, the result of this study demonstrates that the mother’s allocation of time on market activity is directly related to the purchase of market child care. Robins and Spielman(1978) and Connelly(1992) had similar results, finding a positive relationship between a woman’s wage rate and the probability of paying for child care expenditures.

5) The Effect of Wife’s Age on the Demand for Child Care

At the mean values of other variables, the predicted demand for child care (Table 6.2) increases with the wife’s age up to age 33, then decreases until age 50, then increases. The Probit results are similar. Almost all of the wives were under 40 (Table 5.1.) so the increase from age 20 to age 33 is
the most important result to explain. Given that the wife's wage rate is not controlled, the increase with age may be related to the increase in the wife's wage rate. Therefore, this result is consistent with Becker's household production model, with market time being a substitute for the wife's time spent in household work.

6) The Effect of the Wife's Education on the Demand for Child Care

The amount of child care demanded is higher for households with a wife who has more than an undergraduate college education or better (Tables 6.2 and 6.4). Because the wife's wage rate was not controlled, it is plausible that these results are due to women with more education having a higher wage rate. This result is also consistent with Becker's household production model, with market time being a substitute for the wife's time.

7) The Effect of the Number of Children of Different Ages on the Demand for Child Care

The amount of child care demanded is lower for households with children over the age of 5 (Tables 6.2 and 6.4). The amount demanded is decreases with the number of children under 6 according to the Type I Tobit results (Table 6.2) but not according to the Probit results (Table 6.4). Clearly, families use older children as babysitter. Whether this is a
desirable result from the point of view of society, especially for children aged 6 to 11, is questionable.
CHAPTER VII

SUMMARY AND CONCLUSION

This chapter presents the purpose of this study, the procedures of the empirical analysis, results of the empirical analysis, strengths of this study, and finally the conclusions and implications of this dissertation research.

1. The Purpose of this Study

There were five goals for this study:

1. To bridge the gap between demand and choice theories in the neoclassical approach and the household production approach;

2. To explore the effects of income, price, financial assets, wife’s time at market work, and other socio-demographic variables on the demand and choice for child care, especially income and price elasticities of child care quantity demanded;

3. To construct statistical and econometric models addressing the issues of statistical efficiency and
unbiasedness as well as sample selection bias correction, and to model type I and II Tobit;

4. To show the simulation graphically using the results from the empirical analysis; and

5. To provide useful information for family resource management or consumer and family economics educators, financial planners, financial counselors, and public policy makers.

2. Procedures of the Empirical Analysis

This study attempted to test both the conventional theory of demand and household production function theory simultaneously. The proposed models were the type I Tobit and the type II Tobit. Within the type I Tobit model, an unrestricted model and a restricted model were constructed. The variables restricted were household type, mother’s ethnicity where White, Black, Asian, and other race were coded as dummy variables, and metropolitan statistical residency. On the basis of the log-likelihood ratio test, the restricted type I Tobit model was selected as a demand model for child care services.

The type II Tobit model was also constructed. In the type II Tobit model, Heckman’s two-step method was executed but it showed statistically inefficient results. From the first step
of Heckman's two-step statistical method, the model for the choice of purchasing market child care services was constructed.

Simulation results were based on the results from the type I Tobit estimates in which the household's potential expenditures for child care were analyzed, and the estimated mean marginal effects for all households and for households with positive child care expenditures were compared. Simulations were conducted for income, price of child care, mother's time at market work, and mother's age.

For the purpose of exploring the demand for child care services, the restricted type I Tobit analysis was chosen, whereas step 1 from the type II Tobit model was performed in order to analyze the household's choice for child care services.

3. Results of Empirical Analysis

The sample used in this study consisted of 791 urban households with at least one child under age six. Among the total sample (N=971), 37.60 percent of the households (N=365) had positive child care expenditures and 62.41 percent of households (N=606) had zero child care expenditures. The mean child care expenditures including daycare, nursery school, and
babysitting or other home care were $2,008.91 for households with positive expenditures (N=365) compared to $755.15 for all households (N=971). The mean child care budget share for all households was 2.46 percent, whereas the mean budget share for households with positive child care expenditures was 5.61 percent.

According to the U.S. Bureau of Census (1995), child care expenditures were a greater burden for the poor family and showed that poor families who paid for child care for their preschoolers spent 18 percent of their income in 1993, whereas 7 percent was spent on such care for non-poor families. Another report by the 1991 National Child Care Survey (NCCS) was in line with the Census report that the average budget share of two parent families with the youngest child under age five was 9 percent for employed mothers. In NCCS data, expenditure on child care is mainly the sum of payments across all child care arrangements such as relatives, in-home providers, family day care, centers and other lessons. The difference between the NCCS data and the CES data may stems from the reason that the former data set only included households with positive expenditures whereas the data set used in this study included both positive child care expenditures and zero expenditures.
Results indicated that child care is a normal good and a necessity for the households that already had positive expenses (N=365), while child care is a luxury good for all the households with young children (N=971). The own price elasticity of quantity demanded for child care was -1.65 and -1.26 for both households with total samples (N=971) and positive expense groups (N=365), respectively. This implies that own price effects can be considered as evidence of the law of demand which would be a part of the consumer decision making process.

Empirical results suggested that as more time is spent at work, households tend to spend more on child care services indicating that the mother’s time spent in the labor market is complemented with the purchase of market child care services, and thus it is also substituted for time spent in home production called self-child care. Child care expenditure increases from mother’s age 18 until age 33. At age 33, estimated child care expenditures reach a peak of $2,200 and $700 for both households with positive expense groups and all households including no-expenditure groups, respectively.

Empirical results showed that the wife’s (mother’s) educational effect is much greater in higher education groups. In the case of households where the wives or mothers had more than an undergraduate college degree, the households’ annual
child care expenses are $501 more than those with less than a high school diploma. For households with positive child care expenditures (N=365), households' child care expense, where the mother's level of education was more than an undergraduate college degree was $425 more than their counterpart households. Estimated annual potential child care expenditures subject to the unconstrained optimization was $1,540 more for households where the mother's level of education was more than an undergraduate college degree, compared to households where the mother's education was less than a high school diploma.

One more child aged less than two leads to $144 more in child care expenditures than their counterpart households without an oldest child less than two. For households with some child care spending (N=365), one additional child aged less than two caused $122 more spending than their counterpart households without an oldest child aged less than two. Conversely, one additional child aged between 6 and 11 lowers annual child care expenditures by $114 for all households and $96 for households with positive expenses, compared to households without children belonging to those age categories, respectively. An increase of one more child aged between 12 and 17 decreases annual child care expenses by $268 and $227 for all households and positive expenditure groups, respectively.
4. Strengths of this study

The Consumer Price Index for child care was incorporated as a proxy for child care prices. Additionally, as a supplement, the American Chamber of Commerce Researchers Association's (ACCRA) Cost of Living Index was used in the process of determining Child Care Price. Unlike most studies on family consumption which are mainly focused on the relationship between income and expenditures (so-called Engel analysis), this study can analyze the demand for child care services as well as expenditures since both income and price elasticities of child care quantity demanded were obtained due to the richness of the data set. This price information may provide useful information to public policy makers in that government regulation with respect to quality of child care is directly affect the price of child care. Yet, none of child care study addresses the relationship between government regulation concerning the issue of child care quality and price information. Thus, this study is unique.

In addition to the income and price effects, the relationship between a mother's time and a household's market production was revealed, yielding those as substitutes. Therefore, gap between neoclassical demand theory and household production theory was empirically tested and effectively bridged, which has not been widely attempted in
Two different econometric approaches in Tobit Model, type I and type II, were initiated in this study. Derived Log-likelihood functions for both Tobit models were given in order to explain the process of obtaining unbiased and statistically efficient estimators. Furthermore, mean marginal effects as well as expected values of Tobit model based were calculated according to three different groups.

Simulation of the statistically significant variables based on the Tobit result was the one of the purposes of this study. Thus, illustrating the estimated child care expenditures subject to both constrained and unconstrained optimization according to the changes of income, price, mother’s working hours, and mother’s age was unique in this study.

Therefore, this dissertation research indeed showed one stream from the theoretical considerations to the empirical findings because, theoretically, a household’s utility maximization is the objective concern of theories of consumer or household behavior, and the simulations based on the solution of both the unconstrained and constrained optimization in this study involved the empirical proof (testing) of the theoretical frameworks.
5. Conclusion and Implications

This study provides useful information to the consumer or family economist or family resource management educator, financial planner and counselor, and public policy maker. Proposals and implications based on the empirical results from this dissertation follow.

1) Implications for Consumer and Family Economist or Family Resource Management Professionals

The ultimate mission and goal of study in the fields of Consumer and Family Economics, and Family Resource Management may be to maximize the household's utility and satisfaction (here, the use of consumer unit, household, and family is interchangeable). However, testing the theories of utility maximization is empirically difficult when a researcher uses a secondary data set such as Consumer Expenditure Survey data. This study attempted to show the household's behavior when purchasing child care services subject to both unconstrained and constrained optimization. This is a unique aspect in this study.

Furthermore, bridging the gap between neoclassical demand theory and household production function theory is another
strength of this study so that it will contribute to the theoretical considerations for other studies in the fields of Consumer and Family Economics or Family Resource Management.

2) Implications for Consumer Educators and Financial Planners

The results of this study also can be useful for consumer educator and financial planners or counselors in order to guide consumer, family, or households those who need an assistance for their financial problem. Hanna (1991) has revised the "Family Spending Program", a software program in which financial counselor can examine one household's spending pattern and budget allocation, and also analyze each household's financial situation compared to average other households. Results from this study can incorporated into the "Family Spending Program" incorporating child care spending information of 971 households. Thus, consumer educator and financial planner can give a guideline for clients (consumer, family, and households with young children) to understand how they allocate their budget on child care services compared to other similar households with similar characteristics of children, mother's working status and the like.
3) Implications for Public Policy Makers

The structure of the tax credit might help explain the relative size of the elasticities from the Type I Tobit (-1.65 for all households and -1.26 for households with positive expenditure,) as the effective price reduction from the tax credit was only available for those making some expenditure, and was probably not relevant to households considering a small level.

Subsidized child care centers typically have a graduated payment system, so that low income households face a lower price than high income households. The fact that income has a significant, positive effect implies that the combined effect of the tax credit system and any subsidy programs do not have a very large effect. On the other hand, the relatively low size of the income elasticity for households with positive child care expenditure may be related to implicit price effects.

Government regulation aimed at increasing the quality of child care, if not accompanied by increased tax credits or subsidies, might lead to a substantial decrease in household purchases of child care. The price elasticities estimated imply that a regulation resulting in a 10 percent increase in price would cause a 12.6 percent decrease in the quantity of
child care purchased (among those already spending money on child care) and 16.5 percent decrease in the quantity of child care among all households with young children. The Probit analysis for the Type II Tobit Model implies that an increase in the price index from 100 to 120 would result in a 2.5 percent decrease in the choice of child care.

Possible effects of regulation on demand for child care can be considered and presented in Figure 7.1 based on the price effect in this study. If there are no "Lemon" effects, we can just consider demand curve D. Regulation increases costs from MC=AC=6, to MC=AC=8. We can assume that total revenue before regulation is 2400, and after regulation is 1600. Arc price elasticity as shown would be \((\text{percent change in quantity})/(\text{percent change in price})\) -1.5.

If the effects of the regulations are not valued by consumers, there is a loss in consumers surplus of approximately 600. If consumers value the effects of the regulation, the value could be approximately represented by the new demand curve D', such that the higher price could result in no decrease in quantity demanded.

If the cross-sectional differences in child care costs are due to differences in regulation, and if there is a "Lemons" effect such that there is a higher demand curve, we
should have seen a smaller price elasticity.

There may be benefits to regulation, but the fact that the price elasticity estimates are high suggests that regulation without increased subsidies will result in a substantially decreased amount of child care demanded. Therefore, the result of this study may give useful guideline in decision making for policy makers.

4) Limitations and Suggestions for Future Research

Data used in this study did not have information on the quality of child care services, so that it was not possible to measure the real impact of government regulation on consumers and society but only hypothetical impact. Furthermore, there was no way to explore the supply of child care using the Consumer Expenditure Survey data set. It is, however, highly recommended that demand and supply be simultaneously analyzed in the field of child care research.

In Econometric modelling, several problems still remain regarding household demand for and choice of child care services: fertility, decision to work, choice of purchasing market services, simultaneously. In the long-run, we indeed need to attempt child care analysis where the multivariate normal distribution is involved, whereas this dissertation
only tested bivariate normal distribution in Econometric and Statistical consideration.
APPENDIX 1

1) Elasticity of expenditures with the population with non-zero expenditures, where the mean expenditure was considered only by the non-zero cases is

$$\frac{1}{\text{EXP}} \frac{\partial e[\text{EXP}]}{\partial \log x} |_{x = \bar{x}} = \frac{\beta_1 \Phi(\bar{X}/\sigma)}{\text{EXP}(\text{for case, with EXP} > 0)}$$

2) Elasticity of expenditures with the population including zero expenditures, where the mean expenditure was considered only by the total sample size is

$$\frac{1}{\text{EXP}} \frac{\partial e[\text{EXP}]}{\partial \log x} |_{x = \bar{x}} = \frac{\beta_1 \Phi(\bar{X}/\sigma)}{\text{EXP}(\text{for all cases, with EXP} = 0)}$$

Now, we need to calculate the elasticity of quantity demanded. From the semi-log form,

$$P \cdot Q = \beta_0 + \beta_1 \log P + \beta_2 \log I + \ldots + \beta_n$$

Derivatives both side with respect to P, then we obtain
\[ Q + P \cdot \frac{\partial Q}{\partial P} = \beta_i \cdot \frac{1}{P} \]

Divided both side with \( Q \), then we get price elasticity of quantity demanded as,

\[ \frac{P}{Q} \cdot \frac{\partial Q}{\partial P} = \beta_i \cdot \frac{1}{PQ} \cdot 1 \]

and income elasticity of demand is same as income elasticity of expenditure.
APPENDIX 2

Effects of the Government Regulation on the Household's Demand for Child Care Services, For the Case of Simple Exposition
REFERENCES


American Chamber of Commerce Researchers Association (1992). *Cost of Living Index*.


