Essays in Child Care Quality

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ABSTRACT

This research investigates three topics in child care quality, mother's labor supply, and early childhood development. In the first study, we evaluate how child care quality influences the potential impacts of mothers' labor supply on child development. Although, previous studies have acknowledged the importance of the quality of child care, none have integrated quality in analyzing the effects of maternal employment. We find that the negative effect often found in past studies is largely due to the use of low quality child care.

The question we ask in the next study is, "What are the effects of child care quality on child development?" In this study we tried to separate out the contribution of initial child ability in child test scores of development from the effects of other inputs, particularly child care quality. We show that even after resolving endogeneity issues, we still find that child care quality has a significant positive effect on early cognitive development.

The third study investigates the determinants of households' demand for child care, particularly, child care quality. We determine if households' choices regarding child care quality, as well as quantity, respond to economic factors. A family's condition is defined by the combination of family choices on mother's work status, mode and payment type of child care, and child's age. We group families by condition and estimate demand for child care quality and hours by group. The results indicate that higher income will lead to higher quality for non-working mothers but lower quality for some working mothers. Demand for quality by non-working mothers are more price sensitive than working mothers. Wage effects on quality are positive only for users of home-based care. Demand for quality is more sensitive to economic factors when the child is around 3 years old than at 6 months. These results suggest that the form, target and timing of financial assistance need to be considered for it to be effective in promoting the use of quality care.

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I am writing this two days before Valentine's Day, and I still have no gift for my wife. So, ...

I dedicate this work to my lovely wife, Daisy, who endured plenty of hardships so that I can get my degree. Thank you, Beb, for all kinds of support (spiritual, emotional, scholastic, financial, and …) and for being the greatest wife and mother.

I was inspired to do this research by my beautiful daughters, Lia and Maia, whose early childhood development Daisy and I are very much committed to.

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1.0 INTRODUCTION

1.1 MOTIVATION

To parents, the motivation to know what influences their child's cognitive and social development is clear. Cognition, the capacity to engage in abstract symbolic reasoning, is the foundation of learning. Several studies (Thomas and Currie, 1999) show a significant link between preschool kids' knowledge of words, sounds, symbols and letters, and their academic performance. Their academic performance in turn broadens their economic opportunities later in life as adults. Early development of social skills is also important as it helps the child function well in society. To policy makers, fostering early child cognitive and social development should also be a priority since it enhances the child's readiness to attend school. A recent national survey (Rimm-Kaufman, Piant & Cox) revealed that kindergarten teachers reported 15% of their pupils had "serious problems" and 30% had "some problems" in adjusting to school. A child's lack of readiness to attend school reduces the productivity of resources devoted to the child, as well as imposing external costs to the child's peers. Addressing this problem can improve the educational system and the efficiency of accumulating human capital.[1] Heckman and Carneiro (2002) also demonstrated the importance of early childhood experiences in accounting for racial and ethnic gaps in school performance and college attendance. This recognition of the importance of early childhood experiences and development produced an explosion of research on what determines early child outcome, particularly, cognitive and social development.

A significant amount of this research is devoted to studying the experiences of very young

[1] Lucas (1988) argues that the efficiency of accumulating human capital influences the rate of economic growth.

children in non-maternal care, and the associations with child development. Lamb (1998) and Love, Shochet and Meckstroth (1996) provide excellent surveys. Besides the growing recognition of the importance of early childhood development, there are two reasons for these studies. One is the increased labor force participation of women, especially, mothers of children less than five years old. In 1960, 18.6% of mothers with children under six were in the labor force (Desai, Chase-Landsdale and Michael (1989)). In 2000, this has increased to 62.8% (U.S. Bureau of the Census 2002), and the Bureau of Labor Statistics projects that by 2012, there will be 77.1 million women in the labor force. As more mothers enter the workforce, more and more children will be placed in non-parental care arrangements.[2] Largely because of this maternal employment trend, placing children in non-maternal care have been commonplace. In 1994, there were 10. 3 million children under the age of 5 who were in child care while their mothers worked, including 1.7 million infants under 1 year of age.[3] Even among households with unemployed mothers, the percentage of children in some form of non-parental care is significant.[4] All in all, there were 12 million children from 0-5 years in 2001 who received some form of non-parental care on a regular basis. For 2010, the number of 0 to 5 year-old children in non-parental care is projected to increase to 15.61 million.

Another reason is the so called child care quality problem. According to the 1995 Cost, Quality and Child Outcomes Study (CQO Study), a frequently cited study, the average quality of childcare centers in the U.S. is poor to mediocre. The study rated child care environments using the Early Childhood Environment Rating Scale (ECERS) and the Infant/Toddler Environment Rating Scale (ITERS). The ECERS and ITERS cover a wide range of factors related to safety and health, facilities, materials, toys and activities, and interactions between staff and children. The scale ranks child care quality from 1 to 7, with 1 equaling "inadequate" care, 3 equaling care meeting "minimal" requirements for sound child development, 5 "good" care, and 7 "excellent" care. On this scale, the CQO researchers concluded that 10 percent of the preschool classrooms examined were "inadequate" (scoring

[2] In 2002, 15.2% of women in the labor force are women with children less than 6 years old. Basing on past trends, this percentage is not likely to go down.

[3] U.S. Bureau of the Census, 1997.

[4] Thirty nine percent in 1997, 37.4 percent in 1999 and 2002 (SIPP).

between 1.5 and 3.0); 66 percent were "mediocre" (scoring between 3.0 and 5.0), and 24 percent were presumably at least good (scoring between 5.0 and 7.0). Other forms of child care do not fare better.[5] In light of these findings, parents and policy makers ask if we are putting the children in harm's way in placing them in non-maternal care.

This dissertation makes a contribution to this line of research by investigating three interrelated topics: (i) the relationship between maternal labor supply and cognitive development, (ii) the effects of child care quality on cognitive development, and (iii) the demand for child care quality. Although (i) and (ii) have been investigated extensively, isssues in methodologies abound. On the other hand, research on topic (iii) have been scant.

1.2 OVERVIEW OF CHAPTERS

The common theme in the three esssays is the quality of child care used. A simple model of maternal labor supply and household child care choice will describe the studies in this dissertation and how they are connected. This simple model will be sufficient to illustrate the general issues and motivation regarding these studies. A fuller version of the model will be discussed in Chapter 4.

The dissertation and the model concentrates on a child's early developmental period, particularly the period before the child enters formal school. This is a period that the child experiences phenomenal developmental changes, the decision whether the mother should work or not is the most pressing, and the amount of developmental inputs that need to be considered, are fewer, since the child is mostly at home or at a child care. Inputs from formal schooling, which can confound the analysis, have not yet taken place.

At a given period t, the household cares about its consumption, G_t, the child's (cognitive) development, C_t, and the mother's leisure, L_t. Thus, the household's utility function is an increasing function of these variables, $U_t = U(G_t, C_t, L_t)$. The child's developmental outcome depends on the effective care received by the child, E_t, and the amount of other material inputs given to the child (food, medical care, toys, books, etc.), $\mathbf{K}_t$, as well as the child's previous development level, C_{t-1}, i.e., $C_t = C_t(E_t, K_t, C_{t-1})$. The effective care received by

[5] Kontos (1995).

the child depends on the quality and quantity of mother's care (q and M, respectively) and the quality and quantity of non-maternal care (Q and N, respectively). Substituting for E_t, we derive an expanded production function:

$$C_t = C_t\left(q_t, M_t, Q_t, N_t, \mathbf{K}_t, C_{t-1}\right) \tag{1.1}$$

The amount of goods consumed and the quantity and quality of purchased material inputs depend on the mother's earned income and non-maternal work (exogenous) income, $G_t + \mathbf{k}_l'\mathbf{K}_t + p\left(Q_t\right)N_t = w_t H_t + v_t$, where $\mathbf{k}$ is a vector of prices of other child inputs, $p\left(Q_t\right)$ is the child care price function which is an increasing function of its quality, w is the mother's wage, H_t, is mother's work hours and v is income from sources other than the mother's work. The mother's time is devoted to working, taking care of the child or leisure, i.e., $M_t + H_t + L_t = T$, while the child's time is spent with the mother or non-maternal care,[6], $N_t + M_t = T$. These time constraints imply $N_t = H_t + L_t$. We assume that the father/partner's work decision is exogenous. He either has a job, in which case exogenous income is positive, or is not employed and he becomes one available free non-maternal care.

The household maximizes utility by choosing the following variables: how many hours to work, H_t, how many hours of non-maternal care to use, N_t, what kind of quality to use, Q_t, how much food, medical care, toys, books, etc., to provide to the child, $\mathbf{K}_t$. The variables that are given to the household decision maker are: the child's previous outcome level, C_{t-1}, quality of maternal care, q,mother's wage, w, unearned income, v, (such as spouse's income), the child care price function $p(Q)$, in particular its parameters: the intercept, α, and slope, β, of the function. Solving the first order conditions of the utility maximization problem, we derive the reduced-form demand functions for H, N, Q and $\mathbf{K}$ as functions of the exogenous variables:

$$\left(H_t \quad N_t \quad Q_t \quad \mathbf{K}_t\right)' = \Phi\left(w_t, v_t, \alpha, \beta, q, C_{t-1}, \mathbf{k}_t\right) \tag{1.2}$$

Substituting this into the production function we can derive the reduced-form demand function for child outcome,

$$C_t = C\left(w_t, v_t, \alpha, \beta, q, C_{t-1}, \mathbf{k}_t\right) \tag{1.3}$$

[6]Non-maternal care includes father care, if available, relatives, friends, family day care and center care.

Figure 1 illustrates the model, and relates the three essays. In this chart we grouped the variables into the exogenous variables (the givens); choice variables (H, N, Q and K); and utility function variables (G, C, L). The solid arrows refer to hypothesized causal relationships or effects that are consistent with the model. These are: (1) Choices about mother's labor supply and non-maternal care hours affect mother's leisure. (2) Child care hours, child care quality, maternal care quality, other child-related inputs, and previous cognitive development level affect cognitive development. (3) All choice variables affect household consumption. (4) Exogenous changes in mother's wage, non-maternal income, and child care price, among others influence household's demand functions for these inputs. The double broken arrow (mother's labor supply to cognitive outcome) refers to relationship that is not consistent with the model but has been estimated in the past. The single broken arrows pertain to issues that may arise in estimating these relationships.

The first essay in Chapter 2 estimates the association between maternal labor supply and the child's cognitive development (represented by the blue double broken arrow). Motivated by the rising maternal labor force participation, many studies have analyzed the "effects" of maternal labor supply on child development. This is important to parents deciding whether the mother will return to work or not, and to policy-makers formulating family leave policies. The essay adopts the methodology commonly used in this literature. That is, to estimate a linear function relating cognitive test scores and labor supply, e.g.,

$$C_t = b_0 + \sum_{j=0}^{t} b_{1j} H_j + e_t \tag{1.4}$$

The objective of past studies is how to get accurate and consistent estimates of the effects of maternal labor supply, given that mothers who work are very different from mothers who do not work. Issues of omitted variable bias due to unobserved heterogeneity arise, and a variety of methodologies were adopted to address this. The results from studies vary, but recent works by economists reveal negative association between maternal labor supply and child care. Although, most of these studies have acknowledged the importance of the quality of child care, none have integrated quality in analyzing the effects of maternal employment. In Chapter 2 of this thesis, we integrate quality considerations in the analysis of maternal labor supply effects. Our question is, if there is a significant effect of maternal

labor supply, is this due to the quality of non-maternal care used? This has important policy considerations because if there is a negative association between employment and child development, should the policy recommendation be geared towards more generous family leave benefits or to support quality improvements.

Estimating equation 1.4 is useful in that it gives us a simple and immediate picture of the relationship between two important and prominent variables, i.e., mother's labor supply and early child development. This type of studies however suffer from a conceptual flaw. These studies endeavor to estimate the total effect on cognitive development of an exogenous change in mother's labor supply. That is, how would child cognitive development be affected when the mother is made to work, say, 20 hours more. It implies that mother's work hours will have the same impact under all conditions. However, mother's work hours are seldom exogenous. It is decided subject to several givens, in particular, the household's economic situation. Thus, changes in non-maternal income, mother's wage, and/or child care price will have an influence over work hours. And it is likely that although the effect on work hours may be the same, the impact on the other child development inputs can be different. For example, a fall in income, and a rise in mother's wage can lead to similar increases in work hours. But it is likely that they will have opposing effects on the other inputs relevant to child development.

Thus, we believe a more accurate way of determining the implication of maternal work hours to child development, is to first estimate a proper child cognitive production function. One that relates the output and the inputs, such as equation 1.1, to establish, which inputs are relevant to development. Next is to estimate the input demand functions together with the mother's labor supply function. From this we determine those factors that lead to an increase in mother's labor supply, and what the effects are of those factors on the demand for child development inputs.

We address this issue by estimating a "proper" production function in the essay in Chapter 3 (represented by the red solid arrows in Figure 1). In particular, we specified and estimated equation 1.1. The emphasis is on child care quality effects on child development because of the richness of quality indicators in the dataset. Also because large amount of resources from the Child Care Development Fund are committed to improving child care

quality. This study is important on two counts. First, the studies that have been conducted on the effects of child care quality on child outcomes do not provide strong evidence that child care quality leads to better outcomes for children. Studies on this subject often come to inconsistent and contradictory conclusions (Blau, 2000). Findings vary by age of the child, child care arrangement, and outcomes examined. Some studies find no correlation between measured characteristics (such as staff/child ratios, and group size) and child outcomes (such as social and cognitive development). Others find small correlations between some characteristics and some outcomes for some groups of children. The second reason is the child care quality problem cited above. If we determine that child care quality does influence child development, then this assessment regarding the state of child care is worrisome.

The main objective in this chapter is how to separate out the contribution of initial child ability in child test scores of development, from the effects of other inputs, particularly child care quality (red broken arrow in Figure 1). This is similar with studies which investigated if quality of schools makes a difference in the academic performance of students. The central issue in these studies is that estimates of school quality effect maybe biased by children's innate cognitive ability. We draw methodologies from this literature accordingly. A minor issue is that because we cannot observe maternal care quality, q, we used variables to proxy for this such as mother's education, mother's age, mother's intelligence, and number of children.

Chapter 4 investigates and estimates the effects of income, wage and price changes on the demand for child care quality and quantity (the green solid arrow). We try to determine if households' choices regarding child care quality, as well as quantity, respond significantly to economic factors. If it is determined that child care choices significantly influence child development, and a government commitment to improving quality is made, then the results from this study will be an important input to policies that will be designed for quality improvements. For policies to be effective, they should recognize that child care is ultimately a household decision, and the household will choose the child care that satisfies them best. Under this principle, would providing economic incentives be effective in encouraging households to use higher quality child care. If not, then other interventions may be more effective in achieving quality improvement goals, e.g., the government itself providing quality child

care like the HeadStart program.

The hypothesis in this essay is that the effects may vary according to the family's situation. These differences arise because: (1) child care will have differing roles in working mother and non-working mother households; (2) the availability of child care across payment types (free or paid) and modes (family day care and center-based); and (3) differences in the price functions between family day care and center-based care. To get more accurate estimates of these effects we estimated the demand functions according to different situations or states.

Chapters 3 and 4 answer different questions but are derived from the same framework. Together, they could answer how changes in economic variables can affect child development. Although such question can be answered directly by estimating a reduced form demand function for child development, as in equation 1.3, the additional utility of undertaking these essays is that we can determine the pathways of these economic effects.

1.3 THE DATASET

This research used data from the National Institute of Child Health and Development (NICHD) – Study of Early Child Care (SECC), Phases 1 and 2. This unique dataset provided us with means to explore the research goals identified above, and answer many important questions in child care. The data set collected numerous information on the child, the mother, the home and the child care used. This wealth of information allowed us to assess the "effects" of maternal labor supply in Chapter **2**, and the effects of child care quality in Chapter **3** with numerous control variables. The quality of non-maternal care was assessed on various facets in the study: dynamic or process and structural features. Dynamic features refer to caregiver behavior such as positive interaction with children (holding, smiling and speaking at eye-level), listening attentively, actively engage the children in variety of activities, and others. Structural features refer to classroom structure such as group size, child-caregiver ratio, caregiver education, etc. With this we were able to study the implications of the various aspects of quality.

Moreover, the information about the childcare provider and home characteristics were

collected by trained observers, which should reduce measurement errors. The study is longitudinal, which allowed us to determine if impacts differ according to time, and to use panel data techniques that address presence of maternal and child fixed effects. Presence of data on household income, mothers' wages, child care expenditure, subsidies received, demographic characteristics and features of the child care provider also allow us to estimate the households' demand for non-maternal care and maternal labor supply that is based on a household optimization framework in Chapter 4. Finally, the study is still continuing such that future information collected can be used to build on the results of this research.

The NICHD-SECC is a multi-site, longitudinal study of the experiences of 1,364 children and their families. The study collected information during the child's first 10 years on the families' experiences in child care, the home and school and how these experiences relate to the children's development. The developmental outcomes studied are in the social-emotional, cognitive, linguistic, achievement and physical growth aspects.

The participants were selected from hospitals in 10 sites. Phase 1 of the study began in 1991, which tracked the children and their families from birth to 36 months, and Phase 2 from 37 months to first grade. Phase 3, which will track the children through sixth grade, is under implementation. The original selection design for the hospitals and those to be screened, the exclusion restrictions and later attrition made the remaining sample non-random, and is not nationally representative. Conclusions will be difficult to generalize for the national population. Nevertheless, the sample is socially and economically diverse and large for an observational study. The sample also represents its catchment area, hence the study results would be very useful for areas similar to the catchment areas. The study designers tried to maintain at least 10% mothers with less than high school education, at least 10% single-parent households, at least 10% minority mothers. A detailed description of the dataset is provided in Appendix 7.1.

2.0 IDENTIFYING THE SOURCE OF MOTHER'S LABOR SUPPLY EFFECTS ON COGNITIVE DEVELOPMENT

2.1 INTRODUCTION/REVIEW OF LITERATURE

The increasing trend in mothers' labor force participation is well recognized. Moreover, among women who works, the proportion who are working year round (50-52 weeks) and full-time (35 hours or more per week) has also increased in the past several decades.[1] These trends motivated researchers from psychology, sociology and economics to analyze the how mothers' labor supply affects child development. Since the traditional caretaker of children are the mothers, there is perception that mother's care is the best form of care for the child, and that any non-maternal care would be harmful for the children. Conceptually, however, the effect of mother's labor supply on cognitive development is ambiguous, and we show this in section 2.2.1. Moreover, there is a possibility of bias in estimation due to unobserved heterogeneity in the mother's quality of care. That is, if there are unmeasured traits of the mother that determine marketplace work, and also affect child outcomes. To address this issue many methodologies and samples have been used in different studies.

Accordingly, the conclusions about maternal labor supply effects have been mixed. There are studies which show that maternal work has little or no effect on a child's cognitive development, assessed with the Peabody Picture Vocabulary Test (PPVT). These are Desai et. al. (1989), Leibowitz (1977), Parcel and Menaghan (1994), Harvey (1999), James-Burdumy (2004). Vandell and Ramanan (1992), on the other hand, examined low-income families, and their results show that maternal employment has a significantly positive effect on reading and math scores. Others find mixed results according to the timing of mother's

[1] Monthly Labor Review (2003).

work. A common conclusion among these studies is that maternal employment during the child's first year has a harmful impact but often with no effect or offsetting benefits during the second and third year (Blau and Grossberg (1992), Baydar and Brooks-Gunn (1991), James-Burdumy (1999), Han, Waldfogel and Brooks-Gunn (2001), Hill et. al. (2001), Brooks-Gunn, Han and Waldfogel (2002)). Finally, there are those which are less optimistic and show maternal work hours as having negative impacts. In particular, Parcel and Menaghan (1990) and Hill and O'Neill (1994) find that PPVT scores are decreasing in maternal hours of work. The more recent investigations done by economists (presumably, carefully conducted) are also among this latter category (Ruhm (2004), Baum (2003), Bernal, (2002)).

One contribution of our study is to provide more accurate estimates of this effect. With the richness of the NICHD dataset, we are able to use an extensive set of regressors to mop out the unobserved heterogeneity. Another contribution of this study is to investigate what accounts for the effect, if there is any. One shortcoming in the existing literature is that these studies were unable to pinpoint the factors that might explain the effects of maternal work. In section 2.2.1, we show that effects of maternal labor supply depend in part on the relative quality of non-maternal care to maternal care. In section 2.4 (Results), we show how the effect of maternal labor supply changes when we account for the quality of child care.

2.2 CONCEPTUAL ISSUE AND EMPIRICAL STRATEGY

2.2.1 How mother's labor supply affects cognitive development?

In theory, the relationship between mother's labor supply and early child cognitive achievement is not clear. The main channel by which mother's labor supply influences cognitive achievement is in the effective quality of care received by the child, E_t, which is a function of the quality of maternal and non-maternal care, q_t and Q_t, respectively, and of maternal care and non-maternal care time (M_t and N_t), acting as weights. If quality of chosen non-maternal care is lower than the mother's, then the more mother works the lower the effective quality of care received by the child, and would be harmful to his development relative to

when he is exclusively taken cared of by the mother. Moreover, the long hours that the mother works may negatively affect her quality of care. On the other hand, the mother's work contributes to household income, and the higher income can be used to purchase goods that will help in the child's development.

Let us consider a child cognitive production function where outcomes at time t, C_t, depend on previous period status, C_{t-1}, the effective amount of material goods devoted to cognitive production, K_t, and the effective care received by the child, E_t,i.e., $C_t = f(K_t, E_t, C_{t-1})$.[2]The effective amount of care received by the child depend not only on the actual hours enjoyed but on their quality as well. For simplicity let us assume that effective care is the sum of the product of maternal care quality, q_t, and quantity, M_t, and the product of non-maternal care quality, Q_t, and quantity, N_t, so that $C_t = f(K_t, M_t \cdot q_t + N_t \cdot Q_t, C_{t-1})$.

How does maternal work enter the production function? First, because of time constraints, maternal care time is total time available to the mother, T, net of time spent at work, H_t, and at leisure, L_t. For simplicity we assume that mother's leisure hours are minimal, and we can disregard it in the succeeding discussion. If that is the case then mother's time is either spent taking care of the child or at market work, that is, $M_t = T - H_t$, and that time in non-maternal care is equal to mother's work hours i.e., $N_t = H_t$. Second, the quality of mother's care can be negatively affected by stress from market work. Third, since quantity and quality of child-related material goods are often purchased, the amounts consumed will depend on the income available to the household. Household income in turn comes from the mother's work income and other non-maternal employment sources, e.g., spouse's. If w is the mother's wage rate and v is income from sources other than the mother's work, then total household income is $Y_t = wH_t + v$.

Integrating these considerations into the production function, we can re-express the child cognitive production function as:

$$C_t = f\{K_t(Y_t), [T \cdot q_t(H_t) + H_t \cdot (Q_t - q_t(H_t))], C_{t-1}\} \tag{2.1}$$

Equation 2.1 shows that there are three possible channels as to how the mother's labor

[2]This is a value-added specification similar to the model used by Blau, Guilkey and Popkin. It assumes that given previous development level, we only need to know present input levels to determine current child cognitive development.

supply can affect child development. Differentiating the above expression with respect to mother's work time, H_t, we obtain

$$\frac{dC_t}{dH_t} = f_E\left(Q_t - q_t\right) + f_E \cdot M_t \cdot \frac{\partial q_t}{\partial H_t} + f_K \frac{\partial K_t}{\partial Y_t} \cdot w \tag{2.2}$$

where f_E and f_K are the marginal products of effective care and material goods, respectively, and $\frac{\partial Y}{\partial H} = w$.

From 2.2, we see that a direct way mother's work can have a negative effect on child development is if alternate care is of inferior quality. With the mother unable to take care of the child, the family might replace mother's care with a less productive one, i.e., $Q < q$, such that the "substitution effect" is negative. Also, even if the alternate care used is as good as the mother's, the quality of mother's care can decline from the increased stress or reduced energy from working, which is $f_E \cdot M \cdot \frac{\partial q}{\partial H}$. Finally, since the quantity and quality of other child-related goods are often purchased, an increase in family income when the mother works more can potentially increase these purchased goods (income effect). That is, $\left(f_K \frac{\partial K}{\partial Y}\right) \cdot w > 0$.

The above highlights the ambiguous impact of maternal labor supply on cognitive development. While the first two channels can produce a negative impact of the mother working more, the third channel can have a countering positive effect, and the final impact will depend on the relative intensities of these effects. It is therefore not surprising to see varying conclusions regarding maternal labor supply effects. Harvey (1999) pointed out that one possible reason for the divergence in conclusions is that conclusions were sample specific. That is, the data used are predisposed to a certain direction. For example, for low-income groups the positive income effect from working more hours would likely outweigh any negative effects from substitution of non-maternal care, especially, if maternal care is of low quality. Vandell and Ramanan (1992), concentrating on low-income households, indeed found positive effects of maternal labor supply. Ruhm (2004) divided his sample into high and low earning mothers, i.e., with wage less than $10 per hour in 1996. He found negative effects for the high wage earners but not in the low wage-earners. Determining the impact of maternal labor supply is therefore an empirical question.

2.2.1.1 Econometric Issue To determine the effect of maternal labor supply on children's cognitive development, ideally, we want to get a representative sample of mothers of young children, then randomly assign who works and by how many hours, as in an experimental study. If we are able to obtain this then we can estimate through OLS an equation of the form:

$$C_{it} = \alpha + \sum_{j=1}^{t} \beta_{t-j} H_{it-j} + u_{it}$$

where u_{it} is an error component with zero mean, and independent of H_{it-j} because the latter is a fixed regressor.[3] However, almost all data used in these kinds of studies are obtained from household's actual choices, particularly, on mother's employment and labor supply. The issue of endogeneity, therefore, arises, which means that there may be omitted factors that are correlated with mother's labor supply decisions, and directly influence child development. It is likely that factors that led the households to those employment choices are the ones that are affecting child outcome, and not the choices. That is $Cov(H_{it-j}, u_{it}) \neq 0$, and the estimate of β_{t-j} will therefore be biased.

The direction of the bias is unknown. For example, the mother may know that she is not good at taking care of her child, and she opts to work instead rather than exclusively take care of the child. In this case her inadequacy when it is her time to take care of the child maybe what is leading to lower child outcome, and not the work choice. This leads to a downward bias of the estimate. On the other hand, mothers who are employed are more intelligent and would likely pass this on genetically to the child . Employed mothers are also more educated, which can improve their effectiveness in home production. These factors will bias the estimate upwards. The child's characteristics can also play a role. Being sick often can harm the child's cognitive development, and can also be a reason for the mother to not work.

To address this issue we adopt methods from two studies that took considerable care in addressing the endogeneity of the maternal work hours variable. First is a strategy similar to that of Ruhm (2004), where we include a host of background characteristics of the

[3] This is not a production function nor a reduced-form demand function. Rosenzweig and Schultz (1986) calls this a hybrid equation.

The coefficients here mix technological/production considerations with household preferences. For example, families may differ in the amount of income to allot to purchasing goods for the child's development.

mother, family and child to act as proxy variables to reduce as much residual heterogeneity as possible. The regression model we estimate is

$$C_{it} = \alpha + \sum_{j=1}^{t} \beta_{t-j} H_{it-j} + \boldsymbol{\gamma} \mathbf{X}_i + \varepsilon_{it} \tag{2.3}$$

where $\mathbf{X}_i$ is a vector of family characteristics that serve as control variables, and ε_{it} may contain unobserved fixed effect that is correlated with maternal employment. The effects of maternal work hours will be consistently estimated if the added regressors in X sufficiently control for the other determinants of child development, such that the $cov(H_{it}, \varepsilon_{it})$=0. We thus include numerous covariates to make the error term orthogonal to H. We will estimate a progression of models, with each succeeding model adding a set of family characteristics that are deemed relevant to child's cognitive development. We take note of the change in the work hours variable at each model.

We begin with Model A which includes only the work hours variables at different years. The variables that will be added relate to the mother's labor market participation, as well as, her ability in home production. Model B adds variables that are often included, in other studies, and will serve as a benchmark relative to other studies. These variables are: mother's age at birth and years of education; if child is Hispanic, black, and male, the child's birth order, and dummy variables for the household's location. Model C adds regressors not often found in other data sets: father lives with child at year 3, mother is married at years 1 and 3, mother's PPVT (intelligence) score, number of children at years 1 and 3, if mother smoked, child's gestational age, parental experience in child rearing, mother's progressive attitude in child caring, and child's weight at birth. Finally, Model D includes mother's work characteristics prior to birth. These are her work hours, occupation, and wage prior to birth. This model can be used to test if there is still bias due to unobserved maternal factors. If we assume that work characteristics prior to birth do not influence child outcome then the coefficient for this variable will provide an estimate of the heterogeneity bias.

If the bias is due to some unobserved characteristics of working mothers that also influence their child raising ability,[4] then a second strategy that can be adopted is to estimate

[4]Empirical evidence suggests that employed mothers do systematically differ from mothers who are not employed. For example, McCartney (1984) finds that the child-rearing views of employed mothers are "less traditional" than those of nonemployed mothers. Hock, DeMeis, and McBride (1988) find that employed mothers are more willing to be separated from their infant during a portion of the day.

a regression based on a sample of mothers who were working prior to birth. This sample should be less susceptible to unobserved heterogeneity bias because these mothers are more homogeneous. We refer to this as Model E.

2.2.1.2 Role of Child Care Quality It is important to understand what brings about the association between maternal labor supply and cognitive development, if there is any. While the previous subsection pointed out the possibility of the estimate of β_{t-j} being biased due to correlation between H_{t-j} and the error term, here we explore the factors that may influence this parameter. As we have shown in equation 2.2, the effect of work hours depend on a few things. If we determine that the work effect is negative, which is consistent with recent findings in the economics literature, using equation 2.2, there are two likely explanations. One is that on average the quality of child care used is lower than the quality of maternal care, or, two the stress from working affects maternal quality negatively. It would be very difficult to determine the latter, but the former factor can be tested. The contribution of this study then is to determine to what extent the negative effect is due to the use of low quality child care. How do we test this proposition?

For a mother who decides to work, she will work up to the point where the marginal benefit of working (which is the marginal utility of consumption times the net wage) equals the marginal cost of working (which is the marginal utility of mother's leisure and child outcome times the marginal reduction in child outcome). This trade-off occurs if the quality of the chosen childcare is lower than that of the mother's. In this case, the household trades off more consumption for less child outcome. For households who fall into this case, we should see a negative correlation between work hours and child outcome.

For households who were able to find good quality care, (a good substitute for mother's time) the trade-off between consumption and child outcome should not occur. We therefore expect that the negative correlation between mother's work hours and child outcome does not exist for households in this category. Thus, if we define a dummy variable indicating low quality care, dLQ_{t-j}, and interact this with mother's work hours, we expect that the coefficient for this interacted variable is negative. However, what is high or low quality childcare as described is relative to mother's quality. Nevertheless, if maternal and non-

maternal quality are not correlated, then on average low quality care should still produce a negative correlation between work and cognitive development if indeed it is quality that matters.

Therefore, in addition to equation 2.3, we also estimate the model,

$$C_{it} = \alpha + \sum_{j=1}^{t} \beta_{t-j} H_{it-j} + \sum_{j=1}^{t} \delta_{t-j} \left(dLQ_{t-j} \cdot H_{it-j} \right) + \boldsymbol{\gamma} \mathbf{X}_i + c_i + \varepsilon_{it}.$$

If the hypothesis that it is low quality care that produces the negative effect of maternal work hours, then estimating this model should produce an estimate for β that is smaller in absolute value (or less negative) than the previous models. Moreover, δ_{t-j} should be negative. In the data section we describe the variable we use to classify if childcare is of high or low quality.

Including dLQ, however,can lead to estimation bias if it is correlated with the error term. Since this is a variable chosen by the household (an endogenous variable in the analytical model), it can therefore be correlated with the error term due to factors similar with work hours. For example, if mothers with low quality in maternal care also chooses low quality childcare, and it is low quality maternal care that really matters in child development, then the estimate for δ_{t-j} will be biased downwards. We may show a negative effect of low quality work hours even if there is no such impact. However, if mother's ability is the source of the correlation, then the procedure that we undertake to address the endogeneity of work hours will resolve this endogeneity problem of child care quality as well. The endogeneity problem of the childcare variables will be addressed fully in the next chapter. In this section, we want to uncover features of the production function for cognitive development to provide us more information about the nature of the effect of maternal workhours, which a reduced-form equation such as 1.4 will not provide. At the same time we do not want to deviate radically from the methodology in this literature.

2.3 VARIABLES

The research uses data from the NICHD Study of Early Child Care. The NICHD-SECC is a multi-site, longitudinal study of the experiences of 1,364 children and their families. The

study collected information during the child's first 10 years on the families' experiences in child care, the home and school and how these experiences relate to the children's development. Tables 6.1 and 6.2 present descriptive statistics of the NICHD families. Table 6.1 shows some time-invariant characteristics of the child and family. Half of the NICHD children are boys, 6 and 13 percent are Hispanic and African-American, respectively, and about 45 percent are first -borns. Relative to the National Longitudinal Survey of Youth (NLSY), which is a nationally representative sample, the NICHD households have mothers with greater education, are older at the child's birth, and are predominantly white. Table 6.2 shows family characteristics over time, such as family income and mother's average hourly salary. In comparison to national averages again, the NICHD mothers have greater hourly income, and households have higher than average income to needs ratio. A detailed description of the dataset is provided in Appendix 7.1.

Cognitive Achievement Measures, C_t

The cognitive achievement variables that we use are the Woodcock-Johnson Picture Vocabulary (WJPV), Applied Problems (WJAP) and Letter-Word Identification (WJLW) administered when the child was 54 months. The picture vocabulary test measures the ability to recognize or to name pictured objects, and is a test of crystallized intelligence.[5] The applied problems test measures the subject's skill in analyzing and solving practical problems in mathematics. The letter-word identification test measures the subject's reading identification skills in identifying isolated letters and words.[6] Since our interest is primarily on parental inputs at early periods, we used the 54-month (4 $\frac{1}{2}$ years) cognitive assessment tests because these were the last assessment taken before the child entered formal school. There would be added complication of disentangling the effects of parental inputs from school inputs if we use assessments when the children are already in school.

The cognitive test scores were all standardized in the NICHD data to have a mean of 100 and standard deviation of 15, with higher scores indicating better development. We

[5] Crystallized intelligence can be defined as "the extent to which a person has absorbed the content of culture." (Belsky, 1990). It is the store of knowledge or information that a given society has accumulated over time.

[6] CCDR#210. NICHD Study of Early Child Care.

converted them to have a mean of 0 and standard deviation of 1 so that coefficient estimates could be interpreted as the size effect of a given change in the explanatory variable, and to be comparable with estimates in other studies.

Plotting the means of the children's cognitive scores by the mothers' work hours at year 3 in Table 6.4, some very interesting patterns emerge. We observe that children of mothers who do not work (zero hours) have lower scores than children of working mothers. Among children of working mothers, however, greater work hours is associated with lower test scores. This pattern suggests a negative marginal impact of mothers' work hours. However, we also note that other factors, which are positively associated with children's cognitive scores, such as mothers' education, her intelligence score, her age at birth, and whether or not the family is poor, follow the same pattern against work hours. That is, the averages of these variables spike upwards from the 0 to positive work hours group but the means decline thereafter. For example, the mean years of mothers' education in the zero hours group is 13.83 years, 15.06 years for the 1-29 hours group, and 14.40 for greater than 30 hours group. These patterns, which can proxy for the mother's quality of caregiving, indicate that these factors, rather than maternal labor supply might be what are causing the negative association between cognitive development and work hours. Not controlling for these factors will overestimate the negative impact of work hours.

These patterns are also interesting in that they contrast with the patterns researchers noted about the National Longitudinal Survey of Youth (NLSY) sample. This is the data set commonly used in past studies, in particular Ruhm's and Baum's. In the NLSY it is observed that children's cognitive scores, as well as mother's education, age, intelligence score, etc., are always increasing with mothers' work hours. Thus, it would be worthwhile to compare the results from using the same econometric methodology on two very different samples, as it can lend credibility to each other's results.

Low Quality Childcare, dLQ_t

Datasets used in previous studies, such as the NLSY, lacked information on the quality of child care used. At most, the data contained child care mode (i.e., whether relative, family day care or childcare center). However, as determined in studies such as the CQO study,

the variation of quality within a specific mode is very wide such that mode itself cannot be used as an indicator of quality.

In this chapter, we will use three variables to indicate quality of childcare: group size, child-caregiver ratio, and the Observational Record of Caregiving Experience (ORCE). The motivation for doing so is to assess which quality indicator is most relevant to child cognitive development.

In the NICHD study, child care quality is assessed using the ORCE. Observations were obtained for the primary non-maternal caregiving arrangements that were used for more than 10 hours per week. The ORCE was developed for the NICHD study based on scientific studies that looked at qualities of parenting, which are necessary to the development of secure attachments and competence in children. It was also developed by NICHD to overcome the limitations of the ECERS and ITERS,[7] two of the most widely used measure of child care quality. These limitations are (a) the ECERS and ITERS lump together several dimensions of process quality (child-caregiver interaction, presence of curriculum and safety and health practices of the caregiver) into one composite number, and leaves the effect of each component unidentified and (b) the ECERS and ITERS have different systems for home and center-type cares, thus comparison across types could not be done. One part of the ORCE is the Qualitative Ratings, which indicate the quality of child-caregiver interaction and is what we use to indicate the quality of child care in this paper. This index captures desired caregiver behavior such as sensitivity/responsiveness to nondistress calls, detachment/ disengagement (reflected), stimulation of cognitive development, positive regard for the child, and flatness of affect (reflected). The index ranges from 1 to 4, with 4 being the highest.

The means of group size, child-caregiver ratio and ORCE were computed for each group reported above, and reported in Table 6.4. Similar with variables that may have a positive association with cognitive development, we note that quality of child care gets worse with higher work hours. The mean ORCE of child care used in the greater than 30 work hours category is 6 percent lower than the 1-30 hours group (2.94 versus 2.75).

As mentioned, what is low quality child care takes meaning only when compared with

[7] ECERS stand for Early Childhood Environment Rating Scale while ITERS stand for Infant/Toddler Environment Rating Scale.

the quality of the mother's care. The dataset, however, does not report an indicator of quality similar to those reported for nonmaternal care, hence it is not possible to tag an inferior quality non-maternal care by comparison with the mother's. To get around this in a simple manner, we compared the child care with the average child care in the dataset. We assigned those child care with quality indicator lower than the average as low quality child care, $dLQ = 1$. For example, at year 3 child care with ORCE scores lower than 2.8 (the mean ORCE score) were assigned a 1 for dLQ. Likewise, child care with group size greater than 8.38 was also considered as having low quality.

2.4 RESULTS

Table 6.5 summarizes the results of Models A through E discussed above for each of the three cognitive achievement test scores. Again, the dependent variables are test scores normalized to have a mean of zero and standard deviation of 1. Maternal work hours refer to average weekly work hours (divided by 20) in the specified period. Maternal work hours in year 0 is the average of mothers' work hours in month 1 and month 6. Work hours at year 1 is the average of work hours in months 15 and 24, and work hours in year 3 is work hours at month 36. The empirical strategy is to examine how the addition of more variables will change the coefficient estimates of maternal labor supply.

The first panel of rows in Table 6.5 show results for the WJPV scores. In Column A, which controls only for work hours, 20 hours of employment per week during the child's first two years are associated with a .11 and .15 standard deviation increase in verbal ability. The positive association with maternal work hours, however, disappears as we add more control variables. Adding a basic set of regressors in Model B, switches the positive sign of year 0 work hours to negative, and reduces the parameter estimate for year 1 by 40%. In later models, we no longer observe any significant positive association even for year 1 work hours. These results are similar with previous results showing a positive association between maternal work hours and cognitive achievement, when there are minimal controls, but disappearing and switching in sign as more comprehensive sets of controls are included.

Similar to what we observed in the descriptive analysis, we note that mother's work

hours are already negatively associated with cognitive achievement in Model 1 (-0.145). However, as discussed in the data section, this can be due to omitted variables bias from the mothers' characteristics. When we add more control variables related to mother's ability, the negative coefficient is reduced to -.011 (Model B), -0.073 (Model C), and 0.069 (Model D). Nevertheless, a negative significant effect of work hours in year 3 remain even if we add more control variables not found in other data sets (Model C) and work-related variables before birth (Model D). The estimates in Model C and D indicate that an additional 20 hours of work at year 3 is associated with a .07 standard deviation decline in WJPV. Another method for addressing bias due to mother's ability is to estimate the model only among a sample of mothers who worked before birth. The results from this estimation (Model/column E) reinforce the negative finding regarding work hours at year 3, albeit at a lower degree (-0.037).

Are results consistent with other cognitive assessments? The lower panels show the results when we estimate these models on alternative cognitive achievement scores: WJ Applied Problems and WJ Letter-Word Identification. As with the WJPV regressions, adding more control variables reverses (or reduces in significance) the positive association between maternal work hours (in years 0 and 1) and WJAP score. In models D and E, we find that a 20 hours increase in work hours is related with a significant decrease in test score (-.127 and -.068, respectively). Year 3 work hours have a negative effect although it is not significant. We find similar patterns of parameter estimate changes for the WJLW scores. The estimates are seldom significant, however.

What is the role of low-quality child care? We hypothesized that if there are any significant effect of maternal employment, the quality of child care used will be a significant contributor to this effect. For instance, the harmful effect that we determined can be due to the low quality of child care. To prove this hypothesis, we interacted a low-quality variable with maternal work hours, and included this variable in Model C. The results are summarized in Table 6.6. The table compares the work hours estimates from Model C with and without the interacted variable (the first two columns), as well as the estimated parameter for the interaction variable (column δ). The expectations are that: (i) the work hours coefficients will be reduced when the interaction term is included, and (ii) the coefficient for the

interaction term, δ,is negative.

When high group size and high child-caregiver ratio are used as indicators of low quality, the coefficients for mother's labor supply do not change. These results indicate that structural measures, such as these two variables, may not be very useful indicators of quality. This is consistent with findings from Blau (1999). He estimated the effects of these variables on NLSY children's PPVT scores and find little association (or at worst, the wrong association). We also interacted child care mode with maternal work hours. However, similar with results from Ruhm (2004) and Baum (2003) we failed to uncover any consistent pattern. Baum conjectures that this is likely due to child care mode not being a good indicator of quality.

We then used low ORCE scores as the proxy for low quality non-maternal care. With this variable we uncover the expected results (see Table 6.6). The coefficient for year 3 work hours effect on the WJPV score changes from a significant -0.073 to 0.02; in the WJAP score from -0.032 to 0.058, and in the WJLW regressions from -0.026 to 0.054. Likewise, without the interaction term, we find that 20 additional work hours at year 0 has a -0.96 standard deviation effect on WJAP score. This is reduced to an insignificant term when the interaction term is added. The results for δ coefficient also confirm our expectation of a negative sign regarding. The results are presented in the δ column, with the parameters for year 3 estimated precisely. Finally, we repeated the process for the more homogenous subsample of working mothers only. Pattern of results are similar with the full sample. The negative work hours coefficient for year 3 drops from -0.193 to -0.093 in the WJPV, from -0.256 to -0.212 in WJAP, and -0.043 to 0.016 in WJLW.

2.5 CONCLUSION

With the increase in mothers' labor force participation, and propensity for full-time work, as well as the recognition of the importance early childhood experiences in later school and economic performance of the child, there is a demand to determine the impact of mother's labor supply on children's development. Although numerous studies have been conducted, the conclusions on the impact on early cognitive development, are mixed.

The issue that is often cited in these works is the endogeneity of the mother labor supply

variables in the early cognitive score regressions due to mothers' and family characteristics related the quality of caregiving environment in the child's home; essentially, the quality of the mother's care when it is her time to take care of the child. The mothers' labor supply decisions may also be affected by child characteristics which also have direct implications on the child's development, such as the child's health. A variety of techniques have been applied to resolve the problem of endogeneity of work hours variable. Because of the care undertaken in recent studies by Ruhm (2004) and Baum (2003) in addressing this issue, we used the technique in these studies to verify their results. We also used a different dataset, whose households appear very different than the NLSY households, to lend credibility to the methodology and findings. Our results indicate that after controlling for mother's and child's characteristics, any positive association between maternal work hours in the child's early years (years 0 and 1) and verbal and mathematics ability (WJPV and WJAP scores), disappear into insignificance. This is one pattern that is similar to the Ruhm results. Another similar conclusion with Ruhm's and Baum's as well, is that we also find a significant negative association between year 3 work hours and WJPV and WJAP scores. This less optimistic result contrasts with studies, which reveal negative effects in the early year, but no negative effect or even countering beneficial effect in later years.

We also set out to understand the mechanism why this negative association takes place, which past studies failed to identify. The hypothesis that low quality non-maternal care is the one that provides this negative association is verified. The negative effect of work hours falls by an average of .08 standard deviations when we interacted a dummy variable for low quality care with work hours; a decline of more than a 100%. For example, the significantly negative effect of year 3 work hours on WJPV score changes to a positive value (-.073 to .20), and the estimated impact of low quality childcare is -.139 standard deviation. This establishes that use of low quality child care is the main reason why a negative effect arises. Researchers who find a negative effect of maternal work point out that the policy recommendation of their findings is not clear. Should it be that mothers must stay at home with their child requiring companies to provide more generous leave policies, or should policies be made to improve the quality of child care. The answer seems to be that government should work to improve quality of child care, by perhaps providing

incentives for mothers to use higher quality care.

Notwithstanding these improvements over the literature, however, this study, as well as those in the literature, suffer from an analytical flaw. As mentioned in the introduction, these studies try to estimate the effect of an exogenous change in mother's labor supply. That is, how would child cognitive development be affected when the mother is made to work, say, 20 hours more. However, mother's labor supply and other child development inputs, such as child care quality, are choice variables. They are chosen subject to several exogenous factors that affect the household's economic situation. Thus, changes in non-maternal income, mother's wage, and/or child care price will influence work hours, and other child developments inputs. And it is likely that although the effect on work hours may be the same, the impact on the other child development inputs can be different. For example, a fall in income, and a rise in mother's wage can lead to similar increases in work hours. But it is likely that they will have opposing effects on the other inputs relevant to child development.

Thus, a more accurate way of determining the implication of maternal work hours to child development, is to estimate a proper child cognitive production function, such as equation 1.1. Next is to estimate the input demand functions together with the mother's labor supply function, to determine those factors that lead to an increase in mother's labor supply, and what the effects are of those factors on the demand for child development inputs.

3.0 MODELING THE EFFECTS OF CHILD CARE QUALITY ON COGNITIVE ACHIEVEMENT

3.1 INTRODUCTION/REVIEW OF LITERATURE

The previous chapter provided estimates of the relationship between two important variables: mother's labor supply and child cognitive development. As pointed out in the introduction, however, this association does not conform to a production function consistent with the household model of child care choice and maternal labor supply. The estimated β coefficient of the regressions of equation 2.3, combines the effects of several inputs, and the regressions do not provide us with production parameters that help us answer questions such as, "What is the effect of input x holding other factors constant?" In particular, the previous regressions do not give us the marginal effect of child care quality on child development. We have introduced quality only to unravel the negative association between work hours and cognitive achievement. Moreover, the distinction between low and high quality care was arbitrary.

In this chapter, we attempt to estimate a production function for cognitive achievement, focusing on the quality of child care used. What we want to determine is how raising the quality of child care used can improve cognitive achievement. This parameter is important to determine because quality improvements will entail costs, and policymakers will be reluctant in providing more resources to improve quality if they are skeptical of this effect.

Many studies in the past have investigated the effects of child care quality. The early research that were highly cited were the Perry Preschool project and Carolina Abecedarian study (Cato Policy Analysis No. 333). These studies randomly placed children into an experimental group, which enjoyed high quality child care, and a control group. Being experimental studies, they were able to control for factors that might confound the effects

of the quality group. Children in the experimental group were shown to have significantly higher cognitive test scores, and performed better at school. High quality intervention composed of several positive attributes of child care, but the children in the quality care group enjoyed a combination of support not only in child care but at home, as well. Because the experimental and control groups differed in a variety of dimensions, not only in child care quality, the studies were unable to identify which attribute was delivering the positive effect on the children. More recent studies, and this particular study, try to determine, which quality attribute affects development most.

More recent studies, which involved larger samples are not based on controlled experiments where children are randomly assigned to varying child care quality. A major issue that has been identified in this research is the endogeneity of child care quality due to unobserved maternal and family factors. These studies have attempted to control for family factors that could influence both child care choice and child development. For example, households with higher income choose higher quality care, but may also buy more developmental inputs for the child. More educated parents choose higher quality care, but at the same time may provide more developmentally appropriate care themselves. As a result of this concern, it has become standard practice for researchers to incorporate family selection factors into their analyses.[1] Love, Schochet and Meckstroth (1996) cites this issue in a review of child care quality studies, and discusses the different strategies adopted. They conclude that a substantial positive relationship between child care quality and child well-being exists. However, they still cannot rule out selection bias in this relationship.

Although, controlling for family factors has become standard practice, a primary shortcoming in these studies is that they are unable to control for measures of child development prior to the exposure to the child care arrangement. No study has yet to address the endogeneity of child care quality due to children's inherited endowment of mental capacity. Similar with the issue in the returns to schooling literature, there is a possibility that the "positive effects" of higher child care quality is biased from unobserved innate child ability. Most studies also do not include measures that will capture the extent of home inputs provided to the child, such as books, toys, etc. In view of these issues it is hard to use results

[1] We argue below, however, that family income is not appropriate to include as a control variable.

from the studies surveyed by Love, Schochet and Meckstroth (1996) and Lamb (1998) to draw any conclusions about the effects of child care quality on child outcomes.

In this chapter, we attempt to address these issues. Given the richness of the data set we are using, we are able to include measures of child development prior to a particular child care used, as well as, some measures of home inputs. More importantly, to address the possibility of confounding child endowment effect, the data set also allow us to employ several methodologies suggested in Todd and Wolpin (2001). We discuss these methodologies in the next section.

3.2 EMPIRICAL MODEL

3.2.1 Specification

Cognition is defined as, "The mental process of knowing, including aspects such as awareness, perception, reasoning, and judgment." Like any good we can consider child's cognitive achievement as an output that can be produced with labor and material inputs, such as toys, books, health foods, etc. In this section we discuss how various variables of interest enter into the development process. Research made by psychologists and sociologists does not seem to regard that child's cognitive development is a production process. As such, those studies were prone to including all variables that can be argued as having a possible effect. The result is that in many models, too many variables were included and it is difficult to figure out (or justify) why they are there. Are they an input to the production, or are they taste variables that influence the demand for these inputs? Interpretation of the estimated coefficients becomes tricky.

We can begin perusing what variables to include by treating child development as a production process. That child development requires inputs to be produced. After laying out what these inputs are, then we can relate other variables to them; either they are inputs themselves, or they influence the amount or quality of the inputs.

3.2.1.1 Value-Added Specification The effects of child care quality and quantity are investigated by estimating a production function for the child's cognitive achievement. Development of the cognitive achievement production function draws from the agricultural production literature, particularly, those which model labor as a heterogeneous input (Prem Jung Thapa, 2003). This literature recognizes that there can be differences in the productivity of family and hired labor in farm production, due to the inability to monitor hired labor's actions or from the owner's greater knowledge of the farm. This situation is very much similar to using non-maternal care. Parents often fear that the child care provider may not provide care as well as the mother would. In addition, productivity can differ among various non-maternal care due to differences in socio-demographic backgrounds, intelligence and/or training.

Child's cognitive achievement is an output that is produced with labor and material inputs, such as toys, books, health foods, etc. Depending on data availability, several specifications of the production function have been proposed. One is the value-added specification, which assumes that given the child's previous cognitive achievement level, only the contemporaneous inputs are necessary to determine current level.[2] Thus, letting C_{it} as the child's cognitive achievement score at time t, we assume that this is influenced by the effective care received by the child, E_{it}, other material goods received, K_{it}, and the child's previous cognitive score, C_{it-1}.[3]

$$C_{it} = \gamma_0 + \gamma_1 \ln E_{it} + \gamma_2 \ln K_{it} + \gamma_3 C_{it-1}$$[4]

K_{it} is an index that captures the quality and quantity of the material goods used in the production of cognitive development. E_{it} is an index of the effective care received by the child. This index is a function of the qualities of maternal and non-maternal care, and the amount of time the child spends with these care. In this setting, we assume that child

[2] See Blau, Guilkey and Popkin (1996), Hanushek (1992) for other studies using this specification.

[3] Since effects occur after a lag, inputs subscripted as t were provided between the periods when the test scores where taken. Thus, Q_t is quality of child care experienced between the times when C_t and C_{t-1} were taken. In this dataset, cognitive tests were administered at 54, 24 and 15 months. The contemporaneous inputs for the 54^{th} month score are the 36^{th} month levels, for the 24^{th} month are the 15^{th} month levels and for the 15^{th} month are the 6^{th} month levels. *(We can probably say this in the description of the dataset.)*

[4] The production function is specified as Cobb-Douglas since this specification involves few parameters but is not restrictive with regard to the relationship between the inputs.

care is either provided by the mother or by an alternate caregiver (e.g., father, relative or more formal entities such as center-based care or home/family day care). We lump all non-maternal caregiver into one category since we are only interested in determining the effect of non-maternal care quantity.[5]

Let mother's time spent with the child be, M_{it}, and time spent in non-maternal care, N_{it}. Also, let EM_{it} and EN_{it} be the indices of effective maternal and non-maternal labor input, respectively. The amount of effective care that goes into production will be an increasing function of these two variables. Effective labor is specified as a Cobb-Douglas function,[6]

$$E_{it} = (EM_{it})^{\rho_1} (EN_{it})^{\rho_2}$$

As suggested above, different types of labor will differ in their quality or effectiveness in converting their time inputs into effective labor units. Some mothers will be more efficient in the use of their time compared to other mothers because they know more, are better skilled or because they have more energy for the task. In a similar manner, some alternate caregiver are more productive than others because he/she has been trained more, or the environment where she operates in is more conducive to learning. Adjustments then have to be made to incorporate the quality dimensions of these labor types.

For the mother's care, we assume that her quality is influenced by her background characteristics, such as her education, intelligence, age at birth of target child, and number of children in the household.[7] Let $\mathbf{D}_i$ be the vector of background characteristics, i.e.,

[5] An argument was made to have a separate category for father or grandparent care to distinguish from other non-maternal care. Because the incentive to take better care of the child and promote development is higher for fathers or grandparents the quality of care therefore might be different. We did not do this because fathers and grandparents were observed if they were the primary caregivers and the quality of their care was assessed using the same quality assessment used to assess caregivers in center and family daycare. We assume that the differences in their quality can be captured by this indicator.

[6] We initially specified the effective labor function as a CES function to have a more general function. The resulting cognitive production function, however, was highly nonlinear. The nonlinear estimation often resulted in large standard errors, and was very sensitive to the sample used.

The estimated elasticity of substitution (EOS) of the nonlinear specificaiton, however, is very close to one. A CES function with EOS equal to 1 is a Cobb-Douglas function. The advantage of specifying E as a Cobb-Douglas function is that it generates a log-linear production function, which is easier to estimate. The estimated coefficients of interest of the nonlinear and linear models base case were almost identical, and so we restricted our attention to the linear models.

[7] We use these factors to represent mother's quality in the absence of direct information (or observation) about the quality of the mother's care.

$\mathbf{D}_i \equiv (m\_educ_i,\ m\_intelligence_i, m\_age_i, kids_i)$.We also assume that her employment status, H_{it},affects maternal care quality. We include number of children in the household and work status because these can affect the amount of energy the mother has when it is her time to take care of the child.

We specify the mother's effective labor as $EM_{it} = M_{it} \cdot \left(\prod_{D_i \in \mathbf{D}_i} D_i^{\alpha_D}\right) \cdot e^{\alpha_H H_{it}}$. We use a Cobb-Douglas specification for the adjustment to allow for flexibility in the relationships of these factors. (A linear function implies that each factor will be a perfect substitute for the others.) The adjustment for work situation uses the exponential function since work hours can be zero, and to allow work to be alternatively specified as working or not working. The hypotheses are that the $\alpha' s$ for mother's education, intelligence and age are positive while the $\alpha' s$ for number of children and work situation are negative.

According to development psychologists, the features of a child care arrangement associated with quality include the manner in which caregivers interact with children, the nature of the curriculum and materials, and the health and safety practices of the provider.[8] We index the caregiver's interaction with the child by the ORCE – Qualitative score, Q_{it}. This will be discussed in more detail in the data section. Higher ORCE scores mean more positive interaction. We have no information, however, on whether or not the caregiver has a curriculum, while the survey for health or safety practices were conducted only for center-type care. Compared to home or family-type of care, however, center-type arrangements are perceived to follow a curriculum and have superior health and safety practices because they are easier to monitor and regulate.

As we will note in the data section, in this dataset we find that average ORCE scores of center and non-center cares do not differ significantly, yet children in center-type care have significantly higher cognitive scores. This may be indicating that other quality attributes are at work. We include a dummy variable, CTR_{it}, if the mode of care is center, to try to capture quality information other than child-caregiver interaction. We specify the effective non-maternal care as $EN_{it} = N_{it} \cdot e^{\beta_1 \cdot Q_{it} + \beta_2 \cdot CTR_{it}}$.

By construction, mother's and non-maternal care time are related via the child's time

[8] Love, Schochet, Meckstroth (1996).

constraint, $T = N_{it} + M_{it}$.[9] Inserting these considerations, we can rewrite effective care as,

$$\ln E_{it} = \rho_1 \left(\ln M_{it} + \sum_{D_i \in \mathbf{D}_i} \alpha_D \cdot \ln D_i + \alpha_H H_{it} \right) + \rho_2 \left(\ln N_{it} + \beta_1 \cdot Q_{it} + \beta_2 \cdot CTR_{it} \right)$$

Substituting this into the production function and letting $a_M = \gamma_1 \rho_1$, $a_D = \gamma_1 \rho_1 \alpha_D$, $a_H = \gamma_1 \rho_1 \alpha_H$, $a_N = \gamma_1 \rho_2$, $a_Q = \gamma_1 \rho_2 \beta_1$, we estimate the equation

$$\begin{aligned} C_{it} &= a_0 + a_M \ln (T - N_{it}) + \sum_{D_i \in \mathbf{D}_i} a_D \cdot \ln D_i + a_H \cdot H_{it} + a_N \ln N_{it} && (3.1) \\ &\quad + a_Q \cdot Q_{it} + a_{CTR} \cdot CTR_{it} + a_K \ln K_{it} + a_C C_{it-1} + u_{it} && (3.2) \end{aligned}$$

where u_{it} is an error component that includes unobserved shocks, measurement errors, error in functional form, other unobserved factors. For ease of notation we refer to $\mathbf{X}_{it}$, as the vector of time varying inputs/variables, i.e., $\mathbf{X}_{it} \equiv (Q_{it}, CTR_{it}, H_{it}, \ln N_{it}, \ln M_{it}, \ln K_{it})'$, and rewrite equation **??**, as

$$C_{it} = a_0 + \mathbf{a}_D \ln \mathbf{D}_i + \mathbf{a}_X \mathbf{X}_{it} + a_C C_{it-1} + u_{it} \qquad (3.3)$$

Few studies which investigated the effects of quality considered the mode and/or quantity of child care in the same model. On the other hand, studies that examined the quantity of care, which typically reported significant negative associations between child care hours and behavior problems, do not include assessments of child care quality or type. This study improves upon past studies in that we are able to estimate the effects of quality, quantity and type in a single model.

[9] During the interview, mothers were asked, *"Is anyone other than yourself caring for BABY/CHILD on a regular basis? If yes, what arrangements do you have? How many hours a week is baby cared for in this arrangement?"* Given these questions, we assume that the rest of the time the baby is not in an arrangement, he is taken cared of by the mother.

3.2.1.2 Cumulative Specification A second specification used in these kind of studies assumes that current cognitive development is a function of input history.

$$C_{it} = f\left(\ln E_{it}, \ln E_{it-1}, ..., \ln E_{i0}, \ln K_{it}, \ln K_{it-1}, .., \ln K_{i0}\right).$$

If households use past achievement in choosing current levels of inputs, then having a lagged score as one of the regressors, as in the value-added specification, can make the model susceptible to bias if there are omitted inputs in the error term. Bias can exist even if the omitted inputs and included inputs are orthogonal. The advantage of the cumulative speficiation is that it avoids this issue.

Integrating the discussion regarding effective labor from the previous section, the cumulative specification becomes

$$C_{it} = b_0 + b_D \ln \mathbf{D}_i + \mathbf{b}_{X,0}\mathbf{X}_{it} + \mathbf{b}_{X,1}\mathbf{X}_{it-1} + ... + \mathbf{b}_{X,t-1}\mathbf{X}_{i1} + \mathbf{b}_{X,t}\mathbf{X}_{i0} + e_{it} \tag{3.4}$$

A more general version allows input effects to depend on the age of the child when the input was applied, and the distance to when the achievement score was measured.

$$C_{it} = b_0^t + b_D^t \ln \mathbf{D}_i + \mathbf{b}_{X,0}^t\mathbf{X}_{it} + \mathbf{b}_{X,1}^t\mathbf{X}_{it-1} + ... + \mathbf{b}_{X,t-1}^t\mathbf{X}_{i1} + \mathbf{b}_{X,t}^t\mathbf{X}_{i0} + e_{it} \tag{3.5}$$

For example, $b_{Q,0}^2$ tells us the effect on the cognitive achievement score taken at age 2 of contemporaneous (or zero periods away) child care quality; that is, quality at age 2. The effects on cognitive score taken at year 3 of child care quality at year 2 (1 period removed) may be different because it is farther away from the achievement test, i.e., $b_{Q,0}^2 \neq b_{Q,1}^3$. Also, the effects may vary by the child's age. For example, the effects of contemporaneous (zero periods away) quality is different when child is 2 or 1, i.e., effects of child care quality at year 2 on achievement score at year 2, $b_{Q,0}^2$, is different from the effects of quality at year 1 on achievement score at year 1, $b_{Q,0}^1$. If equation 3.5 is the true model of the production function,Todd and Wolpin (2003) shows how the value added specification can place very restrictive assumption on the production function. To derive equation 3.3 from 3.5, we would have to assume that $b_X^t = b_X^{t-1}$.

3.2.2 Estimation Issue

A household with a young child faces many decisions regarding child care. The household will have to decide whether or not to use non-maternal child care, how long the child will be in non-maternal care if they do use non-maternal care, and to pay or not for care, among others. In many household surveys, families also revealed that they base their child care choice on the quality of child care. If quality is a choice child input then a critical issue in the estimation of the above equations is the endogeneity of the child care quality in the model. Similar with the issue in the returns to schooling literature (or effect of school quality on a child's cognitive achievement), the estimation of the effect of quality (and quantity) of care is hampered by inconsistency in estimation coming from omitted child endowment of mental capacity (or the child fixed effect), which may be correlated with child care quality. Rewriting 3.3 to reflect the child fixed effect, c_i, in the error term:

$$C_{it} = a_0 + \mathbf{a}_D \ln \mathbf{D}_i + \mathbf{a}_X \mathbf{X}_{it} + a_C C_{it-1} + c_i + v_{it} \tag{3.6}$$

where v_{it} is uncorrelated with current inputs as well as previous shocks.[10] Presence of the child's initial endowment in the error term can mean that the choice inputs are endogenous if the household observes initial endowment and uses this to decide on the input levels. That is, the unobserved effect c_i is correlated with child care quality, and possibly with the other inputs. If that is the case, then the OLS estimator for a_Q will be biased.

The bias in the estimate of a_Q in the value added specification is $\hat{a}_Q - a_Q = \frac{Cov(Q_{it}, c_i)}{Var(Q_{it})}$. For example, parents who observe that their child is intelligent could reinforce this observed intelligence by choosing high quality care. In this case, the unobserved initial endowment and child care quality are positively correlated and this biases the estimate for the child care quality coefficient. Parents may also compensate their child with low ability by putting them in higher quality. This, on the other hand, biases estimate downwards.[11]

[10] The interpretation for having initial endowment in the error term even if we have prior cognitive measure is "that mental capacity is fixed for life at conception but has an age-varying impact on achievement that reflects changing efficiency in the use of mental capacity."

[11] If parents' marginal utility for child achievement is decreasing and child endowment is already high, the marginal utility of trying to increase the child's ability further by spending more time with the child falls relative to greater household consumption or maternal leisure. This means child care/work hours would be negatively correlated with endowment.

3.2.3 Strategy

We do not rely on one method to address this endogeneity. Our goal is to improve the reliability of our results, by employing several methods, and verifying if results from one method will be validated by the others. The methods we employ are: to proxy for the unobserved time-invariant effects; to use instrumental variables in place of the endogenous inputs; and with multiple observations of the child's cognitive achievement, to use within-child estimators.

Variables to Proxy for Child Initial Endowment

Let $\mathbf{W}_i = (W_{1i}, W_{2i}, ..., W_{Ki})$ be a set of proxy variables. That is, c_i is correlated with each W_{ki} and $E(C_{it}|\mathbf{D}_i, \mathbf{X}_{it}, C_{it-1}, c_i, \mathbf{W}_i) = E(C_{it}|\mathbf{D}_i, \mathbf{X}_{it}, C_{it-1}, c_i)$. The latter condition means $\mathbf{W}_i$ is not needed when we know c_i or is redundant. Including proxy variables will reduce the bias from the omitted variable if $E(error_{it}|D_i, X_{it}, C_{it-1}, c_i, W_i) = 0$.

Since we are concerned with initial child ability, we use variables that we believe are related to the child's endowment of mental capacity. We include the child's gender, ethnicity, gestation age, birth order, mother's assessment of child temperament and health at 1 month, and father's years of education, in addition to mother's education, age at birth and intelligence score.

Behrman and Taubman (1986) report that lower birth order children perform better at school and have higher earnings. Several biological reasons have been hypothesized for the presence of this effect. One is that birth defects increase with the mother's age so that later-born children have a greater probability of starting with lower genetic endowments. Father's education is included since this a manifestation of his ability, which could be transmitted to the child. Child temperament, which is the mother's rating of how difficult the child was at one month, is an indicator of the child's intelligence.

Instrumental Variables

The requirement for an instrumental variable is that it is correlated with the potentially endogenous input but not with the error term. Following the approach taken by Rosenzweig

and Schultz (1986), we use the predicted values from the estimated reduced-form demand equations as the instrumental variables for the endogenous variables. The excluded variables from the first state regressions are: the difference between current family income and permanent income, average caregiver wages for center and home-based care, average quality, average child care price, work hours of mother's partner, and unemployment rates.

We assume that permanent income may be correlated with child endowment through genetic transmission. Thus, we use transitory deviation from permanent income as a source of exogenous variation in input demand. In the agricultural production literature, variations in the price of inputs are commonly used as instruments. We also use this here but after adjusting for the quality in the price of child care. Following Baum (2003), which used local area labor demand conditions, we include city unemployment rates as a source of exogenous variation in employment decision. We also include the work hours of the mother's partner because this can influence mother's work time and non-maternal care time. To capture variations in local area child care supply, we also included the average quality score and caregiver wages in the families' respective areas. The averages, however, exclude the concerned household in the averaging. We estimate a Tobit model for the child care hours variable, OLS for child care quality and learning materials, and probit models for the decisions to work and use center care.

Within-Child Estimator

When multiple observations of the child at different ages are available, another method to address the endogeneity of the inputs due to initial child endowment is to use within child estimators (or fixed effect estimation). Theoretically, this is a better approach in accounting for presence of child (and household) fixed effects because it allows for arbitrary correlation between the explanatory variables and the time-invariant unobserved factors. The proxy variables method does not eliminate inconsistency but merely reduce it. The reduction will be higher, the higher is the correlation between the proxy variable and the fixed effect. Unfortunately, there is no test to determine this. When variables are poor proxies, it may even exacerbate the model's inconsistency. The instrumental variables solution has also been criticized because instruments such as child care cost or subsidies have little exogenous

variation. Child fixed-effect method is also better than the within-sibling estimator in other studies (Blau (1998)), which was used to account for unobserved household fixed characteristics. Analyses have shown that mothers make "time" compensation depending on the ability of the child. Hence, using a household fixed effect model in which it is assumed that siblings have the same ability endowment will not be appropriate.

We implement this approach in the value-added specification by assuming that (i) input effects are not age specific, i.e., the input coefficients, $a's$, are age-invariant, and (ii) effects of child endowment are the same at all ages. Differencing three achievement test scores taken at different ages and two sets of the input vectors will consistently estimate the parameters in the presence of unobserved child initial endowment. We differenced 3.3 and estimated the equation,

$$C_{it} - C_{it-1} = \mathbf{a}_X \left(\mathbf{X}_{it} - \mathbf{X}_{it-1}\right) + a_C \left(C_{it-1} - C_{it-2}\right) + \left(v_{it} - v_{it-1}\right) \tag{3.7}$$

As we can see, the fixed effect, c_i, as well as the time-invariant factors, $\mathbf{D}_i$, such as the mother's education, are purged from the model. Assuming that $E(v_{it}) = E(v_{it}, v_{it-1}) = E(v_{it}, \mathbf{X}_{it}) = E(v_{it}, \mathbf{X}_{it-1}) = 0$, we can consistently estimate $\mathbf{a}_X$.

For the cumulative model, two estimation models can be derived depending on the assumption about the effects of inputs by age. If we assume that the effects of inputs vary by age and distance from the score, $b^t_{Q,j} \neq b^{t'}_{Q,j}$then differencing two achievement scores will allow us to retrieve the parameters only for the inputs after t' and the difference of the parameters for inputs applied at t' and before. For example, if we take the difference of the achievement scores taken at ages 3 and 1

$$C_{i3} = b^3_0 + b^3_D \ln \mathbf{D}_i + \mathbf{b}^3_{X,0}\mathbf{X}_{i3} + \mathbf{b}^3_{X,1}\mathbf{X}_{i2} + \mathbf{b}^3_{X,2}\mathbf{X}_{i1} + \mathbf{b}^3_{X,3}\mathbf{X}_{i0} + c_i + e_{i3} \tag{3.8}$$

$$C_{i1} = b^1_0 + b^1_D \ln \mathbf{D}_i + \mathbf{b}^1_{X,0}\mathbf{X}_{i1} + \mathbf{b}^1_{X,1}\mathbf{X}_{i0} + c_i + e_{i1} \tag{3.9}$$

grouping common terms we get

$$\begin{aligned} C_{i3} - C_{i1} \;=\; & \left(b^3_0 - b^1_0\right) + \left(b^3_D - b^1_D\right) \ln \mathbf{D}_i + \mathbf{b}^3_{X,0}\mathbf{X}_{i3} + \mathbf{b}^3_{X,1}\mathbf{X}_{i2} & (3.10) \\ & + \left(\mathbf{b}^3_{X,2} - \mathbf{b}^1_{X,0}\right)\mathbf{X}_{i1} + \left(\mathbf{b}^3_{X,3} - \mathbf{b}^1_{X,1}\right)\mathbf{X}_{i0} + \left(e_{i3} - e_{i1}\right) & (3.11) \end{aligned}$$

Doing this procedure will allow us to retrieve the estimates for the effects of child care quality in ages 3 and 2 on the achievement score taken at age 3.

If we assume that the effects of inputs do not vary by age (only by the distance from the test score), i.e., $b^t_{Q,j} = b^{t'}_{Q,j}$, then differencing the two achievement scores will allow us to retrieve parameters for the effects of inputs from all periods. This assumption is often made in fixed-effect estimation. Using the previous example,

$$C_{i3} - C_{i1} = \mathbf{b}_{X,0}\left(\mathbf{X}_{i3} - \mathbf{X}_{i1}\right) + \mathbf{b}_{X,1}\left(\mathbf{X}_{i2} - \mathbf{X}_{i0}\right) + \mathbf{b}_{X,2}\mathbf{X}_{i1} + \mathbf{b}_{X,3}\mathbf{X}_{i0} + \left(e_{i3} - e_{i1}\right) \quad (3.12)$$

3.3 DATA - VARIABLES

Non-maternal Care Quality, Q_{it}

In the NICHD study, childcare quality is assessed using the Observational Record of Caregiving Environment (ORCE). These observations were obtained for the primary non-maternal caregiving arrangements that were used for more than 10 hours per week. The ORCE were developed for the NICHD study based on scientific studies that looked at qualities of parenting, which are necessary to the development of secure attachments and competence in children. It was also developed by NICHD to overcome the limitations of the ECERS and ITERS, two of the most widely used measure of child care quality. These limitations are (a) the ECERS and ITERS lump together several dimensions of process quality (child-caregiver interaction, presence of curriculum and safety and health practices of the caregiver) into one composite number, and makes the contribution of each component difficult to identify, and (b) the ECERS and ITERS have different systems for home and center-type cares, thus comparison across types may not be done.

One part of the ORCE is the Qualitative Ratings, which we use here to indicate the quality of child-caregiver interaction, Q_{it}. At 6, 15, 24 and 36 months, observations were conducted during two half-day visits within a 2-week period. At each half-day visit, observers completed two 44-minute cycles of the ORCE. Each cycle is composed of four 10-minute periods of observation, where the observer looks for the occurrence of specific kinds of behavior directed by the identified caregivers to the target child. In between the 10-minute periods,

the observer makes brief notes and tentative qualitative ratings of the caregiver's behavior. At the end of the 44 minutes the observer makes final qualitative ratings for up to 3 caregivers using a 4-point scale that range from not all characteristic (a score of 1) to highly characteristic (a score of 4), on certain desired behaviors. These scores are based on all four 10-minute periods.

For the 6^{th}, 15^{th} and 24^{th} month observations, a total quality composite score is recorded which is the sum of the observed caregivers' scores on the following 5 desired behaviors: (1) sensitivity/responsiveness to nondistress calls, the extent to which caregiver-child interaction is characterized by prompt and appropriate responses to the child's social gestures, expressions, and signals; (2) detachment/ disengagement (reflected) , the degree to which the caregiver is emotionally and physically uninvolved with the child and unaware of the child's needs; (3) stimulation of cognitive development, the quality and frequency of caregiver effort to facilitate the child's cognitive development; (4) positive regard for the child, the quality and quantity of expressions to the child that connote the caregiver's positive feelings toward the child; and (5) flatness of affect (reflected), the frequency with which the caregiver lacks animation in facial and vocal expression and tone.

For the 36^{th} month observation, the total quality composite score is the sum of the five mentioned above plus the scores on (6) intrusiveness (reflected), the degree to which the caregiver imposes her agenda on the child as opposed to interacting in a way that provides a sense of control to the child and (7) fostering exploration, the quality of opportunities for and encouragement of the child's exploration of objects and the environment. For the 54-month period, the total quality composite score is the sum only of (1) sensitivity, (2) detachment (reflected), (5) flatness of effect (reflected) and (6) intrusiveness (reflected).

The components of the total quality scores differed since in some periods, the psychometric properties of some components are not desirable. For example, in the 6^{th}, 15^{th} and 24^{th} month, although intrusiveness was observed and scored, there were few variations. Thus, to have comparable quality scores across the different periods, we took the mean score, i.e., total score divided by the number of components.

Mode of child care used was also recorded, which we used for the center dummy variable, CTR_{it}. Average child care quality and the percentage of those using center-based care are

given in Table 6.3. We used the 6^{th}, 15^{th}, 24^{th}, and 36^{th} month observations, respectively, for years 0, 1, 2 and 3. Overtime, we note an increasing propensity to use center care, an indication that households view center-based care as a stage to prepare children for school. We note, however, that there is a decline in the quality of child care used as the children ages. This is a pattern that we have not fully explored the explanations for yet.

Non-Maternal Care Hours, N, and Maternal Work, H

Since information about non-maternal care use was updated almost every two months, the information reported during the major assessment/interview periods can be taken as description of childcare experience during the last 4-8 weeks prior to the interview dates with the caregivers. Number of hours per week, expenditure per week, among others, were asked for the three primary childcare arrangements. We used the sum of these arrangements for N_{it}. We used the 5^{th}, 14^{th}, 22^{nd}, and 33^{rd} month information, respectively, for years 0, 1, 2 and 3. Table 6.3 shows the percentage of households using some form of non-maternal care and the average care hours of those using care. Maternal work, H_{it},is a dummy variable to indicate whether the mother is working or not. We recorded mother is working if she reports positive work hours.

As is often documented, the chances that the mother will work and for the family to use non-maternal care increase as the child gets older (see Figure 2) By the time the child is 6 months old, around two-thirds are already working, compared to just about 10% in the first month, and 72% of the children were in some form of non-maternal care. The percentages steadily increase until the 36^{th} month. Average work hours of those who are working do not vary too much overtime, however . We also note that use of non-maternal care and mother's labor supply are closely linked suggesting that the main reason for using non-maternal care is employment.

Learning Materials, K_{it}

The learning materials index, is a component of the Home Observation for Measurement of the Environment (HOME) Inventory Score. The HOME Inventory Score is a widely used home environment measure designed to assess the quality and quantity of stimulation

and support available to a child in the home environment. It is composed of several items pertaining to parental responsivity, acceptance of child, among other things. We use the learning materials component only because the other components refer to behaviors of the parents, which can be influenced by child care and work experience . We also wanted to include a proxy for the actual physical goods provided to the child. The HOME inventory was undertaken in the 6^{th}, 15^{th} and 36^{th} months only. The observers conducted another test, on the 24^{th} month observation period, and had to drop the HOME inventory due to financial and time constraints. We designate values from the 6^{th}, 15^{th} and 36^{th} assessment periods as child inputs at years 0, 1 and 3, respectively.

Cognitive Achievement Scores, C_{it}

When the children were 54 months old, a battery of Woodcock-Johnson tests were administered to them. Similar with other NICHD studies that combined these tests to form a composite score, we use the mean of the Picture Vocabulary, Applied Problems and Letter-Word Identification scores as the child's cognitive achievement score. The picture vocabulary test is a test of crystallized intelligence, while the applied problems and letter-word identification are achievement tests on math and reading, respectively. Because inputs take effect after a lag, we designate this as the year 3 achievement score. For years 1 and 0, we used the Bayley Mental Development Index administered when the children were 24 and 15 months, respectively, as measures of the cognitive ability. The tests administered at 36 months were test of school readiness and are not considered as cognitive achievement tests. This left us with no cognitive score designated for year 2.

The scores were all standardized in the NICHD data to have a mean of 100 and standard deviation of 15, with higher scores indicating better development. We converted them to have a mean of 0 and standard deviation of 1 so that coefficient estimates could be interpreted as the size effect of a given change in the explanatory variable. This would also facilitate interpretation and comparison with other studies as advised by McCartney and Rosenthal (2000).

Another use of standardizing the test scores is in facilitating the differencing procedures. Since cognitive ability at different periods were measured using different testing procedure

(Woodcock-Johnson at 54 months, a revised Bayley MDI at 24 months, and the original Bayley MDI procedure at 15 months), it is possible that a change in a child's score from one period to the next might be brought about by the change in scoring system, and not by a change in her underlying cognitive ability. By standardizing the scores, we are essentially, comparing the target child against the average child in her age group. If her cognitive ability improves while the rest remain the same, then her distance from the average child should increase and the difference between the new and old standardized scores should capture this.

3.3.1 Data Patterns

Table 6.7 shows the means of children's scores for different groups. These groups are: an all maternal care group (i.e., children were exclusively cared for by the mothers), and four groups of varying child care quality. We see from the table that the mean of child's cognitive scores are increasing with the quality of non-maternal care. However, other family and maternal characteristics that are related to mother's quality of care are also increasing with child care quality. For example, households with more educated mothers and have higher incomes tend to choose higher quality care. The amount of learning materials that households have are also positively associated with child care quality. This demonstrates the selection bias issue that is confounding researchers on this topic.

While selection bias due to mother's or family characteristics have been identified and dealt with in many studies, there is also the issue of selection bias due to the child's endowment. As Table 6.8 shows, children in higher quality groups (i.e., quality score greater than zero) had higher health ratings at 1 month old, and were also heavier at birth (another sign of good health). Also, children in higher quality care are often the low birth order children, usually the first borns. We take note of this pattern because there are studies, such as Behrman and Taubman (1986), which find birth order effects in schooling and earnings. They find that first (or lower order) born children have higher earnings. Finally, we also note from this table that children in high quality groups had higher temperament scores when they were 1 month old.

Child-caregiver interaction is only one aspect of child care quality. Other aspects such

as presence of curriculum and health/safety practices are also deemed to be important. The mode of care has also received attention as an important determinant of children's development. Center-based care is believed to be a better promoter of cognitive development. Indeed, if we compare means of cognitive scores by mode of care, children in center-based care do have higher scores, even if quality of child-caregiver interaction is similar across modes. However, selection bias can also be an issue as more educated mothers and higher income families have a higher tendency to choose center-type care.

3.4 RESULTS

As argued above, child care quality can be correlated with the unobserved child endowment of mental capacity if households use their observation/assessment of their child's ability in choosing the child care to use. To check whether or not this hypothesis is supported by the data, we conducted the Hausman test for endogeneity (Hausman, 1983) To implement the test, we estimated first the reduced form equations for child care quality, child care quantity and learning materials on the exogenous variables. These included the mother's education, mother's age at child birth, mother's intelligence score, number of children, average child care quality, average child care price, average caregiver wage, unemployment rate, deviation from permanent income, and partner's work hours. We then included the predicted residuals from these first stage regressions in the value added specification model and tested for their significance. The test suggests that if the a residual from the reduced form equation is significant, then that input is endogenous. We see in Table 7.1 in Appendix 7.2 that the predicted residual from the year 1 quality regression is significant suggesting that child care quality at year 1 is endogenous. We did not get any significant results from the cumulative specification for the quality residuals. Although, child care hours and learning materials' residuals are significant, suggesting these inputs are also endogenous.

We also regressed child care quality at year 3 on previous cognitive scores (as well as exogenous parental characteristics) and found it is significantly and positively associated with the cognitive score from year 1. Child care quality at year 1 is also positively related to year 0 score. We take this as evidence that parents utilize their assessment of their child's

mental abilities in choosing the quality the child care to use.

3.4.1 Effects of Child Care Quality

3.4.1.1 Base Model The results of our empirical analyses for child care quality are summarized in Table *6.9*. The table shows the estimates beginning with (A) Base models, (B) Proxy Variables models, (C) Instrumental Variables models, and (D) Within Child models (or differenced models). The first three columns show the coefficient estimates for child care quality experienced in the child's year 3, 1 and 0, from the value-added specification . The second set of columns, on the other hand, are from the cumulative specification. Because of unavailability of cognitive test score and learning materials index for year 2, we did not implement the models to recover effects for year 2 inputs that were observed.

We begin our analyses by estimating equations 3.3 and 3.4, as the base models. The base models are similar with the regression models adopted in past studies (NICHD Early Child Care Research Network, 2001; 2003; 2006). These studies attempt to reduce the bias from family selection factors by including variables such as parental education, maternal intelligence, mother's age at birth, among others. We do not include family income, however, as these other studies did, because it will produce bias if family income is correlated with omitted inputs. If family income is included, this would reinterpret child care quality coefficient as the effect of child care quality holding family income constant. If higher quality requires greater money, then this would necessarily reduce purchases of other inputs holding income fixed. Thus, even if child care quality and omitted inputs (such as nutritional food) may be uncorrelated, including family income will produce a correlation.

The estimated size effects from the base models range from a low of 0.057 (year 3, value-added specification) to a high of 0.132 (year 1, cumulative model). (A size effect of 1 means a 1 standard deviation increase in quality leads to a 1 standard deviation increase in cognitive achievement score.) All quality coefficients are statistically significant at the 5% level. Comparing this with the NICHD (2001) and NICHD (2003) study, however, our estimates are at the lower end of the range of estimates in those studies' preferred model, which may be due to their inclusion of family income as a regressor.

We also estimated the value-added model in nonlinear form. These nonlinear equations were derived from assuming a more general CES function for the effective care input, rather than a Cobb-Douglas model. The coefficients from the base estimation were almost equal to the linear base estimates. However, the estimates from the proxy, instrumental variables and within child estimation yielded huge standard errors, so we abandoned the nonlinear specification. Moreover, the estimated elasticity of substitution between maternal and non-maternal care was very close to 1. Hence using a Cobb-Douglas function, which would yield a linear production function, is not unwarranted.

3.4.1.2 Proxy Variables The next line of Table 6.9 shows the results for the proxy variables estimation. These estimations add variables that we argue are correlated with the unobserved child endowment to reduce the omitted variable inconsistency. These proxy variables will be useless if they do not add any explanation to the child's cognitive score. We determine that coefficients for child is boy, child is black, child's birth order, child's gestation age, child's temperament (the last two at the year 0 regressions), and father's education are significant. Adding these variables also increases the R^2 by an average of 0.05; a 9 percent increase in the explained variation.

We also note that the effect of child care quality has fallen by an average of 20 percent. In the value-added specification, the effect of quality at years 3 and 1 fell from 0.057 to 0.045, and 0.078 to 0.043, respectively. We note similar drops in the cumulative model: 0.078 to 0.074 and 0.132 to 0.070 for years 3 and 1, respectively. We expect this to happen if initial child endowment and child care quality are positively correlated. As for the year 0 inputs, we note that the base and proxy model estimates are almost equal. At the child's early months, it is very likely that parents do not have a very good assessment of their child's mental endowment yet. In that case, it should not figure in yet into the parents' choice of child care quality.

There is a danger, however, that the model will still be biased and inconsistent if we include poor proxy variables That is the variables have very low correlation with the omitted variable. Unfortunately, there is no way to test for this. We therefore resort to other estimation procedure to find support for these initial estimates.

3.4.1.3 Instrumental Variable In this procedure we first estimated the reduced form equations for child care quality (OLS), child care hours (Tobit), and center care (Probit). We then used the predicted values from these first stage regressions in lieu of the potentially endogenous observed values in the production function regressions. The variables excluded in the second stage regressions (the instruments) are: the difference between current family income and permanent income, average caregiver wages for center and home-based care, average quality, average child care price, work hours of mother's partner, and unemployment rates. These variables have to be correlated with the endogenous variables but not with the error term. The first assumption can be tested while the second one will have to be assumed. The results of these first stage regressions are given in Appendix 7.2 Table 7.2 Controlling for the other exogenous variables, child care quality is significantly correlated with average caregiver wage for home based care (0.1), average quality of other income group (0.127), average price from other income group (-0.092) and unemployment rate (0.052).

The estimated child care quality coefficients from the second stage production function regressions are in line C of Table 6.9. Information from the results, however is not consistent nor reliable. Either we derive very small and insignificant coefficient estimates, or unbelievably large estimates; a problem often encountered with instrumental variables regression. For example, year 0 coefficient is estimated at 0.199, which is 150 percent larger than the base model estimate. Having insignificant estimates is likely due to weak correlation of the instruments with the endogenous variables resulting in child care quality (and others) being imprecisely estimated, i.e., the standard errors were very large. This issue is often cited in many child care studies using local area information (Baum, 2003; Blau and Grossberg, 1992). The second result can also be due to weak correlation with the endogenous included variables, but at the same time possibly being correlated with the error term as well. Unemployment rate, average price can be correlated not with the initial child endowment but with other family inputs that maybe omitted. This will make the estimator highly biased and inconsistent. In which case, the variables used are not valid instruments.

3.4.1.4 Within-Child Estimation Line D in Table 6.9 shows the results for using within child estimators. In the value-added specification we estimated equation 3.7 with

OLS. One disadvantage of this model is that we can only implement it to recover an estimate for child care quality (and other variables) at year 3. In order to identify coefficients for year 1 inputs, we would need 2 lagged achievement scores and 1 set of lagged inputs. There was only 1 test done before year 1 inputs, however. Thus, years 0 and 1 coefficients were not determined because we lack past cognitive scores. Nevertheless, we find that child care quality at year 3 does not have a significant effect in this model specification.

Estimates in lines D1 and D2 in the cumulative specification, are from models where we assume that effects may vary depending on the age of the child when inputs were applied, and on the distance in time from when the test scores were taken. In D1, we estimated equation 3.10, using scores (and inputs) for years 3 and 1. Doing so we are able to recover the input coefficients applied at year 3. The estimated child care quality effect, however, is insignificant. To recover effects of inputs applied in year 1, we took the difference of scores (and inputs) from years 1 and 0. The estimated child care quality effect is 0.081, and is significant. Year 0 coefficients will not be identified in this method. Line D2 is from a regression that takes the difference of years 3 and 0 scores. This model recovers effects of inputs applied after year 0. Child care quality effects at year 3 is .069 and at year 1 is .065, and both are significant at the 10% level.

Line D3 is from estimating equation 3.12, which assumes that effects are age invariant. The estimates are from a regression that takes the difference of years 3 and 0 scores and inputs. With the assumption of age invariance, this model allows us to identify coefficients for inputs applied at all ages. The estimated effects for child care quality are 0.062 for year 1 and 0.066 for year 3, and are significant at the 10% level.

The estimates from the within-child procedure are smaller than the base and proxy variables model estimates. A viable explanation for this, which is what we hypothesized, is that parents are able to observe their child's cognitive abilities and choose high quality child care to reinforce child's high ability. The proxy variables method, although reduces the bias, it does not completely eliminate it.

3.4.2 Other Child Care Effects

Table 6.10 show the results from the base model when we use other indicators of quality: group size and child-caregiver ratio. The results are consistent across all models in that no significant association exist between these structural indicators and cognitive achievement. Table 6.11 presents the results for child care hours and the use of center care. Similar with the results in Chapter 2, we get negative effects of child care hours without child care quality and center-type care. When quality of care and mode of care are added, however, the negative association between child care quantity and cognitive score disappears. This is a consistent result in all the models that we estimated.

Regarding the use of center care, we observe in Table 6.11 that independent of the effects of child care quality, the use of center-based care during the child's year 0 and 1 age provides a positive effect on the child's cognitive score. The results for year 3 are not consistent across the models and so we view the results for year 3 with less confidence. Taking the average across the models, we estimate that the use of center-based care at year 0 raises cognitive score by 0.23 standard deviation, while the use of center-based care at year 1 raises cognitive score by 0.21 stdev. These size effects are interpreted as the effects of other quality attributes possessed by center-based care aside from the positive interaction between caregiver and child.

The regression results are clear. With respect to a child's cognitive development, the quantity of child care is not a significant predictor. The aspect of child care that matters most is is the quality of care as captured by the positive interaction between caregiver and child, as well as other attributes possessed by center-based care.

3.4.3 Other Issues

3.4.3.1 Issue 1: Omitted Inputs The problem this research tried to address is to eliminate (or reduce) the bias in the estimation of child care effects, which may arise due to unobserved initial endowment of the child's cognitive ability. Consequently, the methods we adopted were designed for taking out the fixed effects of this unobserved ability. The strategy would be valid if we were able to account for all inputs that are relevant to the

child's cognitive development. Admittedly, this is not the case. Although, we included the learning materials index to capture the quality and quantity of inputs that provide cognitive stimulation (books, toys, magazines, etc.), it is very likely that there are other inputs that affect cognitive development through other mechanisms aside from cognitive stimulation. Inputs related to health and nutrition, such as doctor visits, nutritional food, etc.[12] If these are correlated to child care quality and learning materials, and they have a direct effect on cognitive development, then the estimators for the included inputs are biased and inconsistent.

The likely source of correlation is through family income (mother's education and intelligence were already included). Households with higher income would likely purchase more of all inputs. Two points, however, can be raised to argue that the bias is likely to be small. First are scientific reports that say beyond a certain "critical" threshold of health and nutritional inputs, additional nutrition and health expenditure have negligible impact on cognitive development. Since these are American households and with mean income greater than the national average, it is likely that they have already invested beyond these thresholds. The implication is that, if households with higher income do purchase more health and nutritional inputs to their children, as well as in quality of care (i.e., quality and the other inputs are correlated), additional levels of these other inputs have no additional benefit on child's cognitive development. That is, there may be no omitted inputs anymore.

Second, to test whether or not there is still endogeneity due to these omitted inputs, we included the household's income in the proxy variable model for both value-added and cumulative specifications. Since the possible source of correlation between included and omitted inputs is household's income, then including this variable should change the coefficient estimates and household income itself should be significant. Alas, the results showed that estimates did not change, and family income is insignificant. These are evidence that there is little or no bias from the omitted inputs.

[12] Given that the study focuses on the children's preschool years, it is very likely that all relevant inputs were coming from the child's home and child care environment.

3.4.3.2 Issue 2: Size effects The various estimation models yielded estimates in the following range: .045 to .078 for the effects of child care quality at age 4; .043 to .081 for age 2, and .08 for age 1. We prefer the estimates given in line D2, i.e., age 2 quality effect equal to .065 and age 4 equal to .069 since this model is the least restrictive. The estimates in D2 suggest that a sustained 1 standard deviation increase in child care quality beginning at age 2 to age 4 can raise cognitive achievement score by about .13.

What is the practical significance of these estimates, however? Are they large enough to warrant attention from policy-makers and parents? Cohen (1988) gives a guide on how to evaluate size effects for studies in the behavioral sciences; for correlational coefficients, size effects from .1 to .3 are deemed small. He based this on the proportion of variance (PV) associated with size effects, i.e., the percentage of variation in the dependent variable explained by variation in the independent variable. If r is the size effect, $PV = r^2$. Thus, a size effect of .13 would imply a PV of .017, i.e., only 1.7% of the variation in the cognitive scores is explained by the variation in child care quality.

We also compared our estimates from past studies of child care quality effects, and find that our estimates are smaller. The CQO study reported an effect size of .20 on language and math skills scores. The quality indicator used, however, encompassed a broader range of quality. Burchinal, Peisner-Feinberg, et. al., 2000, combined results from the CQO, a study of HeadStart programs in North Carolina and a study of public preschool programs in North Carolina. The effect sizes are from .21 to .24 for pre-reading and math skills. As we argued, however, these estimates are possibly biased because the methodologies used are not fully accounting for omitted variable bias.

Our effect sizes are also much smaller than those reported for experimental studies, such as from the Abecedarian project and Perry Preschool project.[13] However, it can be argued that these studies estimate a different parameter than the ones being estimated here. Studies using observational data, such as this, estimate production function parameters, i.e., the effects of raising an input holding other inputs the same. In experimental settings, what is estimated is a policy parameter; the effect of raising quality but not holding other inputs

[13]It is believed that the greater intensity and duration of these projects, and their targetting of high-risk children are the sources of the large treatment effects.

constant. The reason is that even if one input is exogenously determined, through random assignments, the other inputs are not because they are determined by the parents. It might be that with an increase in quality, parents reduce the investments in other inputs. The parameters estimated then is capturing the effects of quality, but of other inputs as well.

Although the size effects estimated here are small from a statistical context, and in comparison with other studies, the final test of its relevance is to determine what is the cost of increasing child care quality by a standard deviation, and to compare it with the benefits of a 0.06 standard deviation increase in cognitive score. The CQO study has reported that the cost of improving quality in day care centers is moderate. Likewise, in this dataset, the average increase in per hour child care cost for each standard deviation increase in child care quality is only 20 cent ($1) for center-based care (for home care). This would translate into an annual cost of $324 (or $1620). In the following chapter, we also investigate whether or not economic incentives influence households' choice of child care quality. This would be helpful in assessing how much financial assistance should be given for households to raise child care quality by a certain level.

With respect to the benefits of an improvement in a child's cognitive score, this would require further investigation. However, Currie and Thomas (1999) indicate that early test performance is strongly related to future educational and labor market outcomes.

3.5 CONCLUSION

This chapter attempted to gain a better understanding of an important issue, for parents and policymakers alike, i.e., what is the effect of child care quality on cognitive development. This study differ from previous studies in two ways. First, we recognize that the productivity maternal and non-maternal care in producing early cognitive development differs because of variation in quality. We thus modeled the production function to reflect this fact. Second, whereas recent studies controlled for selection bias due to family factors only, we hypothesized that bias may still remain due to unobserved child ability. Our estimation strategy begins with the models often preferred in other studies. The base model includes exogenous mother and household characteristics to control for maternal quality of child care. We estimate

three models on top of the base model: including proxy variables for child endowment of mental ability, instrumental variables and within child estimators. Results from the proxy variables and within-child estimation present evidence for a (positive) bias due to unobserved endowment. Estimates from these two models are lower than the base model by an average of 25 percent.

Nevertheless, the estimation results show strong evidence for the significance of child care quality in a child's cognitive development. We consistently find significant positive effects of an improvement in the quality of child care used during the child's years 1 to 3, whichever model is used. With respect to the use of center-based care, we also observe a significant positive effect over and above the contribution of child care quality. The estimated size effect is not small, about 0.2 to 0.25. Finally, consistent with the findings in Chapter 2, we also determined that, controlling for child care quality the quantity of child care has no significant association with cognitive development.

We also assessed the practical significance of the estimated child care quality size effect. Our approach is that this assessment should include the cost and benefit of this effect. On the benefit side, we reserve this for future work. On the cost side, we turn next to the question of whether households can be encouraged to buy quality care with economic incentives. Our view is that any intervention to improve the quality of child care used should work within the bounds of household choice. Thus, we look at how income, price and wage changes affect demand for child care quality.

4.0 DIFFERENCES IN THE DEMAND FOR CHILD CARE QUALITY AND QUANTITY

4.1 INTRODUCTION/REVIEW OF LITERATURE

As stated in the introduction, the US Bureau of Labor Statistics projects that women in the labor force will increase by 9.6 million to 77.1 million in 2012. As more mothers enter the workforce, more and more children will be placed in non-parental care arrangements.[1] Even among households with unemployed mothers, the percentage of children in some form of non-parental care is significant.[2] In 2001, there were 12 million children from 0 to 5 years who received some form of non-parental care on a regular basis. For 2010, the number of 0-5 year-old children in non-parental care is projected to increase to 15.61 million (FIFCFS, 2003).

While there are several studies that have investigated the determinants of household's choices on employment and mode of child care, only a few examined the demand for child care quantity, i.e., the time that a child spends in non-maternal care, and quality.[3] It is important to study the determinants of the quality and quantity of child care since they are found to influence child development.[4] The purpose of this chapter is to examine the

[1] In 2002, 15.2% of women in the labor force are women with children less than 6 years old. Basing on past trends, this percentage is not likely to go down.

[2] 39% in 1997, 37.4% in 1999 and 2002, (SIPP).

[3] As defined by development psychologists, the quality of child care is its rating on an assessment of features believed to affect a child's development, such as: how caregivers interact with the child, nature of the curriculum and the health and safety practices of the arrangement. To our knowledge, there has not been any work that looks at the demand for quality so defined.

[4] The survey by Love, Schochet and Meckstroth (1996) reports that there is a significant positive relationship between the quality of care and child development. From the last chapter, we also find a positive effect of child care quality and the use of center-based care on a child's cognitive development. An influential paper by Belsky (1988) find high quantity of child care can lead to insecure relationship between mother and

impact of economic incentives on the household's joint decisions on child care quality and quantity.

We emphasize the impacts of economic factors since in the United States, almost all of the child care needs are provided in the market and privately financed by the families.[5] Therefore, any intervention to improve child care quality should preserve the right of households to use the child care of their choice. To influence family decisions, the government relies on financial incentives in the form of tax credits and subsidies, such as the Child Tax Credit, Dependent Care Tax Credit and child care subsidies to low-income families from the Child Care and Development Fund. Changes in tax credits and subsidies can be viewed as changes in the mother's unearned income, her wage or the price of child care used.[6] Impacts of these programs on demand can then be assessed by treating them as mother's nonlabor income, mother's wage or child care price effects.

The innovation in this paper is that we examine if the effects of policies on demand for child care depend on the family's condition. A family's condition is defined by the choices it has made regarding maternal employment, mode of child care and payment status. That is, we determine if these discrete choices generate differential effects of income, wage and price changes on child care quality and quantity. For example, since working mothers who pay for non-maternal care will be less constrained[7] in choosing child care, will the wage effect on work (and child care) hours be larger than that for non-paying working mothers? Would the effect of unearned income on child care hours be different in sign for non-working mothers against a working mother? While the working mother seeks child care to complement her work, the former seeks care possibly to have some leisure time. The impact of a higher income on child care hours could therefore be of opposing signs. Since quality decisions

child.

[5] In 2001, $55 billion were spent for child care and early education in the US, 55% of spending were provided by private households.

[6] Since the Child Tax Credit depends only on the presence of a child and can be claimed by the spouse, an increase in the credit can be viewed as an increase in family income not related to mother's employment. On the other hand, the Child and Dependent Care Tax Credit and the CCDF child care subsidies can be availed of only if the mother is employed; changes here can be viewed as changes in the mother's net wage. If the dependent care credit can also be enjoyed by non-working mothers, then we can view the effect as a reduction in the quality-independent price of child care.

[7] Free non-maternal child care are often provided by government agencies or by relatives and extending child care hours in these settings can be difficult. Hours in government run programs are fixed. Asking relatives to baby sit longer will be difficult especially if it is being done as a favor.

depend on the quantity of child care the family plans to consume, then the impact on the demand for quality would also vary depending on the mentioned conditions.

Very few studies investigated the determinants of child care quality. Blau and Hagy (1998) allowed the wage and price effects on hours and quality attributes to vary but not the income effects. Hagy (1997) estimated demand for a quality attribute for center-based care only, and pooled employed and non-employed mothers. These papers also did not examine whether the age of the child influences the responsiveness of the families' demand to these economic variables, especially for quality. During infancy, children would require plenty of physical care, while older children would need more educational stimulation (see Leibowitz, et.al., 1988). This can lead to differences in how mothers perceive or appreciate the quality of child care and to age variations in the demand for quality. Finally, these papers, use child care quality attributes,[8] which the last chapter and Blau (1999) showed have no significant effects on cognitive development.

In this paper we first analyze the family's choices on maternal employment, mode of child care and whether or not to use paid (or formal) care. We do this because as explained above, these discrete decisions will influence the demand for child care quality and quantity. We will also use this first stage regressions in addressing self-selection problem. This paper models these three discrete choices jointly and in doing so generalizes earlier studies on demand for child care and labor supply. Ribar (1992), Averett, Peters and Waldman (1997) and Kimmel (1998) analyzed whether the mother is employed and if she uses paid care but does not consider the choice of mode of care. Hofferth and Wissoker (1992) investigated mode choice of employed mothers only, without correcting for self-selection. Michalopoulos and Robins (2000) analyzed mode choice and employment and Powell (2002) investigated employment, mode choice and formal versus informal care but both works did not consider the payment status of the child care.

This research uses the Study of Early Child Care data from the National Institute of Child Health and Development. The advantage of using this dataset is that it collected socio-demographic and economic information, including those related to the mother's employment, from the same families over multiple periods. It also collected information from

[8] Such as group size and child-caregiver ratio.

the child care providers used, such as their cost and attributes. These features allow us to estimate the demand for quality and quantity in addition to the discrete choices, and allowing for age effects. Our empirical analysis suggests that the different incentives and constraints associated with the mother's discrete choices imply differential effects on the demand for quality and quantity. One difference is that, while an income increase raises quality for non-working mothers working mothers who use center-based care cut back on quality consumption. Another is that demand for child care quality is more responsive to economic incentives when children are out of infancy. Findings on these differential effects can contribute to policy designs for maternal labor supply and child care quality as it suggests that certain forms of assistance may not generate the desired results for certain groups of households. The results also suggest when the will assistance be most effective.

Section 4.2 of the paper discusses the theoretical framework and empirical strategy. Section 4.3 describes the dataset and points out interesting patterns regarding child care quality and hours by employment status, type of care and by child's age. We present the empirical results in Section 4.4, and assess how equal amounts of financial assistance but given in different forms would impact policy objectives, such as using higher quality child care. The last section concludes and interprets the implications of the results on policies.

4.2 METHODOLOGY

4.2.1 Theoretical Model

The demand for child care quantity and quality are not independent of each other. How much child care to consume would depend on the quality of child care to be used. Aside from the potential effect on child development from using low quality care, the price of child care increases with higher quality. Likewise, a household may not pay too much attention to quality if it knows it will be using child care for a few hours a week only. On the other hand, an upgrade in quality might cost significantly if the household uses childcare a lot. That is, as suggested in the quality-quantity literature, the implicit price of quality increases with the amount of quantity consumed. Choices about child care quality and quantity, therefore,

would have to be jointly analyzed.

Moreover, this chapter posits that the demand for child care quality and quantity will depend on whether or not the mother is working, uses paid formal care, and the mode of child care used. Employment status is important since this determines whether child care is a good that they directly enjoy, or serves as a complement to maternal work. Estimating a demand for quality also will be relevant only to users of paid (or formal) non-maternal care. Availability of free and informal child care is often limited, and it is unlikely that parents can move the child to another free child care of a different quality if the parents' situation changes. Per Hagy (1998), "the ability to estimate the demand for quality ... depends crucially on the assumption that there is a sufficiently large number of alternatives so that, in any one arrangement, consumers can find their desired bundle of attributes." Finally, the typical child care varies substantially across center and home-based or family day care, in terms of quality and fees charged. These variation can be due to observed attributes of the provider chosen and on unobserved factors such as the motivation of the provider. When consumers realize the differences, then the mode of child care chosen will be an important factor in their demand for quality. From the above discussion, it is therefore essential to analyze how a household's demand for quality and quantity would differ by the circumstance they are in, as defined by these three decisions.

The unit of analysis in the model is the household, which is composed of a mother, a partner and a child.[9] The mother makes the decisions in the household on how resources, including her time, are allocated. The mother maximizes a utility function for the household given a production function for the child's development and subject to a household budget constraint and time constraints on the mother and child.

Fertility decisions are assumed exogenous, as well as the husband's or partner's work status and income. These are common assumptions from previous research. The reason for taking husband's time as exogenous is that their work decisions are often unaffected, or less affected than the mother's, by a child's presence (Hill and Stafford, 1980). We also assume that if household chooses to use some form of non-maternal care, only one arrangement is

[9]We limit the model and estimation to mothers with husbands or partners since single mothers have severely limited budget and child care choice sets. Studies by Han and Waldfogel (..), Connelly, (..) indeed showed signicant differences in the elasticities for ... between the two groups of mothers.

used.

What we plan to do is first to discuss how households make these three choices. Once they have chosen these three discrete choices, we investigate their demand for child care quality and quantity.

4.2.1.1 Discrete Choices and States A mother with a preschooler will have to make three discrete decisions: (1) to work or not, (2) to utilize free or paid care, and (3) whether to use parental care, home-based care[10] or center-based child care. Studying the determinants of these choices is important on their own right. In addition, we discussed above why consideration of these different situations is important in the analysis of demand for child care quality and quantity.

Work or not work. Any person of working age faces this decision, balancing the desire to have more leisure with the desire to have more consumption goods. In the case of mothers, there will be an additional cost to working, in the form of lower child outcome, if available non-maternal care is of inferior quality to hers.

Paid versus unpaid care. For a family with a young child, whether or not to use paid or unpaid care is very critical because child care expenditure can occupy a substantial share of the household budget. The CQO Study estimated that for low-income families, child care expenditure can account for as much as 30% of household budget. Aside from the impact on the family budget, there can be significant differences in the characteristics of paid and unpaid care. Unpaid child care is often made synonymous to informal care coming mostly from relatives and/or friends, which are generally perceived to be of lower quality. Unpaid/informal care is also less flexible in terms of the time, day or the number of hours the child can be taken cared of; attributes that are valuable in certain employment situations.

Center-based care versus home/family day care. Attributes of care can vary greatly depending on the mode of care. Center care could differ from home-based care in aspects of quality aside from caregiver interaction, such as the presence of a syllabus and health practices. The two modes can also differ in characteristics not related to quality but are nonetheless desired by households, such as convenience, availability, whether or not the child

[10] Home-based care includes family day care, baby sitters, and relatives or friends.

care is affiliated with a preferred institution, e.g., church. Local governments tend to have different sets of regulations for the two types. Lastly, as suggested by the CQO study, center and home-based care can have different cost structure and price functions.

Blau and Hagy (1998) recognize that these three decisions are interrelated and this is the only work so far that models these decisions in a unified framework. Following their approach, we define a categorical variable S with values s =1, 2, ..., 8, which represent the different combinations of the three decisions. That is, state 1 is when mother exclusively takes care of her child, and therefore uses free child care, and she does not work. States 2 to 4 are combinations involving free child care, while states 5 to 8 are combinations with paid non-maternal care. This study considers households where the mother does not work but the family still uses some form of non-maternal care. This is important to consider in the demand for child care quality because working and non-working mothers have different objectives in using child care. Frequency distribution of the states are given in Table 6.12. We note that states where the mother works have the highest frequencies, partly attributable to the fact that we are utilizing a sample with husbands or partners.

States where the family does not pay for care are not subdivided into center and home-based. Doing so will result in some categories having very few observations. Another reason is that we do not estimate a demand for quality for non-paying households. Estimating a demand function implies that there is a host of choices that the family can choose from. This would be an unlikely scenario in the case of unpaid care.

We assume that utility of the household for choosing state s is a function of household income not from mother's employment (or nonlabor income), v, mother's wage, w, price of child care at state s, c_s, other exogenous mother and family background characteristics, X, and other unobserved factors relating to the households preference and how child outcome or quality is produced, ξ, i.e., $V_s = V_s(w, v, c_s, \mathbf{X}, \xi_s)$. The mother will choose state s if $V_s > V_j$ for all other j possible outcomes, and the probability that state s will be chosen is $\Pr(s) = \Pr(V_s > V_j,\ \forall j \in S,\ j \neq s)$. We are interested in the effects of nonlabor income, mother's wage, and quality-adjusted price on the probabilities that the mother will (i) work, (ii) use paid care, (iii) use paid center care, and (iv) use home-based care. Effects on the use of paid care are of interest since if the household pays for care, it is in a better position

to raise the quality of child care consumed when their economic situation improves. Center-based care on the other hand, is associated with higher child development. As shown in the last chapter, use of center-based care have positive effects on cognitive development. We define the probabilities of interest as the sum of the probabilities of the states that have that condition: the probability of working is $\Pr(work) = \sum_{s=3,4,7,8} \Pr(s)$, for using paid care is $\Pr(paid) = \sum_{s=5,6,7,8} \Pr(s)$, and paid-center care is $\Pr(center) = \sum_{s=5,7} \Pr(s)$.

An increase in the mother's wage is expected to raise the probability that the mother works since a wage increase will affect only the utility of states where the mother is working. On the other hand, an increase in the price of childcare is expected to reduce the probability of working since the rewards from working is reduced. The effect of an increase in nonlabor income on working is not clear, however.

Since a wage increase raises the probability of maternal employment, it should also raise the probability that the household uses nonmaternal care. Given the greater availability of paid care, this would be the likely choice of mothers switching employment status. A price increase will lead to lower utilization of paid care. An increase in the price of center-based (or home-based) care will reduce the probability of using center-based (home-based) care and increase that of home-based (center-based).

Research that have estimated models of child care mode or payment choice have made these conditional on the mother being employed, such as the seminal work by Hofferth and Wissoker (1992). Their work analyzed center versus home-based care decisions, but conditional on the mother being employed, without correcting for selection bias. That is, they assumed that maternal employment is exogenous to child care decisions. They found that a higher price of one childcare mode is associated with a lower probability that mode will be chosen. Also, families with higher income tend to choose center care.

Papers that analyzed child care choice and maternal employment jointly to address this bias, omits some child care choice aspect, however. Ribar (1992) have examined maternal employment decisions together with decisions to use paid or free childcare only. He found that child care costs have strong negative effect on mother's employment and to use paid care. Income on the other hand, has strong positive impact on the decision to use paid care

suggesting that unpaid care is an inferior good.

4.2.1.2 State Specific Child Care Demand Functions In this section we analyze households' demand for child care quality and quantity. This analysis assumes that the households have chosen a state according to the discrete choice model outlined above. We then group these households according to the state they have chosen and determine the different groups' response to policy changes that affect mother's nonlabor income, wage or child care price. We hypothesize that due to differences in the budget and time constraints, and choice set that households face at different states, the effects of policy changes will vary in sign or in size when comparing households from different states.

We assume that the mother maximizes a utility function, $U = U(G, C, L)$, defined over household consumption, G, child outcome (or quality), C, and mother's leisure time, L. The child's outcome depends on the time mother spends with the child, M, and the quality of her care, q.[11] It also depends on time spent with the alternate or nonmaternal care, N, and quality of non-maternal care, Q. Child outcome is then a function of N, q and Q, $C = C(q, N, Q)$.[12]

The mother maximizes the utility function subject to a budget constraint given by

$$G + p_s \cdot N = w \cdot H + v$$

where w is the mother's wage rate and v is mother's nonlabor income, which are mostly from the spouse's income, and H is mother's work hours. p_s is the price per hour of non-maternal care in state s. This price is zero in states with free child care (i.e., states 2 to 4). In the paying states, states 5 to 8, this price is a function of the quality of child care, $p_s = f(Q)$. Following the hedonic price theory, we assume that in the market the household is in, the interaction between consumers and suppliers establishes a relationship between the price of child care and the quality of the child care, such that higher quality care would entail a higher price, i.e., $\frac{\partial p_s}{\partial Q} > 0$. This relationship arises since higher quality care will be preferred

[11] The quality of mother's care in turn are influenced by her and the family's background characteristics, X, such as the mother's education, age, number of children, etc. These are what we will use in the econometric model since quality of mother's care was not reported.

[12] Child outcome is also influenced by other child-related goods. We leave this out for the moment by assuming that this is a constant fraction of G.

over low quality care if both are offered at the same price. Thus, to establish equilibrium in that child care market the price of the high quality care must go up to eliminate the excess demand or the price of the low quality care should go down to eliminate excess supply. Also, producing greater quality care would require more resources, such as more teachers' training, hence would cost more.

Since the price depends on the quality chosen, it is endogenous to the model. What are exogenous are the parameters of the price function, such as the quality-independent component of the price (also called the quality-adjusted price). If we take $p_s(Q)$ to be of the form $c_s + g_s(Q)$, then the quality-independent component is c_s. In this paper, we are interested in the effect of this component since this is comparable with the common form of subsidy given to families. That is, most form of subsidies are given without regard to the quality of child care used. From a policy perspective, this price component would be more relevant since government monitoring of quality can be costly and can limit the extent to which subsidies to be provided can be linked to the quality of the child care used.

Finally, mother's total time, T, is spent on working, H, taking care of the child, M, or leisure, L. On the other hand, the child's total time, also equal to T, is spent either with the mother, M, or with an alternate caregiver, N. Thus,

$H + M + L = M + N = T$. We assume further that if the mother works, her leisure is fixed and that any changes in non-maternal care hours are due to changes in work hours. Doing this simplifies the model in that it reduces the number of variables a household would optimize.[13]

The following describes how the different groups of households can contrast. Working and non-working mothers differ in how they benefit from child care hours, N. Since a working mother's leisure is fixed, the benefit of an increase in N is higher household consumption because the mother is able to work longer hours. The cost of work/child care hours, however, is the decline in child outcome if quality of mother's care is higher. We maintain this assumption, that quality of childcare is lower than the mother's, in the working states.

[13] Admittedly, this is a strong assumption. In this dataset, however, the difference between average non-maternal care hours and work hours is around 4-5 hours per week. If the mother works for 5 days a week then non-maternal care hours exceed mother's work hours by less than an hour a day. It is very likely that this is spent on getting to and from work, which could then be be considered as part of the mother's work hours rather than leisure.

On the other hand, a non-working mother derives benefit from non-maternal care in the form of leisure and/or child improvement. The cost would be a decline in household consumption if she pays for child care plus the negative effect on child outcome if child care is of inferior quality.

One difference between paying and not paying for care is that when the mother uses free (or informal) care, such as from the father or a relative, it would be quite difficult for her to find another free child care of better quality when her economic situation improves.[14] Most likely, when she was comparing the modes of child care to use, she already had in mind the best free care available to her. If she opted to use free care over the paid alternatives, then it must be that she is using the best free child care available to her. An increase in her wage or nonlabor income, therefore, should not change her choice of free care since this is still the best one available to her. It is not the case with paid care, however. If the mother is currently paying for care, she may not have chosen the best quality care available because higher quality care is also priced higher. With an increase in income or wage, a higher quality care may now be attainable.

Thus, aside from different budget constraints, the ability to influence child outcome differs for paying and non-paying households. In terms of the production function, a mother who does not pay for care can only influence the outcome of her child by adjusting the number of hours that she takes care of the child (or the number of hours that the child is in non-maternal care, N). On the other hand, a mother who uses paid care can influence the outcome of her child by choosing the amount of Q, as well as N.

Table 6.13 shows how the model appears for each of the possible states, except state 1 or all maternal care. We discuss in the following paragraphs how the mother chooses the optimal N (and Q) for two cases: first is where the mother works but does not pay for care, and second, for the states where the mother does not work but pays for care. We then highlight the differences in the impacts of unearned income, mother's wage and price on N and Q between working and not working. Next we highlight the differences between those who are paying and not paying for care, among households where the mother is working.

[14] If the family's economic situation worsens, it should not affect her use of the unpaid care since it is free anyway.

Details of how we derived the comparative statics for each state are discussed in Appendix 7.3, Model Solutions.

State 3 or 4: Not Pay - Work - Non-parental or Father

When the household does not pay for child care and the mother works, the household's problem is to $\underset{N}{Max}\ U = U(G, C, L)$, subject to the budget constraint, $G = wH + v$, child outcome production function, $C = C(N)$, and the mother's and child's time constraints. With child care not paid for, quality of child care is fixed, hence child outcome is just a function of N. With the mother working and assuming that her leisure time is fixed at $\bar{L}$, changes in child care hours are due to changes in work hours.

Substituting the constraints into the utility function and then maximizing with respect to N, i.e., $\underset{N}{Max}\ \tilde{U} = U\left(w(N - \bar{L}) + v,\ C(N)\right)$, the first order condition is $\frac{\partial \tilde{U}}{\partial N} = U_G \cdot w + U_C \cdot C_N = 0$. Mother will work and use non-maternal care until the marginal benefit of working (which is higher consumption goods, w, multiplied by the marginal utility of G) is equal to the marginal cost, which is the decline in child outcome times the marginal utility of child outcome, if maternal quality is higher. If non-maternal care is of higher quality then we get a corner solution, $N = T$.

Stated differently, a working (paying or non-paying) mother would choose N^* such that the marginal rate of substitution between child outcome and household consumption, $-\frac{U_G}{U_C}$, equals $\frac{C_N}{\omega}$, where ω is the mother's net wage. (ω equals w if she uses free care and $w - p(Q)$ if she uses paid care). The top panel in Figure 3 in, illustrates the trade-off between child outcome and household consumption. The slope of the frontier of the feasible set is $\frac{C_N}{\omega}$. For simplicity of illustration, we take a linear form for the child outcome function, such as, $C = qM + QN$, where q is the quality of the mother's care, so that $\frac{\partial C}{\partial N} = C_N = -(q - Q) < 0$. The bottom panel shows the budget constraint, $G = \omega N - \omega \bar{L} + v$, where we can determine the optimal non-maternal care hours when the optimal levels of child outcome and household consumption are determined.

State 5 or 6: Pay- Not Work - Center or Home-based

A paying household where the mother does not work can choose the quality of child care

to use aside from how much care to utilize. Now, the child outcome function is expressed as $C = C(Q, N)$, with $C_Q > 0$. Child care expenditure is in the budget constraint but mother's wage is not since she is not working, i.e., $G = -p_s(Q) \cdot N + v$. Because mother is not working, all the time that the child is in child care is considered as her leisure time, i.e., $L = N$. Integrating these constraints into the utility function, the household's problem is to

$$\underset{N,Q}{Max}\ \tilde{U} = U\left[-p_s(Q) \cdot N + v, C(Q, N), N\right] \ ,$$

and where the first order conditions are:

$$\begin{aligned} \frac{\partial \tilde{U}}{\partial N} &= U_G \cdot (-p(Q)) + U_C \cdot C_N + U_L = 0 \\ \frac{\partial \tilde{U}}{\partial Q} &= U_G \cdot (-p'(Q) \cdot N) + U_C \cdot C_Q = 0 \end{aligned}$$

The marginal benefit of non-maternal care hours is that it gives greater leisure to the mother, and possibly child improvement if child care quality is greater. The marginal cost is the decline in household consumption. The marginal benefit of child care quality is an improvement in child outcome, while the marginal cost is a decline in household consumption. The choice between household consumption and leisure/child care hours can be illustrated in Figure 4, for a given level of child care quality.[15] Unlike in the previous chart, the more child care hours consumed, the lower is household consumption because the mother does not work.

Differences in Comparative Static Results

The following text discusses how the effects of nonlabor income, wage and child care price vary by work and payment status.

1. **Effects on Child Care Hours**

1.1. *Paying versus non-paying households.*

[15] *This chart illustrates the case when child outcome is not negatively affected by child care hours. It seems unmotherly of the mother if she willingly trades off child outcome for leisure.*

For households with working mothers. Figure 5 illustrates the difference in the effect of nonlabor income for childcare hours between paying and nonpaying households. In the top panel an increase in nonlabor income shifts out the frontier of the feasible set from $C(qT)\,ab\,(wT+v_1)$ to $C(qT)\,ef\,(wT+v_2)$, as well as the budget constraint line in the bottom panel. In the non-paying state, quality of child care, and the slope of the frontier, remains the same. With well-behaved preferences, the higher nonlabor income leads the household to have more household consumption and child outcome. The household is able to obtain higher child outcome by cutting back child care hours from N_1 to N_2.

The paying household, on the other hand, can also purchase higher child outcome by upgrading quality of care used. Under certain conditions, particularly, if a higher income increases the marginal value of child care quality, the household will buy higher quality care, say from Q_1 to Q_2. Doing this, however, would change the technical rate of substitution between child outcome and household consumption, i.e., the slope of frontier of the feasibility set. In particular, this would flatten the frontier (increase $\frac{C_N}{\omega}$ from $-\frac{q-Q_1}{\omega}$ to $-\frac{q-Q_2}{\omega}$) and rotate the frontier line from ef to eg. This in effect reduces the marginal cost of working because the difference in quality between maternal and non-maternal care is reduced. This allows the mother to work more hours compared to when she is not paying for care. Thus, instead of cutting back non-maternal care hours to N_2, she only cuts back to N_3.[16]

Analyzing the difference in the effect of higher wage on working mothers who pay for care against those who do not essentially follow the same analysis as the income increase. In Figure 6, with a higher wage, w_1 to w_2 (or ω_1 to ω_2) the frontier rotates from ab to ac for the household that uses free childcare. The effect of the higher wage on N is not clear. The higher wage raises the cost of maternal care and induces substitution towards greater work/non-maternal care hours. But the higher wage produces an income effect, as well. At the current work hours, the mother would already have a higher income which allows the household to purchase more of both household consumption and child outcome. With

[16]Increasing quality would also raise the price of child care and reduce the net wage, ω, for the paying mother. This would lessen the extent by which the technical rate of substitution is improved in favor of household consumption and the improvement in the rewards to working would not be as much. Still, the qualitative result would be derived; that the negative impact on N would be lower when the mother is paying for care. This point also suggest how among paying-working mothers there will still be differences (particularly between home-based and center-based care). If the rise in price due to the increase in quality is large, then the negative effect would be closer to the non-paying case. This is true for home-based care.

child care quality fixed, she can only "purchase" greater child outcome by working less or spending more time with the child. If the latter effect dominates, then the effect of higher wage on child care hours would be negative, which is what we illustrate in the figure when child care hours fall from N_1 to N_2.

When the mother is able to (and does) purchase higher quality care, however, the technical rate of substitution between child outcome and consumption could be reduced further since it lessens the difference between maternal and non-maternal care quality, from $\frac{q-Q_1}{\omega_2}$ to $\frac{q-Q_2}{\omega_2}$. This induces the mother to work more (or to lessen the cutback in work hours) such as to N_3, rather than N_2. The implication is that the wage effect on child care hours would be larger for paying than for non-paying households and the likelihood of observing a positive wage effect on N is greater.

For households with non-working mothers. The expected effect on child care hours of a higher income is not clear for non-working mothers. In Figure 7, we illustrate the case where the higher income leads to a fall in child care hours. With the greater income, household consumption increases, which raises the marginal utilities of mother's leisure and child outcome. If the increase in the marginal utility of child outcome outweighs the increase for mother's leisure, i.e., child outcome is a better complement to household consumption than leisure, then the effect on child care hours is negative. In Figure 7, the slope of the indifference curve is -$\frac{MU_L}{MU_C}$. With marginal utility of child outcome rising faster than for mother's leisure, the indifference curve becomes flatter at the old leisure and child outcome point. The slope of the indifference curve is greater than the slope of the frontier. To re-establish equilibrium, the household should "consume" greater child outcome, and the only way to do this is to cut back on child care hours or mother's leisure for the non-paying households. Paying households, however, can improve child outcome by upgrading child care quality. If the household increases quality of care used, then the cost of child care hours is reduced and the (possible) decline in hours is lessened. *The implication is that if the effect on child care hours is negative, then we expect the effect to be weaker or smaller in absolute value for paying households.*

1.2. *Working versus non-working mother households*

Figure 8 illustrates possible difference in the response of working and non-working households from an increase in unearned income. This chart puts together figures 3 and 4. For a household with a working mother, the direction of higher utility is to the northwest since this would give higher household consumption and higher child outcome. On the other hand, higher indifference curves for the non-working paying household is to the northeast since this gives the household higher consumption and mother's leisure. When unearned income increases from v_1 to v_2, the working mother would cut back on her work/child care hours because the higher income reduces the marginal utility of consumption while raising that of child outcome. For the non-working mother, with the higher income she might increase her leisure time and non-maternal care hours because the higher income allows her to "purchase" more of all goods. However, the increase in N may be muted or could even decrease if the increase in v significantly increases the marginal utility of child outcome.

For a paying-non-working mother, an increase in the quality-adjusted price, c_s, would reduce non-maternal care hours if higher quality raises the marginal utility of non-maternal care quantity, i.e., $\frac{\partial \tilde{U}_N}{\partial Q} > 0$. Non-maternal care hours would fall because the higher cost reduces the marginal utility of leisure and raises the marginal utility of consumption. The higher cost, however, could also lead to a reduction in the quality of child care used since the marginal rate of substitution between consumption and child outcome increases. The condition $\frac{\partial \tilde{U}_N}{\partial Q} > 0$ guarantees $\frac{dN}{dc_s} < 0$ even if child care quality declines. For a paying-working mother, however, an increase in the quality-adjusted price of child care, c, can have an ambiguous impact on child care hours, similar to the wage effects. While it would reduce net wage and the rewards to working, there can be a countering income effect (an increase in the marginal utility of household consumption) and a decline in the marginal utility of child outcome. These latter effects would make work/non-maternal care hours more attractive. The implication is that a negative price effect, if there is, would be weaker when the mother is working than when she is not.

2. **Effects on Child Care Quality**

2.1. *Paying versus non-paying households.*

When the household uses free childcare, it must be using the best free childcare available

to it. Changes in mother's wage or spouse income, therefore, should have no effect on the quality of care non-paying households use.

2.2. *Working versus non-working households.*

The effect of a higher spouse income on quality is ambiguous. If child care quality and quantity are complements, however, i.e., $\frac{\partial \tilde{U}_Q}{\partial N} > 0$, then it is possible to observe a negative effect for households with working mothers since these households would likely cut back on child care quantity with a higher v. Since demand for N and Q are simultaneously determined, the mother has to consider how much non-maternal care she plans to consume in deciding the quality of child care to use. With the higher unearned income, the non-working mother would like to raise consumption of all goods: household consumption, child outcome and leisure. Wanting to raise child outcome alone would lead to an increase in child care quality demanded. In addition, since the non-working mother may raise her consumption of leisure and N, she may also raise the quality of child care used to offset the negative effect on child outcome of this increase in child care quantity. On the other hand, the working-paying mother who cuts back on her working time and non-maternal care hours would already be raising child outcome from this cutback alone. If she feels that the increase in child outcome is sufficient, then child care quality could even be reduced (to allocate more money for household consumption). While in the case of the non-working mother, greater child outcome is raised by buying greater quality care, for the working mother the higher child outcome could be "purchased" by cutting back on quantity of care, which may be accompanied by a reduction in child care quality.

An increase in c_s would lead to a decline in Q with the condition that higher quantity raises the marginal utility of child care quality i.e., $\frac{\partial \tilde{U}_Q}{\partial N} > 0$. Similar to the effect on child care hours, the negative effect of a higher child care price on child care quality would be weaker (or lower in absolute value) for households where the mother is working than for households where the mother does not.

2.3. *Variation by Child's Age*

The perception of what constitutes quality in child care is related to what one believes to be the kind of care that is appropriate at the child's age. Some psychologists believe

that appropriate care for infants, i.e., less than one year old, is one that takes care of the child's physical needs. Research suggest, however, that older children benefit from interaction with other children and with an adult trained in early childhood education. For older children, therefore (say 3 years old and above), quality care includes those that provide plenty of positive interaction between caregiver and child, and those that provide stimulating environment. If households adhere to what is developmentally appropriate for the child's age, then it is likely that when their children are older, they would try to use child care that provides greater interaction if given the resources to do so. The quality indicator that we use in this research is an index that measures positive child-caregiver interaction. We hypothesize then that the effects of economic factors on child care quality would be larger the older the child is.

We summarize the postulated effects of nonlabor income, wage and quality-adjusted price of child care in Tables 6.14 and 6.15. The following highlights the hypothesized differences from the model:

1. On Child Care Quantity, N
    a. Paying versus non-paying households
        i. *Among working mothers households.* The effect of higher v (unearned income) is negative for working mothers. The negative effect of higher v is weaker (lower in absolute value) for paying households.
        ii. *Among working mothers households.* The effect of higher w (mother's wage) is ambiguous because of the positive substitution effect and negative income effect. However, the negative income effect is mitigated when the household pays for child care, thus a positive effect of w is more likely when the household pays for care.
        iii. *Among non-working mothers households.* The effect of a higher v is ambiguous. It is more likely to observe a positive effect for paying households, however.
    b. Working versus non-working.
        i. The effect of higher v is negative for working mothers. The negative effect for non-working mothers is weaker or the effect can be positive.

ii. The negative effect of an increase in child care price is weaker when the mother works.

2. On Child Care Quality, Q

   a. Working versus non-working.

      i. The effect of a higher v is ambiguous. If child care quality and quantity are complements, then it is possible to observe a negative effect for working mothers since household would likely cut back on child care quantity with a higher v.

      ii. The effect of an increase in child care price is negative if quality and quantity are complements. The negative impact is stronger for non-working mothers because both income and substitution effects work to reduce quality.

4.2.2 Empirical Approach

4.2.2.1 Explanatory Variables: Wage, Price and Spouse Income Since child care price depends on the demand for quality, it is endogenous to the model. Therefore, prior to the estimation of the discrete choice model and demand functions, we estimate the hedonic child care price function for each mode of care: center and home-based care. In the empirical estimation, p_s differs only with respect to the mode of care (i.e., $p_5 = p_7$, for center care, and $p_6 = p_8$ for home-based care). As reported in the CQO study the cost structure of these two types of care are different. Center care have higher percentage share for labor and occupancy costs. Centers also report greater donations, and this can influence their pricing behavior. We suppose that the price function faced by a working and non-working mothers are the same since caregivers are not likely to price discriminate clients based on work status.

The semi-log form is the common form adopted in hedonic price estimation because of its convenience. Since this form has not been shown to be inferior relative to other forms[17], we adopt this in estimating the relationship between the price of child care and the quality of paid child care. The child care price function to be estimated is

$$\log p_s = \beta_{so} + \beta_{s1m} \cdot dm + \beta_{s2} \cdot Q + \mathbf{B}_S \cdot \mathbf{A} + \eta^p$$

[17] Kokoski, Waehrer, and Rozaklis (2001).

where the subscript m refers to the geographical market the household is in, dm is a market dummy[18], Q is an index of child-caregiver interaction, which is what we use as the primary indicator of quality, $\mathbf{A}$ is a vector of other child care attributes and η^p is an error term. The other attributes include those which are potentially related to child development, such as group size, child-staff ratio, and caregiver training, and others which are not directly related but are nonetheless desired by households, such as whether or not the child care is licensed, center is sponsored by a church, etc. The coefficient for the market dummies represent variations in the different markets that are outside of the household's control, such as cost differences arising from different policy environments. To derive the quality-adjusted price for each market we computed the predicted values for each market holding Q and $\mathbf{B}$ constant at the sample means, i.e., $\hat{c}_{sm} = \exp\left(\hat{\beta}_{so} + \hat{\beta}_{s1m} \cdot dm + \hat{\beta}_{s2} \cdot \bar{Q} + \hat{\mathbf{B}}_S \cdot \bar{\mathbf{A}}\right)$. This constructed price is what we will use in our regression analysis.

Since mother's wage is missing for those who did not work, we estimated a wage offer function correcting for selectivity bias using Heckman's two-step procedure. We use the predicted wages to impute into the missing wages. For the nonlabor income, v, we use the spouse's/partner's income as a proxy for this variable. We did not use total family income less mother's work income since it could still include income from government assistance, which also depends on the mother's working experience.

4.2.2.2 Discrete Choice Estimation For the discrete choice estimation, we assume a linear form to the indirect utility function,

$$V_s = \delta_{s1} \cdot v + \delta_{s2} \cdot w + \delta_{s3} \cdot c_s + \mathbf{X}\boldsymbol{\Delta}_s + \xi_s \quad for\ s = 1, 2, .., 8.$$

State s will be chosen if the utility at state s is greater than all the states. Thus the probability of choosing state s, $\Pr(s)$ is equal to

$$\Pr\left(V_s > V_j,\ \forall\ j \neq s,\ j \in S\right) =$$

$$\Pr\left(\begin{array}{c} \delta_{s1} \cdot v + \delta_{s2} \cdot w + \delta_{s3} \cdot c_s + \mathbf{X}\boldsymbol{\Delta}_s + \xi_s > \delta_{j1} \cdot v + \delta_{j2} \cdot w + \delta_{j3} \cdot c_j + \mathbf{X}\boldsymbol{\Delta}_j + \xi_j, \\ \forall\ j \neq s,\ j \in S \end{array}\right) =$$

[18] The markets are the 10 sites in the NICHD data.

$$\Pr\left(\begin{array}{c}\xi_s - \xi_j \ > (\delta_{j1} - \delta_{s1}) \cdot v + (\delta_{j2} - \delta_{s2}) + \delta_{j3} \cdot c_j - \delta_{s3} \cdot c_s + \mathbf{X}\left(\boldsymbol{\Delta}_j - \boldsymbol{\Delta}_s\right), \\ \forall\ j \neq s,\ j \in S\end{array}\right).$$

Assuming that ξ_s has the extreme-value distribution, then the above probabilities can be estimated using a multinomial logit model. We estimate this through maximum likelihood method.

4.2.2.3 Demand Estimation At each state, solving the maximization problem would yield demand functions for non-maternal care hours and quality in each possible state, N_s and Q_s. These state-specific demand functions will ultimately depend on exogenous factors that define the household's tastes and economic environment, such as the characteristics of the mother and household, the mother's wage, income from other sources, and the parameters of the child care price function. They will also depend on factors that are known to the household but are unobserved by the researcher, such as those pertaining to household tastes and those related to child outcome production, such as the child's initial endowment. We specify log-linear functions for the child care hours demand function in state s for household i,

$$\begin{aligned} lnN_{si} \ = \ & \alpha_{0s} + \alpha_{1s} \ln v_i + \alpha_{2s} \ln w_i + \alpha_{3s} \ln \hat{c}_{sm} + \sum\nolimits_{t=15,24,36} \alpha_{4t,s} \cdot d\_t \\ & + \sum\nolimits_{t=15,24,36} \alpha_{5t,s} \cdot d\_t \cdot \ln v_i + \sum\nolimits_{t=15,24,36} \alpha_{6t,s} \cdot d\_t \cdot \ln w_i \\ & + \sum\nolimits_{t=15,24,36} \alpha_{7t,s} \cdot d\_t \cdot \ln \hat{c}_{sm} + \boldsymbol{\alpha}_s \mathbf{X}_i + \zeta_{Ns}. \end{aligned}$$

and semi-log linear functions for the child care quality demand function, with standardized values of the ORCE score as the dependent variable, i.e.,

$$\begin{aligned} stdQ_{si} \ = \ & \beta_{0s} + \beta_{1s} \ln v_i + \beta_{2s} \ln w_i + \beta_{3s} \ln \hat{c}_{sm} + \sum\nolimits_{t=15,24,36} \beta_{4t,s} \cdot d\_t \\ & + \sum\nolimits_{t=15,24,36} \beta_{5t,s} \cdot d\_t \cdot \ln v_i + \sum\nolimits_{t=15,24,36} \beta_{6t,s} \cdot d\_t \cdot \ln w_i \\ & + \sum\nolimits_{t=15,24,36} \beta_{7t,s} \cdot d\_t \cdot \ln \hat{c}_{sm} + \boldsymbol{\beta}_s \mathbf{X}_i + \zeta_{Qs}. \end{aligned}$$

The standardized ORCE values were computed for each period. That is, for each period we rescaled the ORCE scores so that the new scores would have a mean of zero and standard deviation of 1. Predicted mother's wage, spouse income and quality-adjusted price for each

of the ten sites were expressed in logs, as well as mother's and partner's years of education and mother's age. The coefficient for variable k in the non-maternal care hours regressions, therefore, is interpreted as the percentage change in hours from a 1 percent increase in k. The coefficient for child care quality, on the other hand is interpreted as an x standard deviation change in ORCE score from a 1 percent increase in k. The d_t's are dummies for child's age (15, 24 and 36 months), which are also interacted with v, w and c_s to get the age-specific effects of these variables.

The demand functions are estimated conditional on each state. We ran separate seemingly unrelated regressions (SURs) for N_s and Q_s on households that chose states 5, 6, 7 and 8, respectively (i.e., the states where the mother paid for care). We ran separate regressions of N_s on households that chose states 2, 3, and 4. To account for selection issues, we included selectivity correction terms using Lee's (1983) approach. That is, after we ran the multinomial logit estimation of the discrete choice model, we derived the selectivity correction terms for each state and included them in the regressions. Lee's approach is an extension of Heckman's two-step procedure to the case where there are more than two choices.

4.3 DATA

The research uses data from the NICHD Study of Early Child Care. The NICHD-SECC is a multi-site, longitudinal study of the experiences of 1,364 children and their families. The study collected information during the child's first 10 years on the families' experiences in child care, the home and school and how these experiences relate to the children's development.

4.3.1 Patterns by Age

4.3.1.1 Mother's Employment, Work Hours, Non-Maternal Care Use and Hours

Consistent with other studies, we note that employment and non-maternal care usage are increasing as the child becomes older, Table 6.3. By the time the children were 6 months old, almost 63% of mothers are already working and this would increase slightly to 67%

when the children were three years old. For mothers who were working prior to birth, 73% were already back to work at 6 months. Mother's work and non-maternal care hours are also increasing with children's age but the differences from one period to the next are not significant. As regards, the type of care being used, we note an increasing use of center-based care with the children's age also consistent with other studies.

4.3.1.2 Child care Quality, Q_t In the NICHD study, child care quality is assessed using the Observational Record of Caregiving Environment (ORCE). These observations were obtained for the primary non-maternal caregiving arrangements that were used for more than 10 hours per week. The ORCE was developed for the NICHD study based on scientific studies that looked at qualities of parenting, which are necessary to the development of secure attachments and competence in children. It was also developed by NICHD to overcome the limitations of the ECERS and ITERS,[19] two of the most widely used measure of child care quality. These limitations are (a) the ECERS and ITERS lump together several dimensions of process quality (child-caregiver interaction, presence of curriculum and safety and health practices of the caregiver) into one composite number, and leaves the effect of each component unidentified and (b) the ECERS and ITERS have different systems for home and center-type cares, thus comparison across types could not be done. One part of the ORCE is the Qualitative Ratings, which indicate the quality of child-caregiver interaction and is what we use to indicate the quality of child care in this paper. This index captures desired caregiver behavior such as sensitivity/responsiveness to nondistress calls, detachment/ disengagement (reflected), stimulation of cognitive development, positive regard for the child, and flatness of affect (reflected). The index ranges from 1 to 4, with 4 being the highest. More details about the ORCE are given in the appendix.

Table 6.17 shows sample means of the ORCE score at year 0 and year 3 and by different categories. We note that average ORCE score is declining as the children got older. This is interesting to note since it seems to contradict expectations when looking at spouse income and mother's hourly income, which were increasing during these periods. On the other hand,

[19] ECERS stand for Early Childhood Environment Rating Scale while ITERS stand for Infant/Toddler Environment Rating Scale.

child care cost per hour was increasing.

A more interesting pattern, however, are the changes in the correlations (i) between ORCE score and average hourly cost, and (ii) ORCE score and spouse income over time. In Table 6.18, we note that these correlations are increasing and become significant at higher ages. It is possible that mothers start to give lower preference for child care quality, given that mean quality is falling, at later ages. This change in turn makes their decisions about quality become more sensitive to their household's economic condition at later ages.

4.3.1.3 Patterns by Mother's Work Status, Payment Status and Type of Care

Table 6.12 gives the frequencies for each state at periods when the child was zero and 3 years old. We note that the percentage of children in paid care is higher at 36 months than at 6 months (59.1% against 42.0%) and there is increasing preference for paid center-based care (8.61% to 28.7%).

From Table 6.17, we note that children of working mothers stayed in non-maternal care by more than 16 hours per week on average. More interesting to note is that there is a significant negative correlation between nonmaternal hours and spouse income for working mothers (-.12 and -.2 at years 0 and 3, respectively) but not for non-working mothers. For non-working mothers, the correlation is positive although not significant.

Working mothers also tend to use child care of lower quality and center-based care indicating that center care is more complementary towards mother's employment. We observe a significant positive correlation between quality of child care and spouse income for working mothers, but none for non-working mothers. Moreover, in Table 6.18, the correlation between quality of care and average cost are greater and significant for working mothers compared to non-working mothers.

Mother's work hours and non-maternal care hours are greater for paying households but quality is lower. We also observe that there are significant negative correlations between mother's hourly income and non-maternal care hours both for the paying and non-paying mothers. The negative correlation, however, is larger (absolute value) for the non-paying mother (-.26 versus -.09 at year 0 and -.25 and -.16 at year 3).

Users of center-type care tend to have greater hours on the average, paid more and chose

lower quality care compared to those that used home care. Overtime, however, quality of child care declined significantly for home care yet average hourly expenditure rose. Quality of used centers improved at year 3 and average hourly expenditure was declining. Correlation between average cost and child care quality were greater and significant for home care. Child care centers have a higher probability of being licensed and have caregivers that have greater years of experience in child care.

4.4 RESULTS

Details of the regression results are shown in Tables 7.3 to 7.5 in Appendix 7.2 We report here the estimated effects of the economic variables on the discrete choices and on the child care choice variables.

4.4.1 Discrete Choice Model Estimation

The partial effects of income, price and mother's wage on the probability of state s being chosen were computed as,

$$\frac{\partial P\left(s=j \mid X\right)}{\partial x_k} = P\left(s=j \mid X\right)\left\{\beta_{jk} - \left[\sum \beta_{hk} \exp\left(XB_h\right)\right] \; / \; g\left(X,B\right)\right\},$$

where β_{jk} is the coefficient of variable k in the index XB for state j. $g(X,B)$ is equal to $\left(1+\sum_{h=1}^{J} \exp\left(XB_h\right)\right)$. The partial effect of income (or price or wage) on the probability that the mother works is the sum of the partial effects on states where mother is working, i.e., states 3, 4, 7, and 8. The partial effects on the probabilities of the household paying for care and utilizing center care were similarly defined. The associated elasticity of mother working with respect to variable k was computed using $\left(\sum_{j \in Working\ States} \frac{\partial P(s=j|X)}{\partial x_k}\right)\left(\frac{x_k}{P(Working)}\right)$. The elasticities for paying for care and using center care were similarly defined. The reported partial effects and elasticities in Table 6.19 are means computed over the sample.

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Effects on Maternal Employment

As expected, there is a positive effect of wage on the probability that the mother works. The partial effects on working are significant across all ages (t-statistics are in parentheses). The implied elasticities of these effects are reported below the t-statistics. We estimated the wage elasticity of mother working to be 0.21 at age 0, and 0.20 at age 3. (Estimates from the two closest works are: 0.58 in Ribar (1992) and 0.17 in Blau and Hagy (1998).)

An increase in spouse's earnings reduces the probability that the mother will work. When the child's age is 0 and 3 years, the elasticities of employment are -0.2 and -0.21, respectively. As predicted, an increase in the quality-adjusted price of family day care reduces the probabilities that the mother works. The elasticity of mother's employment with respect to child care price is smaller when the children were 3 years old compared to when they were 6 months.

Effects on Using Paid Care

There is no predicted sign for the effects on paying for care. The effect of higher wage on the probability of paying for child care is positive, however, suggesting that formal arrangements are complementary with maternal employment. This makes sense since employed mothers would likely demand greater flexibility, e.g., extended hours, and stability (provider will not shut down) in child care arrangements to have less disruption in their work. These are more difficult to demand when the mother is not paying for care. This could also be an indication that the mother is trying to improve child quality in paying for care because in doing so she can choose the quality of child care used, which is much less likely when free child care is used.

The income elasticity of paying for care is positive but only slightly significant at age 3. A 10% increase in spouse income will raise the probability of using paid care by 1.2%. The impacts on using paid home and center care are positive but insignificant.

Effects on Using Center and Home-based Care

We find that use of home-based care complements mother's employment given the positive and significant impact of wage on the probability of using this mode of care. Use of center care, however, is not significantly affected. Previous research, on the other hand, have

found a strong effect of mother's wage on the use of center care (Lehrer, 1983; Lehrer and Kawasaki, 1985; Blau and Hagy, 1998; Powell, 2002), which they attribute to the reliability of center care.

As predicted, an increase in the quality-adjusted price of family day care reduces the probability that the family uses home or family day care. On the other hand, it raises the probability that center care is used. The effects of price on using home-based care are smaller when the children were 3 years old compared to when they were age 0.

An increase in price of center care will also reduce the probability that center care is used but will raise the probability that home or family day care is used. The partial effects on using paid care and using paid center care is higher when the child is older.

Wage elasticities of working and paying for care dropped significantly when the child is around 3 years old. Although, the decrease in the wage effect on working is slight, it corresponds with previous finding of Leibowitz, Klerman and Waite (1992). In the context of this model, this suggests that the increase in utility in the working and paying states from an increase in wage would be higher when the child is young.

4.4.2 Child Care Quantity and Quality

Child Care Quantity, N

1. Paying versus non-paying

The model predicts that higher spouse's income will lead to a reduction in non-maternal care hours when the mother works, and that the negative effect is weaker when the household pays for care. In Table 6.20, we consistently find negative effects in the states where the mother works, although many are insignificant. At age 3, a 10% increase in spouse income reduces non-maternal care hours by 0.59% for working mothers using paid-center care, 0.75% for those using paid home care and 0.03% for those using free care. At age 0 and 1 year, we also find evidence that the negative effect of higher income on child care hours is weaker when the mother pays for care. At year 1, the elasticity of child care hours is -0.196 (and significant) when the mother uses free (or informal) child care, while for mothers who use paid-center and paid-home, the elasticities are -0.069 and -0.002, respectively.

The effect of higher wage is not as clear because of a positive substitution effect and a negative income effect. We consistently find that for mothers who use free child care, such as the spouse or relatives, a higher wage reduces their utilization of non-maternal care. At age 0 years, for example a 10% increase in mother's wage would lead to a 1% and 1.84% decline in child care hours per week for non-parental care and for father care, respectively. At at year 3, a 10% increase in wage leads to a decline of 3% and 1.2%, for households using non-parental care and father care, respectively. These results contrast with most empirical studies that find women's labor supply as strongly positively related to the wage rate (Blau and Ferber, 1992). The reason perhaps is that this research is looking solely at mothers. The cut back in mothers' working hours is likely spent more for child development rather than for leisure purposes, and could carry more weight than leisure relative to household consumption.

Although the model is not certain as to the effect of a higher wage, we demonstrated however, that for households that use paid care the negative effect, if there is any, is weaker. We find support for this at all periods. Table 6.20 shows that for households in the pay-center state at age 0 and the pay-home state at age 3, the negative effects are much smaller (and insignificant) relative to the effects in the non-paying states for the same periods. Moreover, we note a significant positive effect for households in the pay-center state at age 1, and positive (albeit insignificant) effects for households in the following states: pay-home at year 0, pay-home at year 1, and pay-center at year 3.

These results are new and interesting because it shows the unique nature of a mother's labor supply. It shows that the welfare of the child is closely linked with the household's decisions about maternal work. Particularly, a mother will take advantage of the better opportunity in the work place (higher wage) only if quality of care is improved. It also means that formal child care is complementary to mother's labor supply.

The effect of a higher spouse income for nonworking mothers is not clear. It would depend on which good, child outcome or maternal leisure, is a better complement to household consumption. The results in Table 6.20 indicate, however, that households which do not pay for child care are likely to decrease utilization of child care. At year 1, a 10% increase in spouse income leads to a 2% decline in child care hours, and 7.6% at year 3. As illustrated

in Figure 7, however, the negative effect would be weaker for paying households. We find evidence for this hypothesis at years 1 and 3. For households using home-based care at year 3, the estimated income elasticity of child care is -0.04, which is significantly lower (in absolute value) than the -0.76 elasticity for users of free care. Moreover, users of center care at year 1 and 3 increase child care hours in response to higher spouse income.

2. Working versus non-working.

The predicted effect of higher spouse income is negative for working mothers. When the mother does not work but uses paid care, we hypothesize that the effect on child care hours is positive on the condition that raising child care quality raises the marginal utility of non-maternal care hours. This condition is likely to be achieved when raising quality does not increase price very much; a condition that appears to describe child care centers (referring to the results in the estimation of the price function).[20] Thus, for users of center-based care at years 1 and 3, we observe positive effects of .07% and 0.3%, with a 10% increase in income, but the coefficients are marginally significant. This indicates that demand for child care is contextual. The effect of the same change in income will depend on the reason why child care is being used. For working mothers, child care is utilized mainly to support mother's work, and thus an increase in income, which reduces work hours will also reduce the demand for child care. On the other hand, for non-working mothers, child care is likely used for child development and/or mother's leisure; both of which are raises household utility. An increase in income, therefore, can lead to an increase in child care hours.

The model predicts that the price effect on non-maternal care hours is negative. For working mothers, the negative effect is weaker since with the higher cost of child care there will be an income effect on work hours. That is, the mother would like to work more because household consumption has gone down with the higher child care cost. All price coefficients (reported in Table 6.20), however, are found insignificant. We do note that most signs are negative. Also, for households using center-based care at years 0 and 3, the estimates for those with working mothers are much lower than the estimates for non-working mothers.

[20] In Section **??**, Table –, we note that child care quality, as indexed by the ORCE score, does not significantly affect child care cost for center-based care.

On Child Care Quality, Q

1. *Paying versus Non-paying*

In Table 7.6 in Appendix 7.2, we show that most non-paying households do not change their non-maternal care providers. The tables show households which used free childcare in two succeeding periods. We can see that most of them continue using the same mode of care, especially the users of center-based care. The Pearson's chi-squared test, a measure of independence of two variables, rejects the hypothesis that use of free child care in one period is independent of choice of free child care in the next. We take this as evidence for the assumption that users of free child care are already using the best free care available to them such that any change in income or mother's wage should not change their choice of free childcare.

2. *Working versus Non-working*

The model predicts that higher spouse income will likely raise the quality of child care used, especially for non-working mothers. For working mothers, however, there is a possibility that the higher income leads to a decline in quality since if child care hours fall, child outcome or quality might improve from this alone. If the mother feels that the increase in child outcome is sufficient enough, she could lower the quality of child care used to reduce child care expenditure further and shift it to household consumption.

At years 0 and 1, the mothers demand for quality are not sensitive to income changes (Table 6.21). In fact, mother's wage and child care price, as well. At year 3, we find that the effect of higher income is positive for households with non-working mothers. The effect is significant for those using center-based care where a 10% increase in income can lead to an increase of 0.6 standard deviations in the ORCE score of child care used. Likewise, we observe a positive income effect for working mothers using home-based care. A 10% income increase leads to an increase of 1.76 std.dev. in ORCE score. However, the hypothesis of a possible negative effect for households with working mothers is confirmed for users or center-based care. For these households, a 10% income increase leads to a decline of 2.2 std.dev. in the quality of child care used.

Regarding wage changes, we predict that a higher wage will have a positive impact on child care quality, but under certain conditions. We find a significant impact, however, only at year 3 for home-based care. At that age, a 10% increase in wage leads to a 2 standard deviation increase in the quality of child care used. For those using center-based care, there is indication that they might even cut back on the quality of child care used.

Regarding price effects, we predicted that the demand for quality is negatively affected by a price increase, which is confirmed by the regression results. At age 0, a 10% reduction in price leads to a .43 and .38 standard deviation increase in quality for working mothers using center and home-based care, respectively. These effects increase (in absolute value terms) when the children are 3 years old to 1.5 std and .6 std, for users of center-based and home-based care, respectively. We also predicted that the negative effect is weaker or smaller in absolute value, for working mothers. We find evidence of this at age 3 for households using home-based care. For non-working households the estimated effect is -.328, and -.066 for working mother households.

We also note that most of the significant effects are found in states using home-based childcare. A possible explanation is the availability of choices within these modes of care. It is likely that for there are more home-based child care that a household can choose from within their locality. Whereas the number of centers operating within their area is limited. Home-based care are easier to set-up, and because home-based care are not as regulated, the variation in quality and price is probably wider than center-based care. Another possible explanation is that parents who choose center care place less weight on the caregiver-child interaction aspect of quality.

3. *Child Age Variations on Q*

Regarding age differences, our conjecture is that as the child gets older, demand for quality becomes more sensitive to wage, price and income changes. Looking back at Table 6.21, we observe significant income and wage effects only when the children were 3 years old. For price effects, we find the effects to be larger (in absolute terms) when the child is 3 years old than at 0 years.

4.5 DISCUSSION AND CONCLUSION

The results from the discrete choice model estimation support the predictions of the theoretical model. An increase in nonlabor income reduces the probability of mother working but increases the probability of using paid or formal child care. A wage increase and a price decrease will raise the probabilities for working and using paid care. A price decrease in one type of care increases the probability of using that type and reduces that of the other type. The estimates of the economic coefficients are also within the range of estimates derived in earlier studies. Moreover, consistent with the findings of Leibowitz, et. al., we find that the effects of wage are stronger when the child is at infancy. To this, we add the finding that the price effect (of home and center-based care) on employment and use of paid formal care are also larger at early months.

The predictions regarding the demand for child care quantity and quality for the most part are also confirmed by the empirical analysis. On the demand for non-maternal care hours, we were able to show that the effect of nonlabor income can have different signs depending on whether or not the mother is working. Working mothers will strictly cut back on hours while non-working mothers may increase child care hours. For working mothers, the negative income effect is smaller (in absolute value) when the household uses paid care. Similarly, wage effects are larger when the mother uses paid care.

Likewise, allowing the effects of income, wage and price effects to vary by work status, mode of care and age of the child reveals differences in the demand for child care quality. The coefficients for the 3^{rd} year period show evidence that for working mothers, income and wage effects can be negative. Referring back to Table 6.21, we see that the income effects for non-working mothers are always positive while for working mothers using center-based care, the effect of higher nonlabor income (such as spouse earnings) is negative. This ties up with the effect of wage on quality for center-based care, which is also negative. Demand for quality by working mothers is also significantly affected by price but not for non-working mothers. Finally, we find that demand for quality are more sensitive to income, wage and price changes when the children are older.

One might question the usefulness of these results given that the analysis concentrates

on a restricted set of households, i.e., households which remain in their respective states even when their income, mother's wage or childcare price changes. Indeed one of the end goals of this project is to determine not only the intra-state effects, but the effects for those changing states as well. Nevertheless, we believe that the foregoing analysis of determining differences by state is still useful because it applies to many situations. Most mothers who have returned to work will remain working throughout their children's preschool years. In this dataset in fact, more than 80% of working mothers are still working after each observation period. Mothers who have not returned to work after six months often remain out of the labor market until their children are out of preschool. Indeed basing on the results from the multinomial logit estimation (and from past research), it would take large changes in mother's wage, non-labor income or child care price to change mother's labor force participation. Regarding mode choice, there are also reports of many families unable to access quality center-based child care, especially, in poorer neighborhoods. These familes would thus have to rely on a network of home-based case such as family day care or relatives for child care even if their economic situation changes (Mathematica PRI, 2003). And for many families, free child care from the government or relatives are just not available. The results of the demand estimation would therefore be applicable to these kinds of families, which we believe takes up a majority of the households. Households, because of preference or other reasons, do not change states once they have chosen a state. If these results are robust, then it suggests that if the objective is to raise child care quality certain forms of assistance should not be given to families in certain situations; such as an increase in nonlabor income for working mothers. Thus, assistance like the Child Tax Credit will not work well for this purpose. Or if the government would like mothers to increase their labor supply, then a wage increase (such as the Earned Income Tax Credit) for non-paying households may lead to the opposite of the desired effect.

Knowing the differences of these effects by child's age is also relevant considering that child care subsidies are now time-bound. With implementation of the PRWORA, there is a time limit of 24 months for the subsidies, which would often begin during the child's infancy and so would terminate when the child is before 3 years old. If in fact, there is little effect of these economic factors on quality choices at early age, then subsidies given during the first

two years would fail in in encouraging greater quality consumption.

This study needs several improvements. First, is that we have to analyze the child care quality and quantity choices when states are endogenous as well. That is, what will happen to the quality of child care used if households decide to change mother's employment, or mode of care care, or if they use paid care. Second, we have not shown formally in the theoretical model how the child's age factors into the mother's decisions and lead to age differences. Most statements above regarding age implications were intuitive rather than derived from the model. We plan to pursue these in the future.

5.0 DISCUSSION/SYNTHESIS

5.1 CHILD CARE SUBSIDIES

The scope of the child care market is extensive. It is a market that all young families have to engage in. It touches many issues that development and labor economists grapple with such as women's labor supply, welfare and education reforms, intergenerational mobility, and others. Attention in the economics profession in this market was mostly related to women's labor force participation and labor supply. The questions often asked were, "Is child care cost a barrier to women's employment? " "What is the effect of child care subsidy on mother's labor supply?" In this dissertation, we focused on the "child" in child care. We investigated topics that were mostly done by psychologists, realizing that researchers in this field are confronted with an issue that is often encountered in economics, i.e., omitted variable bias. In chapters 2 and 3, we examined the effects of mother's labor supply, and child care quality on child development. We utilized methodologies from the education literature in chapter 3.

In chapter 3, we concluded that after addresing endogeneity due to child endowment, quality of child care has a significant positive effect on a child's cognitive development. Using the Observational Record of Caregiving Environment (ORCE) our estimates indicate a size effect of about 0.06 on a child's cognitive test score of a 1 standard deviation increase in the ORCE score of child care used during the child's year 1 to year 3. The ORCE is a composite score which provides a measure of the quality of interaction between the child and caregiver. Behavior such as the caregiver's responsiveness to nondistress calls, stimulation of cognitive development, expressions of positive feelings, etc., are what are looked for. This indicator captures the dynamic features of the child care, which most experts agree should

be the appropriate way to classify quality.

Indicators of dynamic (or interactional or process) features are distinguished from static (or structural) features of the classroom in conceptualizations of quality. Most studies on childcare done by economists used structural features (child-caregiver ratio, group size) in representing quality. Our analysis, however, find that group size nor child-caregiver ratio does not have significant association with early cognitive achievement scores. This finding conforms with Blau's (1998). Using the NLSY, he examined the effects of group size and child-caregiver ratio on the PPVT score, where he find little correlation.

The positive relationship between child development and child care quality raises concern about the assessment of quality in U.S. child care centers. Helburn (1995) states, *"Child care at most centers in the United States is poor to mediocre, with almost half of the infant and toddler rooms having poor quality. Only in one in seven centers provides a level of quality that promotes healthy development."* This statement summarizes the child care problem in the US, for which many call for government action to improve quality.

Is it necessary, however, for the government to intervene in the child care market? Is the market providing a low level of quality relative to the optimal level? Is the low quality of child care a product of market failure, or simply a result of consumer preferences? Is it not possible that parents know the benefits of good quality care but may just be unwilling to pay the price of high quality care?

One source of failure in the child care market is the asymmetry in information. Quality care will be underproduced if parents, who are the decisionmakers, are unable to distinguish the kind of quality "that matters". And even if they are able to determine this, they are not the ones experiencing the child care. When parents have imperfect information, they would be reluctant to pay a higher price for higher quality care forcing firms to provide low quality care.

One evidence cited about this is the report by Cryer and Burchinal (1995). The study reported a direct comparison of parent ratings of various aspects of their child's day care center classroom with trained observer ratings of the same aspects, using data from the Cost, Quality, and Outcome Study. The results show that parents give higher average ratings on every item than do trained observer, by about one standard deviation. Another evidence

of imperfect information is if households demand for child care quality do not respond to economic incentives. Our analysis in Chapter 4 suggests that this may be the case for parents of very young children (0 to 1 year old).

Another reason for government involvement in the child care market exists if there are positive externalities when children experience high quality child care. Similar with the arguments for free public education, the amount of quality that parents will purchase will be less than the optimal amount. The argument for the presence of externalities is that high quality child care experience enhances children's school readiness and completion. Social problems related to low education, such as low earnings, welfare dependence, crime, teenage childbearing, etc., would then be lessened. There are very few studies which kept track of children who experienced quality child care, into their adulthood. Programs such as the landmark Abecedarian and Perry preschool experiments have shown that children who enjoyed early childhood interventions experienced increased achievement test scores, decreased grade retention, decreased time in special education, decreased crime and delinquency, increased high school graduation, higher employment and earnings. Currie and Thomas (1999) also showed that children's test scores are positively associated with earnings at age 33, and we showed that quality has a significant influence on early test scores.

Given the above discussion there are indeed arguments for public involvement in the child care market. But what kind of involvement? The cost of stricter regulation may be prohibitive since there are many child care operators. We also showed that the features that are easy to monitor, such as group size and caregiver-ratio, have no influence on child care quality and child development. To monitor operators based on the dynamic features of child care would be costly since trained observers have to spend a few hours in the site observe interactions. Besides, the caregivers can just behave nicely once the observers arrive.

For households with young children, the demand analys is in Chapter 4 show that financial assistance will not be effective. We showed that income, wage and price changes have no significant effect on the demand for quality, suggesting that parents are reluctant to pay for higher quality. If the reluctance to pay is due to failure to know what the benefits of quality is, then a better intervention would be to provide the parents with information about quality. But if the issue is because of imperfect information, then the government must help

operators who would like to provide high quality care, create credible signals to show to the parents who are willing to pay for high quality care. Signals such as accreditation with a respected organization.

For households with older preschooler, say ages 3 to 4, the analysis in Chapter 4 shows that financial incentives to encourage quality consumption can play a role. Since governments will always face resource constraints, it is useful to determine which form of financial assistance will yield the biggest impact out of the same amount of money, e.g., $1,000 per household each year.[1] From the empirical results of Chapter 4, we evaluate how a $1000 financial assistance would improve child care quality, if this amount is given as nonlabor income, an increase in mother's wage or as a reduction in the cost of child care. We concentrate the assessment on the 3^{rd} year since almost all of significant effects are found at this period. If given as unearned income, similar to the Child Tax Credit, $1000 can raise the quality of child care used by 0.484 standard deviations for working mother-households using home-based care (state 7).[2] The income assistance, however, will likely lead to a decline in quality for working mother-households using center-based care (state 8). For non-working mother-households, the income assistance will not have any significant effect.

If given as a wage enhancement for working mothers, such as the Earned Income Tax Credit, the money would be equivalent to a 4.5% increase in the mother's wage.[3] This assistance can raise the quality of child care used for home-based users, by 0.936 standard deviations, but may lead to a decline for center-based users. Finally, child care price subsidy has no significant impact on hours used but have very significant effects on the quality of child care used. The $1000 subsidy would be equivalent to a 21 and 25 percent reduction in the hourly cost of child care for center and home-based, respectively. This can raise quality of care used by 3.2 and 1.7 standard deviations for working mothers. Demand for quality by non-working mothers are not significantly affected.

Given these simulations, if the objective is to encourage households to utilize greater

[1] Aside from being a nice round number, we choose $1,000 because this is currently the maximum amount per child for the Child Tax Credit. The provisions of the Tax Relief and Reconciliation Act of 2003, which raised the tax credit, are effective up to 2011 only.

[2] $1,000 is a 2.75% income increase from the sample mean of spouse income. We multiply this with 0.176, which is the income coefficient for child care quality, to get 0.484.

[3] $1000 divided by 52 weeks and then by 35 hours, which is the sample mean of hours worked at 15 months, is equal to $0.56/hour.

quality childcare, the best form of financial assistance would be as a subsidy for childcare expenditure, rather than as an increase in nonlabor income or as an increase in mother's wage. The latter forms are unconditional assistance, and the family is free to use the money for other purpose, which may not necessarily be for the child. On the other hand, a child care price subsidy could only be availed of if the mother actually purchases child care for the child. Since child care hours are not very responsive to price (probably because mother's labor supply is not), households react to the price decrease by raising quality. This assistance should also be limited only to working mother households. In form it would be like the Dependent Care Expenditure Tax Credit.

5.2 MATERNAL LABOR SUPPLY EFFECTS

The welfare reform of 1996 espouses greater economic independence as a solution to poverty. Some of the policies adopted were designed to promote increased participation of mothers in the labor force and increased labor supply. Despite reported success of moving families out of welfare, concern, however, is raised regarding the impact of these policies on child development. Our analyses in Chapters 3 and 4 can help us evaluate different policies/subsidies designed to increase mothers' labor supply or work hours, in terms of their impact on child development.

From Chapter 3, we determined that child care hours have negligible effect on cognitive development. What matters are the quality of care used, and the amount of learning materials provided to the child (which proxies for other purchased materials). Demand for these inputs, together with how much hours to work are decisions made by the household that will depend, among other things, on the economic environment the household faces. Changes in wage, income and/or child care price will bring about changes in the mother's labor supply, as well as the household's demand for child inputs. To analyse the effect of these policies, we have to determine those policies that increase mother's labor supply, and what these policies do to the demand for child development inputs. It is possible that different exogenous changes in the economic environment will lead to different impacts on child development even if these changes lead to an equivalent effect on mother's labor

supply.

The demand estimates from Chapter 4 indicate that when the child is 3 years old, the significant predictors of an increase in mother's work hours are: (i) *a fall in nonlabor incom*e, for households paying for child care, and (ii) *a fall in mother's wage*, for a households not paying for care. By itself, this increase in work hours (and child care hours) should have no effect on cognitive achievement. What is relevant is the impact on the cognitive achievement inputs. For users of paid-center care, the fall in nonlabor income leads to an improvement in the quality of child care, while for home-based users, this leads to a decline in child care quality. (The fall in spouse income, however, has no significant effect on the amount of learning materials.) The increase in work hours due to a fall in nonlabor income (perhaps a reduction/elimination of the Child Tax credit) therefore would be detrimental to child development in the case of home-based users only and not necessarily for users of center care.

On the other hand, an increase in work hours due to a fall in mother's wage would potentially be detrimental to child's development for households utilizing father care. The fall in wage is also likely to lead in a cutback on other purchased child inputs, as proxied by child learning materials. The fall in mother's wage leads to a decline in family income and given that it is the father that is taking care of the child (and likely unemployed) family income is likely very low. This fall in family income takes a bite out of learning materials.

Another policy that can potentially lead to an increase in work hours is a reduction in child care price. For center-based users, the child care subsidy can lead to an improvement in quality of child care and an increase in the amount of learning materials purchased. For users of home-based care, the subsidy will also lead to an improvement in child care quality. These results indicate that an increase in mother's work hours from child care subsidies is not necessarily detrimental to a child's development. On the contrary, the policy can be beneficial. This discussion, although not very rigorous, emphasizes that in the analysis of mother's labor supply "effects", it is important to broaden the analysis to include not only work decisions but the accompanying decisions as well.

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6.0 TABLES AND FIGURES

6.1 TABLES

Table 6.1. Sample Means for Selected Time-Invariant Child and Family Characteristics

	N	*MEAN*	*SD*
Child Characteristics			
Child is Boy	1364	0.52	0.5
Child is Hispanic	1364	0.06	0.24
Child is African-American	1364	0.13	0.34
Child's Birth Order	1364	1.83	0.95
Mother's / Family Characteristics			
Mother's Age @ Birth	1364	28.11	5.63
Mother's Education (Years)	1363	14.23	2.51
Mother's PPVT Score	1167	99.01	18.35
Mother White	1364	0.83	0.38
Mother African-American	1364	0.13	0.33
Father's Education (years)	1250	14.49	2.69
Household Location:			
Irvine, California	1318	0.10	0.30
Lawrence, Kansas	1318	0.10	0.30
Wellesley, Massachussetts	1318	0.10	0.31
Pittsburg, Pennsylvania	1318	0.09	0.29
Philadelphia, Pennsylvania	1318	0.10	0.30
Charlottesville, Virginia	1318	0.10	0.30
Seattle, Washington	1318	0.10	0.30
Morganton, N. Carolina	1318	0.11	0.31
Madison, Wisconsin	1318	0.10	0.30

Table 6.2. Sample Means of Time-Varying Family Characteristics

	Age of Child (Years)		
	0	**1**	**3**
Family Resources			
Mother's Ave. Earning/Hour (Mean $)	12.53	13.56	13.6
(SD)	(10.13)	(15.76)	(11.29)
(N)	812	800	800
Spouse Income (Annual)	36316	37708	40903
	(27171)	(28554)	(31117)
	1024	986	952
Child Care Cost/Hour	1.675	1.779	1.954
	(1.67)	(1.84)	(1.93)
	711	757	802
Family Characteristics			
No. of Children	1.9	1.93	2.13
	(1.04)	(1.05)	(1.00)
	1279	1243	1216
No. of Adults	2.14	2.11	2.08
	(0.69)	(0.67)	(0.66)
	1279	1243	1216
Receive Assistance	0.25	0.19	0.17
	(0.43)	(0.39)	(0.38)
	1279	1243	1216
Income to Needs Ratio	3.53	3.6	3.52
	(3.19)	(3.29)	(3.12)
	1271	1234	1208
Mother Married/Partner	0.81	0.78	0.75
	(0.39)	(0.42)	(0.44)
	1364	1364	1364
Total Household Size	4.04	4.04	4.21
	(1.27)	(1.28)	(1.26)
	1279	1243	1216
Father Living @ home	0.85	0.84	0.8
	(0.35)	(0.37)	(0.40)
	1279	1243	1216
Maternal Depression Index (Mean)	8.97	9.05	9.22
	(8.34)	(8.18)	(8.31)
	1278	1241	1202

Table 6.3. Sample Means of Employment and Child Care Characteristics

	Age of Child (Years)		
	0	**1**	**3**
Working	0.63	0.65	0.67
	(0.48)	(0.48)	(0.47)
	1277	1242	1213
Work hours	32.90	33.86	33.73
	(13.47)	(13.58)	(13.09)
	806	807	807
In non-maternal care	0.72	0.76	0.83
	(0.45)	(0.43)	(0.38)
	1318	1270	1234
Non-maternal care hours	34.9	36.0	35.2
	(15.68)	(15.83)	(16.89)
	951	967.0	1025.0
Percentage in Home-based	42.78	43.34	35.88
Percentage in Center-based	8.89	11.27	30.02
ORCE	2.98	2.93	2.8
	(0.57)	(0.57)	(0.46)
	593	656	707
HOME	0.81	0.83	0.75
	(0.10)	(0.10)	(0.13)
	1279	1234	1179

Table 6.4. Sample Means of Selected Variables by Weekly Work Hours of Mother @ Year 3

	Total	0 hrs	1 to 29 hrs	> 30 hrs
WJ Picture Vocabulary (PV) @ 54	100.48	99.83	103.99	99.61
	(14.84)	(15.37)	(14.97)	(14.11)
WJ Applied Problems (AP) @ 54	103.04	101.57	106.73	102.64
	(15.73)	(17.30)	(13.50)	(15.25)
WJ Letter-Word Ident (LW) @ 54	98.96	97.75	100.84	99.21
	(13.57)	(13.73)	(13.29)	(13.51)
Mother's Characteristics				
Mother's age at birth	28.10	27.60	29.46	28.51
	(5.64)	(5.97)	(5.04)	(5.49)
Mother's education in years	14.23	13.83	15.06	14.40
	(2.51)	(2.63)	(2.14)	(2.47)
Mother's PPVT Score	99.05	97.58	103.73	98.18
	(18.35)	(20.19)	(16.57)	(17.39)
Father lives with child at Year 3	0.78	0.75	0.90	0.75
	(0.42)	(0.43)	(0.30)	(0.44)
Mother is married at Year 3	0.85	0.84	0.94	0.82
	(0.36)	(0.37)	(0.23)	(0.38)
Mother is married at Year 1	0.86	0.83	0.94	0.86
	(0.35)	(0.38)	(0.23)	(0.35)
Mother smoked	0.19	0.22	0.12	0.20
	(0.39)	(0.41)	(0.33)	(0.40)
Family and Child Factors				
Poor @ 1 month	0.22	0.30	0.11	0.20
	(0.380	(0.480	(0.270	(0.280
Number of children @ Year 1	1.92	2.06	1.90	1.80
	(1.03)	(1.11)	(0.92)	(0.98)
Number of children @ Year 3	2.13	2.40	2.14	1.92
	(1.01)	(1.08)	(0.89)	(0.95)
Child is Hispanic	0.06	0.07	0.03	0.06
	(0.24)	(0.25)	(0.17)	(0.24)
Child is Black	0.13	0.15	0.08	0.11
	(0.34)	(0.35)	(0.27)	(0.31)
Child is Boy	0.52	0.51	0.54	0.50
	(0.50)	(0.50)	(0.50)	(0.50)
Child Birth Order	1.83	1.94	1.85	1.68

	(0.95)	(0.97)	(0.94)	(0.83)
Child gestational age in weeks	39.26	39.24	39.48	39.27
	(1.43)	(1.36)	(1.30)	(1.53)
Parental experience	34.19	35.03	34.36	33.52
	(6.46)	(6.58)	(6.28)	(6.38)
Mother's progressive in child caring	32.73	32.59	33.20	32.75
	(3.53)	(3.78)	(3.30)	(3.48)
Child's weight at birth	3491.97	3482.73	3552.86	3491.61
	(504.66)	(509.78)	(481.47)	(513.76)
Child Care				
Group size @ Year 3	8.381	10.115	6.488	8.452
	(6.54)	(6.84)	(6.10)	(6.39)
Child-caregiver ratio @ Year 3	4.178	4.843	3.508	4.204
	(2.69)	(3.12)	(2.13)	(2.69)
ORCE @ Year 3	2.803	2.881	2.936	2.750
	(0.47)	(0.45)	(0.47)	(0.46)

Table 6.5. Estimates of Maternal Work Hours Coefficients in Cognitive Achievement Regression

	Models									
Dependent Variable: WJPV Score										
	A		B		C		D		E	
Work Hrs/20 @ Yr 0	0.117		-0.008		0.003		-0.02		0.012	
	(0.08)		(0.06)		(0.07)		(0.07)		(0.04)	
Work Hrs/20 @ Yr 1	0.15	***	0.09	*	0.046		0.011		0.006	
	(0.06)		(0.05)		(0.05)		(0.05)		(0.03)	
Work Hrs/20 @ Yr 3	-0.145	***	-0.111	***	-0.073	*	-0.069	*	-0.037	*
	(0.05)		(0.04)		(0.04)		(0.04)		(0.02)	
R^2	0.018		0.302		0.342		0.354		0.345	
N	1018		1018		917		917		726	
Dependent Variable: WJAP Score										
	A		B		C		D		E	
Work Hrs/20 @ Yr 0	0.006		-0.095		-0.096	*	-0.127	*	-0.068	*
	(0.08)		(0.07)		(0.07)		(0.07)		(0.04)	
Work Hrs/20 @ Yr 1	0.152	***	0.104	**	0.069		0.042		0.032	
	(0.06)		(0.05)		(0.05)		(0.06)		(0.03)	
Work Hrs/20 @ Yr 3	-0.092	**	-0.066		-0.032		-0.032		-0.024	
	(0.05)		(0.04)		(0.04)		(0.04)		(0.02)	
R^2	0.009		0.255		0.298		0.314		0.268	
N	1012		1012		911		911		722	
Dependent Variable: WJLW Score										
	A		B		C		D			
Work Hrs/20 @ Yr 0	0.064		-0.044		-0.036		-0.055		-0.041	
	(0.08)		(0.07)		(0.07)		(0.08)		(0.04)	
Work Hrs/20 @ Yr 1	0.11	*	0.056		0.034		0.022		0.024	
	(0.06)		(0.05)		(0.06)		(0.06)		(0.03)	
Work Hrs/20 @ Yr 3	-0.052		-0.036		-0.026		-0.026		-0.008	
	(0.05)		(0.04)		(0.05)		(0.05)		(0.02)	
R^2	0.009		0.237		0.269		0.275		0.241	
N	1015		1015		914		914		725	

Table 6.6. Estimates of Work Hours and Low Quality Interaction Coefficients

	Full Sample				Working Before Birth Only			
WJPV	Work Hours/20				Work Hours/20			
	C	w/ dLQ	δ		C	w/ dLQ	δ	
Year 0	0.003	0.025	-0.084		-0.033	-0.049	-0.014	
	(0.07)	(0.08)	(0.08)		(0.09)	(0.11)	(0.09)	
Year 1	0.046	-0.013	0.004		0.153	0.078	-0.005	
	(0.05)	(0.06)	(0.04)		(0.12)	(0.13)	(0.04)	
Year 3	-0.073 *	0.020	-0.139 ***		-0.193 *	-0.093	-0.134 ***	
	(0.04)	(0.05)	(0.04)		(0.10)	(0.11)	(0.04)	
WJAP								
	C	w/ dLQ	δ		C	w/ dLQ	δ	
Year 0	-0.096 *	-0.055	-0.054		-0.097	-0.05	-0.011	
	(0.07)	(0.09)	(0.08)		(0.10)	(0.12)	(0.10)	
Year 1	0.069	0.011	0.018		0.194	0.179	-0.006	
	(0.05)	(0.06)	(0.04)		(0.13)	(0.14)	(0.05)	
Year 3	-0.032	0.058	-0.139 ***		-0.256 **	-0.212 *	-0.109 ***	
	(0.04)	(0.05)	(0.04)		(0.11)	(0.12)	(0.05)	
WJLW								
	C	w/ dLQ	δ		C	w/ dLQ	δ	
Year 0	-0.036	-0.009	-0.078		-0.048	-0.026	-0.097	
	(0.07)	(0.09)	(0.08)		(0.11)	(0.13)	(0.10)	
Year 1	0.034	0.027	-0.029		-0.008	-0.035	-0.032	
	(0.06)	(0.06)	(0.05)		(0.13)	(0.14)	(0.05)	
Year 3	-0.026	0.054	-0.123 **		-0.043	0.016	-0.113 ***	
	(0.05)	(0.05)	(0.04)		(0.12)	(0.12)	(0.05)	

Table 6.7. Sample Means of Selected Variables by Quality of Child Care

		Child Care Quality @ Year 0 (ORCE Score Standardized, Mean=0)					**Child Care Quality @ Year 3 (ORCE Score Standardized, Mean=0)**			
	All Mother Care	< -1	-1 to 0	0 to 1	> 1	All Mother Care	< -1	-1 to 0	0 to 1	> 1
Test Scores										
WJ 54 (Standardized)	-0.202	-0.085	0.050	0.207	0.286	-0.302	-0.300	-0.119	0.195	0.417
	(1.01)	(1.01)	(0.96)	(0.97)	(0.95)	(1.00)	(0.89)	(0.96)	(0.90)	(1.26)
WJPV (Standardized)	-0.182	-0.151	0.109	0.213	0.311	-0.267	-0.298	-0.145	0.163	0.331
	(1.06)	(0.92)	(0.97)	(0.90)	(0.93)	(0.97)	(0.92)	(0.95)	(0.92)	(1.19)
WJAP (Standardized)	-0.145	0.024	0.016	0.063	0.203	-0.253	-0.213	-0.088	0.136	0.439
	(1.05)	(0.93)	(1.00)	(1.02)	(1.01)	(1.12)	(0.94)	(0.96)	(0.95)	(0.96)
MDI24 (Standardized)	-0.235	0.163	0.100	0.122	0.296	-0.345	-0.255	-0.008	0.194	0.456
	(1.06)	(1.04)	(0.92)	(0.98)	(0.83)	(1.08)	(0.98)	(0.94)	(0.93)	(0.89)
MDI15 (Standardized)	-0.053	0.011	-0.070	0.130	0.235	-0.049	-0.136	-0.059	0.039	0.295
	(0.94)	(0.91)	(1.01)	(0.96)	(0.99)	(0.98)	(0.95)	(0.94)	(1.06)	(0.99)
Family Characteristics										
Mother's Age @ Birth	27.60	28.11	29.30	28.74	28.37	26.47	28.29	28.16	29.24	29.30
	(5.90)	(5.51)	(5.41)	(5.45)	(4.91)	(5.83)	(5.99)	(5.31)	(5.31)	(4.97)
Mother's Education (years)	13.43	14.33	14.58	15.13	14.98	13.07	13.99	14.36	15.00	15.06
	(2.46)	(2.30)	(2.42)	(2.54)	(2.37)	(2.43)	(2.41)	(2.56)	(2.48)	(2.28)
Mother's PPVT Score	95.80	99.46	101.36	100.28	103.06	92.47	95.54	98.64	103.04	103.88
	(20.05)	(16.75)	(18.76)	(20.10)	(13.61)	(20.12)	(18.57)	(18.13)	(17.67)	(15.34)
No. of Children @ Yr. 0	2.21	1.94	1.77	1.64	1.46	2.25	1.90	1.76	1.76	1.61
	(1.14)	(0.95)	(0.85)	(0.82)	(0.76)	(1.19)	(0.98)	(0.90)	(0.87)	(0.76)
No. of Children @ Yr. 3	2.46	2.15	1.99	1.87	1.79	2.61	2.17	1.94	1.96	1.93
	(1.14)	(1.06)	(0.93)	(0.80)	(0.76)	(1.11)	(1.11)	(0.90)	(0.90)	(0.81)
Father's Education (years)	14.15	14.37	14.67	15.04	14.81	13.79	14.01	14.14	15.10	15.52
	(2.68)	(2.14)	(2.69)	(2.89)	(2.52)	(2.69)	(2.51)	(2.45)	(2.76)	(2.66)

Table 6.8. Sample Means of Selected Variables by Quality of Child Care

		Child Care Quality @ Year 0 (ORCE Score Standardized, Mean=0)					**Child Care Quality @ Year 3 (ORCE Score Standardized, Mean=0)**			
	All Mother Care	< -1	-1 to 0	0 to 1	> 1	All Mother Care	< -1	-1 to 0	0 to 1	> 1
Child Characteristics										
Hispanic	0.07	0.10	0.04	0.06	0.04	0.05	0.06	0.07	0.06	0.06
	(0.25)	(0.30)	(0.20)	(0.24)	(0.20)	(0.22)	(0.24)	(0.26)	(0.23)	(0.23)
Black	0.17	0.16	0.10	0.09	0.07	0.19	0.22	0.10	0.08	0.01
	(0.37)	(0.37)	(0.30)	(0.29)	(0.26)	(0.39)	(0.42)	(0.31)	(0.27)	(0.10)
Boy	0.53	0.44	0.55	0.54	0.52	0.52	0.51	0.54	0.48	0.48
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
Birth Order	2.11	1.84	1.70	1.58	1.46	2.08	1.87	1.70	1.71	1.59
	(1.04)	(0.89)	(0.82)	(0.74)	(0.79)	(1.05)	(0.95)	(0.81)	(0.83)	(0.76)
Temperament Score	2.28	2.38	2.39	2.41	2.36	2.28	2.34	2.35	2.35	2.42
	(0.55)	(0.55)	(0.53)	(0.55)	(0.56)	(0.55)	(0.49)	(0.54)	(0.57)	(0.58)
Gestational Age (weeks)	39.35	39.22	39.16	39.36	39.14	39.19	39.27	39.37	39.19	39.39
	(1.39)	(1.29)	(1.54)	(1.40)	(1.31)	(1.33)	(1.56)	(1.40)	(1.53)	(1.39)
Health at 1 month Score	3.65	3.66	3.72	3.76	3.80	3.65	3.68	3.69	3.71	3.70
	(0.56)	(0.51)	(0.49)	(0.48)	(0.45)	(0.59)	(0.51)	(0.53)	(0.52)	(0.57)
Weight (grams)	3491	3528	3486	3510	3481	3431	3493	3503	3514	3532
	(489)	(502)	(514)	(526)	(497)	(496)	(517)	(470)	(548)	(496)

Table 6.9. Estimated Child Care Quality Effects of Different Models and Specifications

Value-Added Specification				Cumulative Specification			
	Year 0	Year 1	Year 3		Year 0	Year 1	Year 3
A. Base	0.080	0.078	0.057	A. Base	0.080	0.132	0.078
	(2.46)	(3.09)	(2.31)		(2.46)	(4.23)	(2.87)
B. Proxy	0.083	0.043	0.045	B. Proxy	0.076	0.070	0.074
	(2.53)	(1.68)	(1.78)		(2.33)	(2.22)	(2.56)
C. IV	0.199	0.114	0.031	C. IV	0.199	0.086	-0.010
	(4.02)	(2.57)	(0.74)		(4.03)	(1.16)	(0.16)
D. Within Child (FE)			0.007	D1. Within Child		0.081	-0.004
			(0.34)	(Varying by age)[1]		(2.53)	(0.13)
				D2. Within Child		0.065	0.069
				(Varying by age)[2]		(1.77)	(2.01)
				D3. Within Child	0.006	0.062	0.066
				(Constant)[3]	(0.12)	(1.69)	(1.91)

[1] Year 3 coefficient from C_{i3}-C_{i1}. Year 1 Coefficient from C_{i1}-C_{i0}

[2] Year 3 and 1 coefficients from C_{i3}-C_{i0} regression.

[3] Coefficients are from C_{i3}-C_{i0} regression.

Table 6.10. Group Size and Child-Caregiver Ratio Effects (Base Model)

	Value-Added Specification			Cumulative Specification		
	Year 0	Year 1	Year 3	Year 0	Year 1	Year 3
Group Size	0.000	0.041	-0.030	0.000	0.041	-0.007
	(0.00)	(1.40)	(1.01)	(0.00)	(1.10)	(0.21)
Child-Caregiver Ratio	-0.037	0.034	-0.016	-0.037	0.056	0.024
	(1.18)	(1.34)	(0.60)	(1.18)	(1.77)	(0.81)

Table 6.11. **Effects of Child Care Hours and Use of Center Based Care**

	Value-Added Specification						Cumulative Specification					
	Year 0		Year 1		Year 3		Year 0	Year 1	Year 3			
A. Base												
Use of Center Care	0.224	***	0.184	***	-0.002		-0.03	-0.1	0.166	***		
Child Care Hours	-0.001		-0.001		-0.001		--	-0.003	-0.001			
B. Proxy												
Use of Center Care	0.244	***	0.142	*	0.036		-0.03	-0.131	0.2	***		
Child Care Hours	-0.002		0.000		0.000		--	-0.005	0.000			
C. IV												
Use of Center Care	2.127	***	0.059		0.033		-0.737	1.247	-0.119			
Child Care Hours	0.017	**	0.001		-0.214		--	0.001	0.000			

Table 6.12. **States and Sample Distribution**

		Year 0		Year 3	
	States	Freq.	Percent	Freq.	Percent
1	Not Pay- Not Working- Mother	351	27.9	201	16.8
2	Not Pay -Not Working -Non-parent	44	3.5	46	4.2
3	Not Pay –Working -Non-parent	195	15.6	123	10.2
4	Not Pay –Working –Father	137	10.9	134	11.2
5	Pay -Not Working-Center	8	0.6	86	7.5
6	Pay -Not Working –Home	46	3.7	56	4.7
7	Pay –Working –Center	100	8.0	243	21.2
8	Pay –Working –Home	373	29.7	307	25.7
	Total	1254	100.0	1196	100.0

Table 6.13. State Specific Application of Model

State	C.C. Choice Variables	Budget Constraint	Production Function	Time Constraints Assumption and Implication	Maximization Problem
(2) Not Pay – Not Work – Non-parental Care	N	$G = v$	$O(N)$	$L = N, H = 0$	$\underset{N}{Max}\ \tilde{U} = U\left(v,\ O(N),\ N\right)$
(3 or 4) Not Pay – Work – Non-parental Care or Father	N	$G = w \cdot H + v$	$O(N)$	$L = \bar{L}, H = N - \bar{L}$	$\underset{N}{Max}\ \tilde{U} = U\left(wN - w\bar{L} + v,\ O(N), \bar{L}\right)$
(5 or 6) Pay – Not Work – Center or Home-based	N, Q	$G = -p(Q) \cdot N + v$	$O(N,Q)$	$L = N, H = 0$	$\underset{N,Q}{Max}\ \tilde{U} = U\left(-p(Q)N + v,\ O(N,Q),\ N\right)$
(7 or 8) Pay – Work – Center or Home-based	N,Q	$G = w \cdot H - p(Q) \cdot N + v$	$O(N,Q)$	$L = \bar{L}, H = N - \bar{L}$	$\underset{N,Q}{Max}\ \tilde{U} = U\left(\left(w - p_s(Q)\right)N - w\bar{L} + v,\ O(N,Q), \bar{L}\right)$

Table 6.14. Summary of Comparative Static Results (Child Care Quantity)

	States				
Variable	(2) Not Pay - Not Work	(3,4) Not Pay - Work	(5,6) Pay - Not Work	(7,8) Pay - Work	Remarks
	On Child Care Quantity				
v	< 0 if $\lvert U_{LG}\rvert < \lvert U_{OG} \cdot O_N\rvert$	< 0	> 0 if (i) $\frac{\partial U_N}{\partial Q} > 0$ and (ii) $\frac{\partial U_N}{\partial v} > 0$.	< 0 if $\frac{\partial U_N}{\partial Q} < 0$	For 5 & 6, $\frac{\partial U_N}{\partial v} = -p \cdot U_{GG} + U_{OG} \cdot O_N + U_{LG}$
w	No effect	$\gtrless 0$ if $U_G \gtrless \lvert w\,(U_{GG} \cdot N) + O_N\,(U_{OG} \cdot N)\rvert$	No effect	> 0 if (i) $\frac{\partial U_N}{\partial Q} > 0$ and (ii) $\frac{\partial U_N}{\partial w} > 0$	$\frac{\partial U_N}{\partial w} > 0 \Leftrightarrow U_G > \lvert (w-p) \cdot U_{GG} \cdot N + O_N \cdot U_{OG} \cdot N\rvert$
c	No effect	No effect	< 0 if (i) $\frac{\partial U_N}{\partial Q} > 0$.	< 0 if (i) $\frac{\partial U_N}{\partial Q} > 0$ and (ii) $\frac{\partial U_N}{\partial c} < 0$	$\frac{\partial U_N}{\partial c} < 0$ is very likely in the non-working states, 5 and 6

Table 6.15. Summary of Comparative Static Results (Child Care Quality)

	States				
Variable	(2) Not Pay - Not Work	(3,4) Not Pay - Work	(5,6) Pay - Not Work	(7,8) Pay - Work	Remarks
	On Child Care Quality				
v	No effect	No effect	> 0 if (i) $\frac{\partial U_Q}{\partial N} > 0$ and (ii) $\frac{\partial U_N}{\partial v} > 0$	> 0 if $\frac{\partial U_Q}{\partial N} < 0$	A negative impact of v on quality can be observed when the mother is working.
w	No effect	No effect	No effect	> 0 if (i) $\left(\frac{\partial U_Q}{\partial N}\right) > 0$ and (ii) $\left(\frac{\partial U_N}{\partial w}\right) > 0$	
c	No effect	No effect	< 0	< 0 if (i) $\frac{\partial U_Q}{\partial N} > 0$ and (ii) $\frac{\partial U_N}{\partial c} < 0$	$\frac{\partial U_N}{\partial c} < 0$ is more likely to be achieved in states 5,6 than in 7,8

Table 6.16. Variables in the Child Care Choice Variables Regression

Variables	Definition
Log of Mother's Wage	Mother's earnings per hour; missing values imputed using Heckman's two-step wage offer estimation
Log of Spouse Income	Annual spouse earnings/$10,000
Boy	If child is male.
Log of Partner's Education	Number of years of partner's education.
Log of Number of Children	Number of children leaving in the household.
Log of Number of Adults	Number of adults in the household.
Father is Living at Home	If child's father lives with the mother and child.
Log of Partner's Work Hours	Work hours per week.
African-American	Mother is African-American
Maternal Depression Index	
Mother's Progressiveness Score	Score on test regarding progressive ideas/beliefs in racing children.
Mother's Health Index	
Log of Mother's Education	Years of education.
Log of Mother's age	Age at birth of target child.
Square of Log of Mother's age	
Mother's PPVT Score	Standardized score on the Peabody Picture Vocabulary Test.
South	Family resides in the south.
D_15, D_24, D_36	Dummy variable (D.V.) for child's age = 15, 24 and 36 months.
Log Mother's Wage * D_15 (or D_24, D_36)	D.V. for child's age interacted with log of mother's wage.
Log Spouse Income* D_15 (or D_24, D_36)	D.V. for child's age interacted with log of spouse's income
Log Price * D_15 (or D_24, D_36)	D.V. for child's age interacted with log of child care price.

Table 6.17. Non-maternal Care and Work Hours by Work, Payment Status and Type of Care

	Hours in Care		Work Hours		ORCE Score		Per Hour Cost	
	Age of Child (Year)							
	0	3	0	3	0	3	0	3
Mother Works	36.57	38.94	32.90	33.73	2.933	2.790	1.696	1.920
	(14.58)	(14.44)	(13.47)	(13.09)	(0.57)	(0.46)	(1.65)	(1.86)
	806	807	806	807	377	471	644	685
Does Not Work	23.06	20.63	0.00	0.00	2.934	2.897	1.464	2.150
	(18.26)	(18.09)	--	--	(0.67)	(0.46)	(1.85)	(2.28)
	119	204	--	--	32	68	67	117
Pays for Care	38.87	36.86	36.10	35.11	2.911	2.799	1.675	1.954
	(12.73)	(15.79)	(10.83)	(11.63)	(0.58)	(0.46)	(1.67)	(1.93)
	584	740	506	587	393	514	711	802
Does Not Pay for Care	28.50	30.88	27.50	30.05	--	--	--	--
	(17.71)	(18.82)	(15.60)	(15.83)	--	--	--	--
	367	285	300	220				
Center-based	40.49	34.57	37.24	35.61	2.711	2.761	2.431	2.279
	(10.55)	(17.00)	(9.38)	(12.01)	(0.53)	(0.44)	(1.48)	(1.67)
	117	369	106	257	96	255	107	319
Home/Family Day Care	37.33	37.31	34.96	34.78	2.933	2.790	1.866	2.189
	(14.26)	(15.27)	(11.55)	(11.65)	(0.57)	(0.46)	(1.67)	(2.08)
	552	431	461	358	377	471	497	376
Total	34.86	35.20	32.90	33.73	2.911	2.799	1.675	1.954
	(15.68)	(16.89)	(13.47)	(13.09)	(0.58)	(0.46)	(1.67)	(1.93)
	951	1025	806	807	393	514	711	802

Table 6.18. **Correlation of Quality with Cost and Spouse Income**

	Age of Child (Year)			
	0	**3**	**0**	**3**
	Per Hour Cost of Care		**Spouse Income**	
Total	0.143	0.194	0.071	0.156
(Significance)	(0.00)	(0.00)	(0.12)	(0.00)
Center	-0.032	0.023	0.124	0.045
	(0.75)	(0.71)	(0.24)	(0.50)
Home	0.200	0.296	0.116	0.296
	(0.00)	(0.00)	(0.05)	(0.00)
Working	0.165	0.201	0.081	0.124
	(0.00)	(0.00)	(0.08)	(0.01)
Not Working	-0.177	0.121	-0.123	0.234
	(0.37)	(0.34)	(0.59)	(0.05)

Table 6.19. Discrete Choice Model Results: Partial Effects and Elasticities

	Spouse Earning		Wage		Price (Home)		Price (Center)	
Child Age (Years)	0	3	0	3	0	3	0	3
Mother Working	-0.0331	-0.0333	0.0132	0.0116	-0.0318	-0.0304	-0.0082	-0.0029
	(3.21)	(3.45)	(4.22)	(4.31)	(2.94)	(2.84)	(1.37)	(0.26)
Elasticity	*-0.201*	*-0.212*	*0.213*	*0.203*	*-0.110*	*-0.095*	*-0.039*	*-0.009*
Paying for Care	0.0041	0.0125	0.0076	0.0065	-0.0720	-0.0457	-0.0162	-0.0480
	(0.47)	(1.68)	(3.17)	(2.61)	(4.31)	(2.57)	(1.53)	(2.60)
Elasticity	*0.009*	*0.066*	*0.202*	*0.129*	*-0.433*	*-0.196*	*-0.124*	*-0.145*
Using Paid Center Care	-0.0020	0.0057	0.0027	0.0016	0.0147	0.0345	-0.0296	-0.0963
	(0.78)	(1.21)	(1.22)	(0.88)	(0.98)	(1.59)	(1.30)	(2.61)
Elasticity	*-0.114*	*0.060*	*0.350*	*0.075*	*0.299*	*0.241*	*-1.228*	*-0.683*
Using Paid Home Care	0.0062	0.0068	0.0049	0.0049	-0.0867	-0.0802	0.0134	0.0483
	(0.82)	(1.22)	(2.13)	(2.21)	(4.49)	(4.63)	(0.95)	(1.63)
Elasticity	*0.038*	*0.069*	*0.155*	*0.167*	*-0.596*	*-0.529*	*0.114*	*0.243*

Table 6.20. Child Care Quantity Regression Results

		Year 0			Year 1			Year 3		
		Mother Works		Not Work	Mother Works		Not Work	Mother Works		Not Work
Spouse Income										
Paying	Center-based	0.016		-0.015	-0.069	**	0.007	-0.058	*	0.026 *
	Home-based	-0.039		-0.12	-0.002		0.053	-0.075	*	-0.04 **
Non-paying	Non-parental	-0.102		0.118	-0.196	*	-0.212 **	-0.026		-0.76 *
	Father	-0.021			0.003			-0.001		
Mother's Wage										
Paying	Center-based	-0.025			0.095	**		0.03		
	Home-based	0.045			0.027			-0.02		
Non-paying	Non-parental	-0.103	**		-0.093	**		-0.294	**	
	Father	-0.184	*		-0.076			-0.128	*	
Child Care Price										
Paying	Center-based	-0.02		-0.121	-0.120		0.653	-0.052		-0.062
	Home-based	-0.063		0.433	-0.036		-0.123	0.072		0.484

Table 6.21. Child Care Quality Regression Results

		Year 0			Year 1			Year 3			
		Mother Works		Not Work	Mother Works	Not Work		Mother Works		Not Work	
Spouse Income											
Paying	Center-based	0.11		-0.069	-0.023	-0.283		-0.223	*	0.06	*
	Home-based	0.12		-0.261	-0.012	0.260		0.176	*	0.032	
Mother's Wage											
Paying	Center-based	-0.103			0.19			-0.177			
	Home-based	-0.123			-0.123			0.208	*		
Child Care Price											
Paying	Center-based	-0.043	*	-1.259	-0.12	0.653		-0.153	*	0.161	
	Home-based	-0.038		0.019	-0.036	-0.123		-0.066	*	-0.328	*

6.2 CHARTS AND FIGURES

Figure 1. Overall Framework

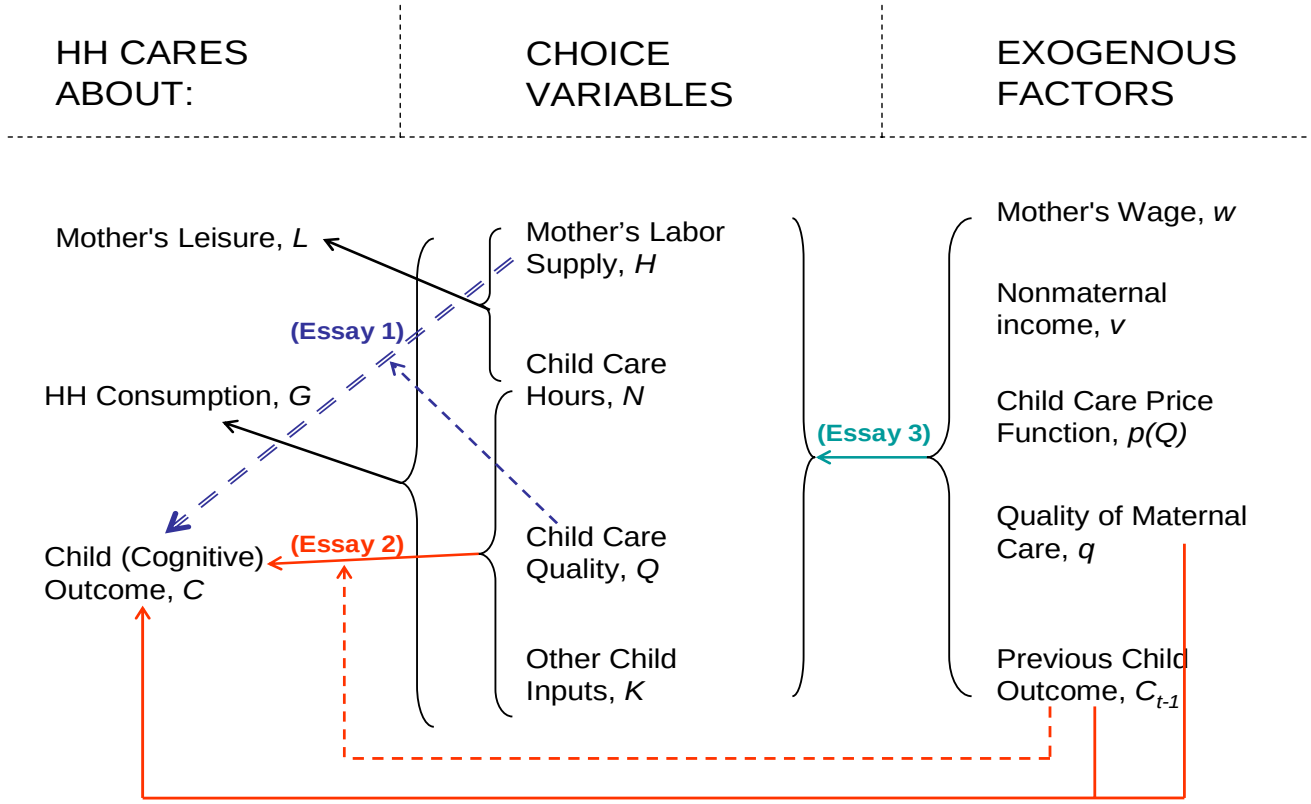


Figure 2. Maternal Employment and Non-Maternal Care Use Overtime

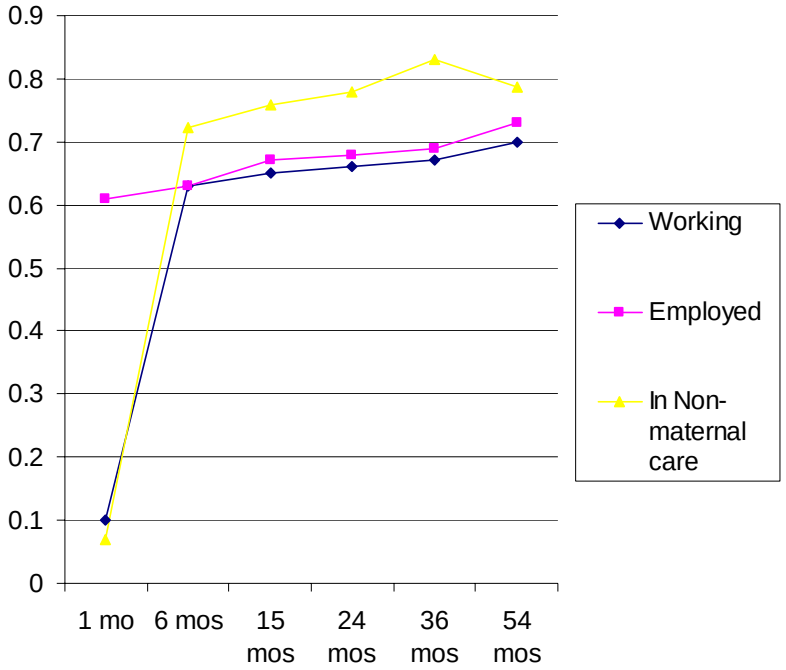


Figure 3. Working Mother: Optimal Child Care Quantity

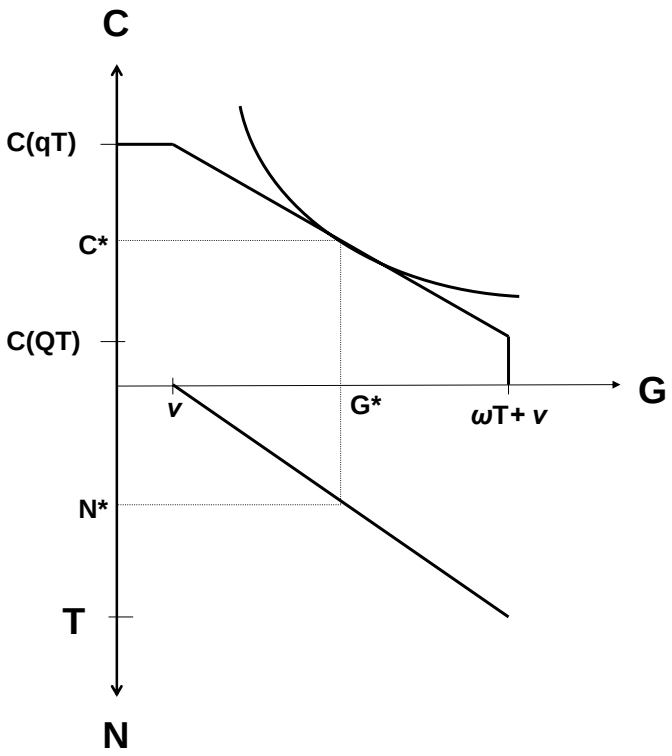


Figure 4. Paying-Non-working Mother: Optimal Child Care Quantity

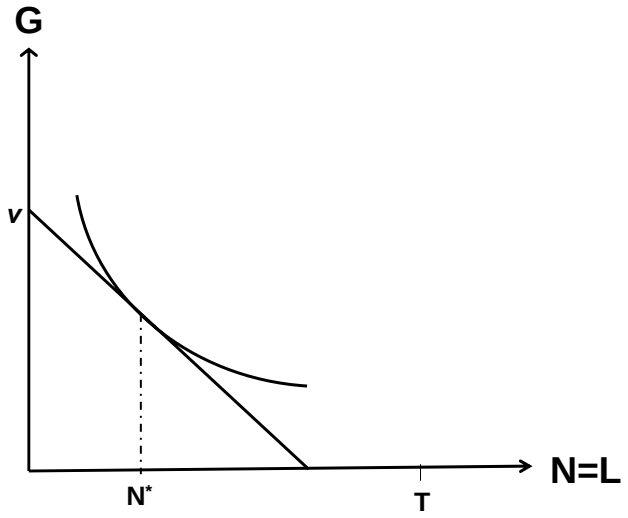


Figure 5. **Non-paying vs. Paying for Child Care, Mother is working: Income Increase**

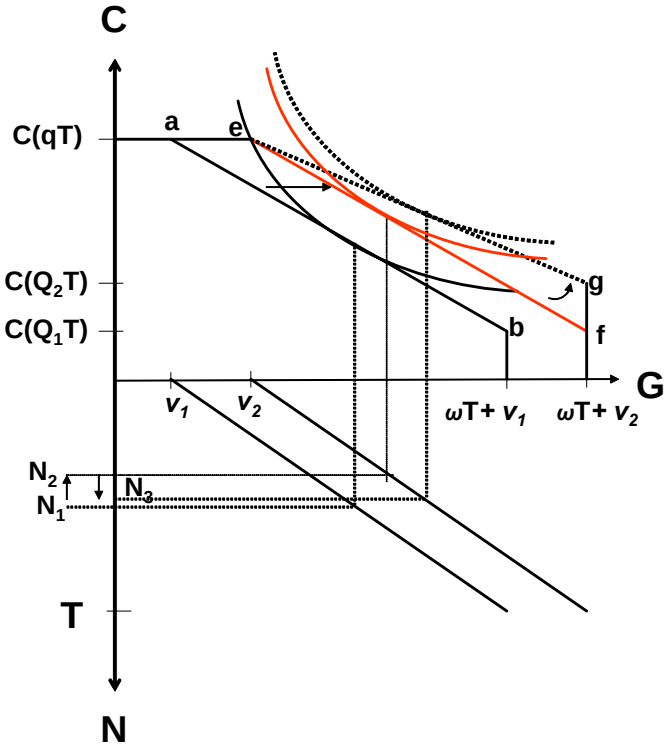


Figure 6. **Non-paying vs. Paying for Child Care, Mother is working: Wage Increase**

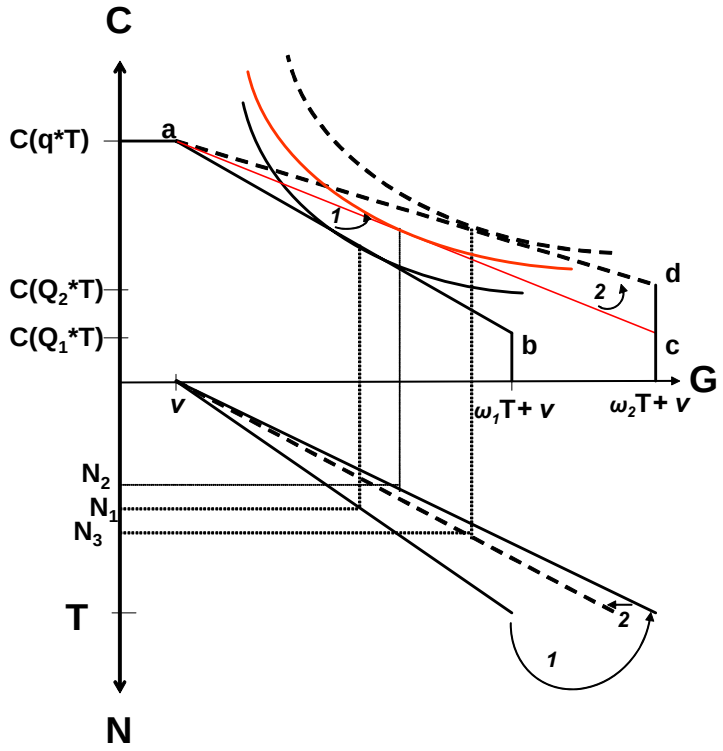
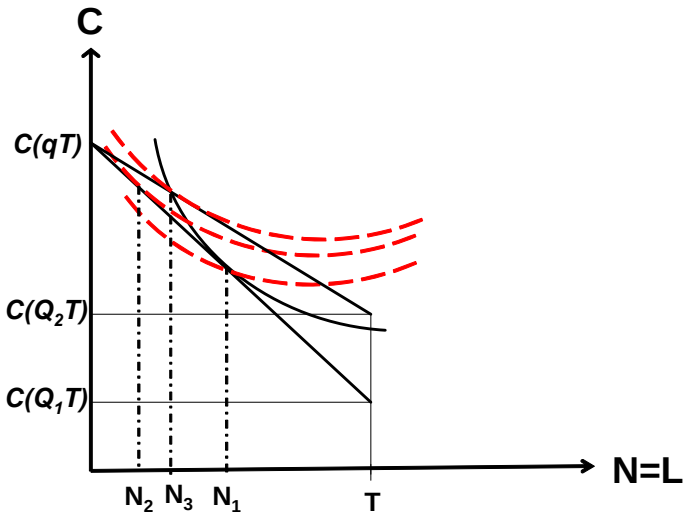


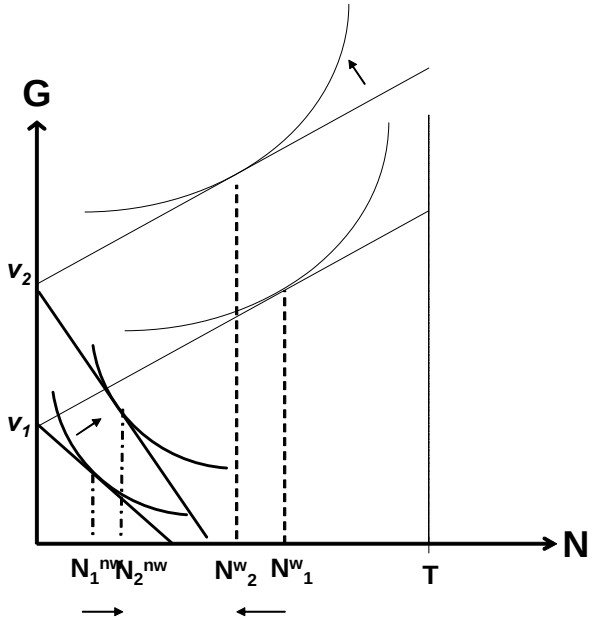
Figure 7. Non-paying vs. Paying for Child Care, Mother is not working: Income Increase



C_N = -(q-Q) , slope of frontier

- MU_L / MU_C = slope of I.C.

Figure 8. Non-working vs. Working Mother: Income Increase



7.0 APPENDICES

7.1 NICHD-SECC DATA

7.1.1 General Description

The National Institute of Child Health and Development - Study of Early Child Care (NICHD-SECC) is a multi-site, longitudinal study of the experiences of 1,364 children and their families. The study collected information during the child's first 10 years on the families' experiences in child care, the home and school and how these experiences relate to the children's development. The developmental outcomes studied are in the social-emotional, cognitive, linguistic, achievement and physical growth aspects.

The participants were selected from hospitals in 10 sites. Phase 1 of the study began in 1991, which tracked the children and their families from birth to 36 months, and Phase 2 from 37 months to first grade. Phase 3, which will track the children through sixth grade, is under implementation.

7.1.1.1 Participants and Screening Participants were selected from hospitals in and around 10 sites (institutional affiliations are in parentheses):

1. Little Rock, Arkansas (Univ. of Arkansas);
2. Irvine, California (UC and UCLA);
3. Lawrence, Kansas (Univ. of Kansas and Univ. of Texas, Austin);
4. Wellesley, Massachusetts (Univ. of New Hampshire and Wellesley College);
5. Pittsburgh, Pennsylvania (Univ. of Pittsburgh and Penn State Univ.);
6. Philadelphia, Pennsylvania (Temple Univ.);

7. Charlottesville, Virginia (Univ. of Washington);

8. Seattle, Washington (Univ. of Washington);

9. Morganton, North Carolina (UNC at Chapel Hill) and,

10. Madison, Wisconsin (Univ. of Wisconsin and Univ. of Texas, Dallas).

In the first 11 months of 1991 investigators from these institutional affiliations recruited and screened 8,986 mother and infant dyads, which resulted to the enrollment of 1,364 families. There were 3 stages to the screening: a hospital screening, then a phone call after two weeks to eligible mothers after the hospital screening and then an interview at the child's first month (1-month interview) to those who agreed to the one-month interview and kept the appointment.

Out of the 8,986 selected for hospital screening 3,750 were excluded due to any of the following reasons (exclusion criteria): mother was less than 18 years, multiple births, mother not fluent in English, family expects to move within a year, medical complications of the baby or mother, baby will be put up for adoption, refusal to two-week phone call, family lives far away, family in another study, family neighborhood is unsafe and mother refused hospital interview. Hospital visits to mother were also used to gather information on child's gender and weight, ethnicity of mother and child, mother's age and education, presence of partner at home and his education, mother's employment status, mother's plan to return to work or school and baby's gestational age.

In the two-week phone call stage, only 3,015 of the 5,416 left from the hospital screening were contacted. Of those 1,526 were scheduled for the 1-month interview. Reasons for the rest's exclusion are baby in hospital after 7 days, family is moving out within 3 years, three unsuccessful calls, refusal and others. Finally, 1,364 were successfully interviewed at 1-month and were enrolled. Retention after the first month surpassed the designers' aim for power not to be less than .85 for the major hypotheses of the study. Only 131 families dropped out after Phase 1 (36 months). Currently there are 1,077 children in Phase 3, a 79% retention rate from the original sample size.

The original selection design for the hospitals and those to be screened, the exclusion restrictions and later attrition made the remaining sample non-random, and is not nationally representative. Conclusions will be difficult to generalize for the national population. Never-

theless, the sample is socially and economically diverse and large for an observational study. The sample also represents its catchment area, hence the study results would be very useful for areas similar to the catchment areas. The study designers tried to maintain at least 10% mothers with less than high school education, at least 10% single-parent households, at least 10% minority mothers. Tables 6.1 and 6.2 present descriptive statistics of the NICHD families. Table 6.1 shows some time-invariant characteristics of the child and family. Half of the NICHD children are boys, 6 and 13 percent are Hispanic and African-American, respectively, and about 45 percent are first -borns. Relative to the National Longitudinal Survey of Youth (NLSY), which is a nationally representative sample, the NICHD households have mothers with greater education, are older at the child's birth, and are predominantly white. Table 6.2 shows family characteristics over time, such as family income and mother's average hourly salary. In comparison to national averages again, the NICHD mothers have greater hourly income, and households have higher than average income to needs ratio.

7.1.2 Data Collection

When the children were 5, 13, 23, 34 and 53 months the mothers were interviewed over the phone to gather information on childcare among other things. Information collected here include the type (e.g., center, home-relative, home-non-relative), hours per week, expenditure per week, satisfaction, when began, presence of other children, and group size of the non-maternal care experienced by the child. The primary non-maternal care arrangement, which is the one with most hours and more than 10 hours per week, was the target for observation.

After the initial home interview at month 1, the mother was interviewed again at home when the child was 6, 15, 24 and 36 months in the Phase I of the study and at the 54th month in Phase II. During these visits, data on employment (status, occupational type, hours), home environment (except at 24 months), family finance (mother's and father's/partner's income, assistance, etc.), mother's characteristics (marital status, depression, parenting experience) and household characteristics (number of adults and children) were collected. Information about the health of the child and family were also gathered during these home visits. These include the child's weight, height, frequency of ear infection and accidents. Other child

outcome measures such as the child's cognitive and social development were gathered in the affiliated institution's lab when the child was 15, 24, 36 and 54 months.

Also around the 6, 15, 24, 36 and 54-months periods, interviewers/observers were sent to the primary non-maternal childcare identified by the mothers during the pre-visit telephone interview. During these visits the director (for center) and caregivers assigned to the child (for center and home care) were interviewed. During these visits, the Observational Record of Caregiving Environment (to be discussed below), Child Care Home Inventory and Profile surveys were conducted.

Information on childcare were collected or updated through telephone interviews with the mother when the child was approximately 1, 3, 5, 7, 9, 12, 14, 21, 22, 27, 30, 33, 42, 46 and 54 months. Thus the information reported can be taken as description of childcare experience during the last 4-8 weeks prior to the interview dates.

7.2. Detailed Estimation Results

Table 7.1. **Hausman Test of Endogeneity**

	Value-Added Specification			Cumulative Specification		
Residuals from:	Year 0	Year 1	Year 3	Year 0	Year 1	Year 3
Child care Quality	1.83	2.69	2.14	1.69	3.18	2.54
Learning Materials	1.21	2.25	2.92	1.09	2.80	3.08

t-statistics of residuals from the reduced-form equation estimation
Predicted residuals were included in production function OLS regression.

Table 7.2. First Stage Regressions for Instrumental Variables Procedure

	Child Care Hours		Child Care Quality		Learning Materials	
Mother's Wage	0.028		0.004	***	0.000	
Transitory Household Income	-0.659	*	-0.031	***	-0.003	
Average Caregiver Wage - Center	0.209		-0.023		-0.016	**
Average Caregiver Wage - Home-based	-4.411		0.073		0.250	
Average Child Care Quality	-4.862	*	0.215	***	-0.025	
Partner's Work Hours	-0.083	***	0.002	**	0.001	**
Local Unemployment Rate	-0.894	***	0.004		-0.009	***
Average Child Care Cost	-7.692	***	0.012		-0.011	
Child is Boy	0.003		-0.052	***	-0.013	
Father's Education in years	-1.578	***	0.017	***	0.008	***
Number of Children	-4.558	***	-0.038	***	-0.037	***
Number of Adults in HH	0.981	*	0.038	**	0.014	**
Mother is African-American	2.484	*	-0.118	***	-0.164	***
Mother's Progressive Ideas in Childcaring Index	0.442	***	0.004		0.006	***
Mother's Health Index	0.345		0.030	**	0.007	
Mother's Education	1.430	***	0.006		0.015	***
Mother's Age	3.003	***	0.004		0.042	***
Mother's Age Squared	-0.044	***	0.000		-0.001	***
Mother's PPVT Score	-0.044		0.000		0.001	***
Mother is Single	7.320	***	-0.106	***	-0.067	***
Family resides in the South	-6.082	***	-0.026		-0.021	*
Family resides in the Northeast	-3.769	*	0.143	***	0.048	*
Family resides in the West	-1.977		-0.075	**	-0.039	**

Table 7.3. (Log of) Average Hourly Fee Regression

	Center Care (N = 511)			Home-based Care (N = 1,144)		
ORCE Score	-0.051	(0.83)		0.083	(2.01)	**
Licensed	-0.214	(1.62)		-0.036	(0.74)	
Children in group are of same age	0.191	(0.43)		-0.081	(0.90)	
Children in group not of same age	0.084	(0.19)		0.049	(1.08)	
Number of other children in setting	-0.006	(0.47)		0.075	(3.11)	***
Number of adults in setting	0.086	(2.02)	**	-0.291	(4.46)	***
Child-caregiver ratio	0.016	(0.74)		-0.096	(3.51)	***
Group size	0.004	(0.50)		-0.022	(2.51)	**
Caregiver education: High school	-0.563	(2.89)	***	-0.084	(1.58)	
Caregiver education: Some college	-0.543	(2.75)	***	-0.001	(0.02)	
Caregiver education: College and more	-0.424	(2.11)	**	0.108	(1.53)	
Caregiver has formal training	0.001	(0.01)		0.128	(2.76)	***
Caregiver has recent training	-0.080	(1.31)		-0.046	(0.99)	
Caregiver age	0.001	(0.26)		-0.006	(4.21)	***
Caregiver years of experience	-0.005	(0.86)		0.011	(3.96)	***
Caregiver is female	0.435	(2.12)	**	0.107	(0.71)	
Caregiver is African-American	-0.198	(2.28)	**	-0.285	(4.66)	***
Caregiver is Hispanic	-0.257	(1.90)	*	0.094	(1.32)	
Caregiver race not reported	-0.548	(2.65)	***	-0.206	(2.43)	**
Caregiver professionalism composite score	0.011	(0.72)		0.012	(1.49)	
Annual caregiver turnover	0.144	(1.31)				
For profit	0.081	(1.33)				
Profile, Total Score	0.014	(3.04)	***			
Center size	0.000	(0.69)				
Caregiver beliefs in raising child	-0.001	(0.54)				
Childcare – HOME Total Score				0.020	(5.55)	***
Caregiver own child present				-0.057	(1.28)	
Caregiver emphasis is on work characteristics				-0.042	(1.24)	
Caregiver emphasis is on care for young kids				0.008	(0.24)	
Caregiver emphasis is on working w/ young kids				-0.047	(1.27)	
Caregiver emphasis is on own needs				0.056	(2.29)	**

Table 7.4. Discrete Choice Model Results

	Not Pay-Not Work - Non Parent	Not Pay-Work-Non Parent	Not Pay-Work - Father	Pay-Not Work-Center	Pay-Not Work - Home-based	Pay - Work Center	Pay - Work - Home-based
Spouse Income	-0.1373	-0.1680 ***	-0.3236 ***	-0.0463	0.0250	-0.1534 ***	-0.1135 ***
Spouse Income* D_15	0.0374	-0.0636	0.0967	0.0258	0.1050	0.0286	0.0283
Spouse Income* D_24	0.0859	-0.0022	0.0581	0.1383	0.0683	0.0183	0.0039
Spouse Income* D_36	0.1842	0.0110	0.0483	0.0814	0.0765	0.0570	0.0217
Mother's Wage	0.0344	0.0504 ***	0.0726 ***	-0.0475	0.0115	0.0949 ***	0.0705 ***
Mother's Wage * D_15	0.0089	0.0375	-0.0116	0.0572	0.0109	-0.0209	0.0144
Mother's Wage * D_24	0.0008	0.0031	0.0177	0.0692	-0.0160	-0.0086	0.0200
Mother's Wage * D_36	-0.0238	-0.0432	-0.0200	0.0343	-0.0204	-0.0245	-0.0028
Price Center				-0.0919		-0.4097 ***	
Price Center*D_15				-0.1197		0.2215	
Price Center*D_24				-1.2965 **		0.0378	
Price Center*D_36				-0.4408		-0.1545	
Price Home-based					-0.2932		-0.4341 ***
Price Home-based*D_15					-0.1917		0.0051
Price Home-based*D_24					-0.2209		0.1549
Price Home-based*D_36					0.1961		-0.0162
Child is Male	-0.7700 ***	-0.1554	0.1167	0.0710	-0.3342 *	-0.1572	-0.1052
hlthbm	-0.0688	-0.2248 ***	-0.1262	-0.3267 **	-0.0938	-0.7836 ***	-0.3167 ***
Baby's Health @ Month 1	-0.2571	-0.1034	0.0415	0.0677	0.0512	-0.0311	0.0762
Gestation Period	-0.0553	-0.0157	-0.0082	-0.0482	-0.0396	-0.0143	-0.0257
Spouse's Education	-0.1442 **	-0.0495	0.0257	-0.0055	-0.0650	0.0610 *	-0.0513 **
Number of Children	-0.2515 **	-0.1930 ***	-0.2360 ***	-0.6288 ***	-0.2761 ***	-0.9755 ***	-0.5992 ***
Number of Adults	0.1823	-0.0316	-0.1969 *	-0.7894 *	0.1489	-0.5243 ***	0.0623
Spouse's Work Hours	-0.0064	0.0183 ***	-0.0098 ***	0.0063	0.0067	0.0104 **	0.0063 *
Mother is African-American	-0.9602 *	-0.4182 *	-0.2332	-0.6635	0.6714 *	0.0516	-0.4628 **
Mother's Education	0.2326 ***	0.1297 ***	0.1146 ***	0.3135 ***	0.2649 ***	0.1643 ***	0.1853 ***
Mother's Age @ Birth	-0.0439	0.0025	-0.0118	0.0514 **	0.0442 **	0.0670 ***	0.0463 ***
Mother's PPVT Score	0.0043	-0.0152 ***	-0.0059	-0.0019	0.0143 **	-0.0061	-0.0083 **
Mother's Health Index	0.1184	0.1791 **	0.1321	0.1285	0.0881	0.3168 ***	0.2946 ***
Mother's Cognitive Stimulat	-0.0955	0.0640	0.0636	-0.0364	-0.1247	-0.0428	-0.0295
South	-0.6820 **	-0.2616 **	-0.7814 ***	-0.0199	-1.4057 ***	0.1302	-0.5147 ***
D_15	0.3046	-0.2743	0.1928	0.2033	0.2389	-0.2833	-0.0464
D_24	0.2118	0.1065	-0.0228	2.4962 *	1.2530	0.3117	-0.2713
D_36	0.6654	0.5063	0.6978 **	2.8062 **	0.4850	1.1720 **	0.4106

Table 7.5.A. Child Care Hour Regressions for Non-Paying States

	Not Work - Non-parent		Work - Non-parent		Work - Father	
Log of Mother's Wage			-0.103	(3.07) ***	-0.184	(2.13) **
Log of Spouse Income	0.118	(0.24)	-0.102	(1.00)	-0.021	(0.98)
Child is Boy	0.093	(0.14)	0.002	(0.03)	-0.092	(1.66) *
Log of Partner's Education	-2.008	(0.95)	-0.213	(0.75)	-0.618	(3.29) ***
Log of Number of Children	-0.819	(1.58)	-0.288	(3.45) ***	-0.177	(2.90) ***
Log of Number of Adults	-0.316	(0.25)	0.481	(2.39) **	0.039	(0.22)
Father is Living at Home	-3.722	(3.68) ***	-0.107	(0.46)	-0.360	(1.67) *
Log of Partner's Work Hours	0.172	(3.67) ***	0.005	(0.46)	-0.010	(2.15) **
Mother is African-American	0.703	(0.52)	0.310	(2.13) **	0.273	(2.71) ***
Maternal Depression Index	-0.078	(2.52) **	0.001	(0.29)	0.007	(1.94) *
Mother's Progresiveness Score	-0.074	(1.00)	0.004	(0.40)	0.002	(0.26)
Mother's Health Index	-0.380	(1.18)	-0.034	(0.64)	-0.077	(1.84) *
Log of Mother's Education	4.031	(1.76) *	-0.233	(0.79)	0.356	(1.44)
Log of Mother's age	-29.863	(0.97)	20.393	(3.45) ***	-5.171	(1.03)
Square of Log of Mother's age	4.606	(1.00)	-3.018	(3.43) ***	0.856	(1.15)
Mother's PPVT Score	-0.018	(1.06)	-0.007	(2.29) **	-0.005	(2.22) **
South	0.416	(0.56)	0.164	(2.04) **	0.039	(0.50)
D_15	3.378	(0.66)	0.840	(0.54)	-0.548	(1.67) *
Log Mother's Wage * D_15			0.010	(0.20)	0.108	(1.00)
Log Spouse Income* D_15	-0.330	(0.66)	-0.093	(0.61)	0.024	(0.95)
D_24	3.096	(0.61)	-1.059	(0.98)	-0.498	(1.44)
Log Mother's Wage * D_24			0.062	(1.29)	0.046	(0.40)
Log Spouse Income* D_24	-0.410	(0.82)	0.094	(0.90)	0.035	(1.39)
D_36	8.152	(1.20)	-0.405	(0.37)	-0.438	(1.29)
Log Mother's Wage * D_36			-0.191	(1.87) *	0.056	(0.50)
Log Spouse Income* D_36	-0.878	(1.31)	0.076	(0.72)	0.020	(0.79)
Selectivity Correction Term	-1.480	(0.72)	0.221	(1.17)	-0.502	(3.41) ***
Constant	57.315	(1.16)	-28.609	(2.97) ***	14.167	(1.71) *

Table 7.5.B. Child Care Hours and Quality Regressions for Paying - Non-Working States

	Center				Home-based			
	Log of Child Care Hours		Standard ORCE Score		Log of Child Care Hours		Standard ORCE Score	
Log of Spouse Income	-0.015	(0.06)	-0.015	(0.18)	-0.120	(0.82)	-0.255	(0.88)
Log of Price	-0.121	(0.21)	-0.121	(0.93)	0.433	(0.98)	1.719	(1.97) **
Child is Boy	0.084	(0.64)	0.084	(0.46)	-0.023	(0.21)	-0.252	(1.17)
Log of Partner's Education	0.283	(0.67)	0.283	(0.77)	0.068	(0.18)	0.154	(0.21)
Log of Number of Children	-0.415	(2.40) **	-0.415	(0.46)	0.058	(0.49)	0.125	(0.54)
Log of Number of Adults	0.037	(0.05)	0.037	(0.67)	0.557	(1.77) *	2.078	(3.33) ***
Father is Living at Home	-0.374	(1.25)	-0.374	(0.56)	0.223	(0.90)	0.002	(0.00)
Log of Partner's Work Hours	-0.002	(0.17)	-0.002	(1.83) *	0.020	(1.33)	-0.012	(0.42)
Mother is African-American	0.058	(0.17)	0.058	(1.07)	0.027	(0.13)	-0.129	(0.31)
Maternal Depression Index	0.000	(0.04)	0.000	(0.86)	-0.009	(1.16)	-0.004	(0.25)
Mother's Progresiveness Score	-0.001	(0.03)	-0.001	(0.58)	-0.015	(1.07)	-0.005	(0.19)
Mother's Health Index	0.029	(0.38)	0.029	(1.48)	-0.114	(1.53)	0.188	(1.28)
Log of Mother's Education	0.677	(1.25)	0.677	(0.41)	-0.100	(0.18)	3.422	(3.06) ***
Log of Mother's age	8.743	(0.72)	8.743	(0.39)	0.885	(0.11)	-21.117	(1.37)
Square of Log of Mother's age	-1.336	(0.76)	-1.336	(0.42)	-0.144	(0.13)	2.957	(1.30)
Mother's PPVT Score	-0.008	(1.89) *	-0.008	(1.51)	0.001	(0.31)	-0.010	(1.31)
South	-0.150	(0.95)	-0.150	(0.35)	-0.228	(1.13)	0.019	(0.05)
D_15	-1.198	(0.23)	-1.198	(0.04)	-1.411	(0.63)	-4.467	(1.00)
Log Spouse Income* D_15	0.022	(0.04)	0.022	(0.19)	0.173	(0.78)	0.564	(1.28)
Log Price *D_15	0.774	(0.95)	0.774	(1.14)	-0.556	(0.97)	-1.661	(1.46)
D_24	0.198	(0.07)	0.198	(0.03)	-0.241	(0.16)	-1.300	(0.43)
Log Spouse Income* D_24	-0.028	(0.08)	-0.028	(0.11)	0.104	(0.73)	0.309	(1.09)
Log Price *D_24	0.219	(0.20)	0.219	(0.26)	-0.968	(1.99) **	-1.988	(2.07) **
D_36	-0.283	(0.12)	-0.283	(0.71)	-1.056	(0.69)	-1.131	(0.37)
Log Spouse Income* D_36	0.041	(0.17)	0.041	(0.29)	0.081	(0.57)	0.281	(1.01)
Log Price *D_36	0.059	(0.10)	0.059	(1.79) *	0.051	(0.08)	-1.968	(1.63)
Selectivity Correction Term	0.491	(1.36)	0.491	(0.59)	0.276	(1.25)	-0.253	(0.58)
Constant	-13.108	(0.65)	-13.108	(0.42)	2.510	(0.19)	28.816	(1.12)

Table 7.5.C. Child Care Hours and Quality Regressions for Paying - Working States

	Center				Home-based			
	Log of Child Care Hours		Standard ORCE Score		Log of Child Care Hours		Standard ORCE Score	
Log of Mother's Wage	-0.025	(0.47)	-0.098	(0.53)	0.045	(1.22)	-0.178	(1.53)
Log of Spouse Income	0.016	(0.43)	0.107	(0.79)	-0.039	(1.20)	0.130	(1.26)
Log of Price	-0.020	(0.28)	0.090	(0.34)	-0.063	(0.82)	0.089	(0.37)
Child is Boy	0.011	(0.48)	0.022	(0.27)	-0.020	(1.11)	-0.022	(0.37)
Log of Partner's Education	-0.055	(0.53)	-0.161	(0.44)	-0.121	(1.69) *	0.488	(2.18) **
Log of Number of Children	0.014	(0.35)	0.082	(0.60)	-0.030	(1.10)	-0.235	(2.70) ***
Log of Number of Adults	-0.113	(0.81)	-0.464	(0.93)	0.141	(2.39) **	0.154	(0.83)
Father is Living at Home	-0.095	(1.29)	0.032	(0.12)	-0.087	(1.35)	-0.132	(0.65)
Log of Partner's Work Hours	0.002	(0.53)	0.033	(2.40) **	-0.003	(1.13)	0.016	(1.93) *
Mother is African-American	0.055	(1.01)	-0.235	(1.21)	-0.001	(0.02)	-0.349	(2.24) **
Maternal Depression Index	0.001	(0.49)	0.000	(0.07)	0.001	(1.06)	0.000	(0.03)
Mother's Progresiveness Score	0.011	(2.89) ***	0.029	(2.14) **	0.007	(2.38) **	-0.006	(0.61)
Mother's Health Index	0.028	(1.65) *	0.121	(2.03) **	0.005	(0.32)	0.043	(0.94)
Log of Mother's Education	-0.199	(1.76) *	0.332	(0.83)	-0.161	(1.82) *	0.399	(1.43)
Log of Mother's age	-2.985	(1.28)	4.239	(0.51)	-0.478	(0.28)	12.466	(2.31) **
Square of Log of Mother's age	0.434	(1.27)	-0.630	(0.52)	0.103	(0.41)	-1.770	(2.23) **
Mother's PPVT Score	0.000	(0.33)	-0.002	(0.58)	-0.002	(2.87) ***	0.001	(0.42)
South	-0.065	(1.82) *	-0.131	(1.03)	0.030	(0.92)	0.142	(1.40)
D_15	0.700	(1.52)	0.725	(0.44)	-0.350	(1.13)	1.377	(1.42)
Log Mother's Wage * D_15	0.120	(1.61)	0.328	(1.25)	-0.018	(0.44)	0.168	(1.28)
Log Spouse Income* D_15	-0.085	(1.60)	-0.131	(0.69)	0.037	(1.12)	-0.142	(1.36)
Log Price *D_15	-0.099	(0.97)	-0.289	(0.80)	0.027	(0.31)	-0.423	(1.56)
D_24	0.906	(1.97) **	0.339	(0.21)	-0.374	(1.19)	0.357	(0.36)
Log Mother's Wage * D_24	0.094	(1.44)	0.439	(1.90) *	-0.018	(0.49)	0.175	(1.47)
Log Spouse Income* D_24	-0.116	(2.16) **	-0.120	(0.63)	0.038	(1.14)	-0.100	(0.95)
Log Price *D_24	0.091	(0.91)	-0.445	(1.25)	0.024	(0.29)	0.084	(0.31)
D_36	0.603	(1.44)	3.289	(2.22) **	0.422	(1.02)	-1.056	(0.81)
Log Mother's Wage * D_36	0.055	(0.83)	-0.072	(0.31)	-0.065	(1.43)	0.324	(2.28) **
Log Spouse Income* D_36	-0.074	(1.50)	-0.307	(1.75) *	-0.036	(0.82)	0.010	(0.07)
Log Price *D_36	-0.032	(0.32)	0.289	(0.83)	0.135	(1.36)	-0.144	(0.46)
Selectivity Correction Term	-0.029	(0.51)	-0.365	(1.82) *	0.064	(0.83)	-0.097	(0.40)
Constant	9.212	(2.33) **	-9.278	(0.66)	5.114	(1.74) *	-24.912	(2.70) ***

Table 7.6. Frequency of Child Care Type Over 2 Periods

	Child Care Type @ Year 1						
Child Care Type @ Year 0	Father/ Partner	Grandparent	In-Home Care	Child Care Home	Child Care Center	Other	Total
Father/Partner	67	4	1	0	1	1	74
Grandparent	8	39	1	0	1	1	50
In-Home care	0	3	3	0	2	1	9
Child Care Home	4	0	2	5	0	0	11
Child Care Center	0	0	0	0	3	0	3
Other	0	1	0	1	0	0	2
Total	79	47	7	6	7	3	149

Pearson chi2(25) = 252.2589 Pr = 0.000

	Child Care @ Year 2						
Child Care Type @ Year 1	Father/ Parent	Grandparent	In-Home Care	Child Care Home	Child Care Center	Other	Total
Father/Partner	69	6	0	3	0	2	80
Grandparent	5	35	0	3	0	0	43
In-Home care	1	0	2	1	1	0	5
Child Care Home	0	1	0	7	1	0	9
Child Care Center	1	0	0	0	9	0	10
Other	0	0	0	0	0	1	1
Total	76	42	2	14	11	3	148

Pearson chi2(25) = 359.2134 Pr = 0.000

Child Care @ Year 3							
Child Care Type @ Year 2	Father/ Parent	Grandparent	In-Home Care	Child Care Home	Child Care Center	Other	Total
Father/Partner	60	4	0	2	4	0	70
Grandparent	5	30	0	0	1	0	36
In-Home care	2	1	1	0	0	0	4
Child Care Home	1	3	1	4	1	0	10
Child Care Center	2	0	0	0	11	1	14
Other	2	1	0	0	1	0	4
Total	72	39	2	6	18	1	138

Pearson chi2(25) = 203.7313 Pr = 0.000

7.3 DEMAND MODEL SOLUTIONS

7.3.1 State 2

When the mother does not work nor pay for child care, the household's problem is to $\underset{N}{Max}\ U = U(G, C, L)$ subject to the budget constraint, $G = v$; child outcome production function, $C = C(N)$ and the mother's and child's constraints. With free child care, quality of child care is fixed,[1] hence child outcome is just a function of N. With mother not working, the time constraints imply that her leisure is equal to non-maternal care hours, $L = N$.

Substituting the constraints into the utility function and then maximizing with respect to N, i.e., $\underset{N}{Max}\ \tilde{U} = U(v, C(N), N)$, the first order condition obtained is

$$\frac{\partial \tilde{U}}{\partial N} = U_C \cdot C_N + U_L = 0$$

where U_i is the marginal utility of good *i, i=(G, C, L)* and $C_N = \frac{\partial C}{\partial N}$. When mother's care is of higher quality, then $C_N < 0$ and we have an interior solution; otherwise $N{=}T$. The first order condition means that she will determine N such that the marginal utility of leisure is equal to its marginal cost. If maternal care is of higher quality than the free non-maternal care, then the cost of leisure is the fall in child outcome times the marginal utility of child quality. If non-maternal care is better then $T{=}N$.

Comparative Statics

Let $\tilde{U}_N = \frac{\partial \tilde{U}}{\partial N}$. The effect of higher spouse income on child care hours is given by $\frac{dN}{dv} = -\frac{\frac{\partial \tilde{U}_N}{\partial v}}{\frac{\partial \tilde{U}_N}{\partial N}} = -\frac{C_N \cdot U_{OG} + U_{LG}}{C_N(U_{CC} \cdot C_N + U_{CL}) + U_{LC} \cdot C_N + U_{LL}}$. This expression applies to the case when $C_N < 0$, since if it is not, then we have a corner solution for N and changes in v has no significance. Therefore, if $C_N < 0$, then the predicted effect of higher income is

$\frac{dN}{dv} = -\frac{(-)(+)+(+)}{(-)((-)(-)+(+))+(+)(-)+(-)} = -\frac{(-)+(+)}{(-)+(-)+(-)} = \frac{(+/-)}{(+)}$. $\frac{dN}{dv} \lessgtr 0$ if $|U_{LG}| \lessgtr |U_{CG} \cdot C_N|$.

[1] At the initial stage when the mother was choosing a state, the free child care she was considering must be that child care with the highest quality that is available to her. For if there was another free child care of a higher quality which was also available, then there is no reason why she would not choose that child care given that there is no financial cost to her.

The above expression implies that since an increase in unearned income, v, raises the household's consumption, G, the effect on child care hours, N, will depend on which good, child outcome or leisure, is a better complement to household consumption. If child outcome complements consumption better than leisure and/or if non-maternal care is of very low quality such that C_N is large in absolute value, then a higher unearned income leads the mother to cut back on non-maternal care hours. A scenario why a mother would cut back on non-maternal care hours with a higher income is if non-maternal care is used to support work-related activities, such as going to school or training or to simply look for work. With a higher income, the value of these activities is diminished relative to the child's outcome.

7.3.2 State 3 or 4

If non-maternal care used is free, quality of care is fixed. The household's problem is to $\underset{N}{Max}\ U = U(G, C, L)$ subject to the budget constraint, $G = w \cdot H + v$; the child outcome production function, $C = C(N)$, and the time constraints. Given the assumption that mother's leisure is fixed at $\bar{L}$ when she is working, then changes in non-maternal care hours are due to changes in work hours, i.e., $H = N - \bar{L}$.

Substituting the constraints into the utility function and then maximizing with respect to N, i.e., $\underset{N}{Max}\ \tilde{U} = U\left(wN - w\bar{L} + v, C(N), \bar{L}\right)$, we derive the first order condition as,

$\frac{\partial \tilde{U}}{\partial N} = U_G \cdot w + U_C \cdot C_N = 0.$

This means that the mother will work and use non-maternal care until the marginal benefit of working (which is higher consumption goods, w, multiplied by the marginal utility of consumption) is equal to the marginal cost. The cost of the mother working materializes if maternal care is of higher quality such that $C_N < 0$. If non-maternal care is of higher quality then we get a corner solution.

Comparative statics

Using the Implicit Function Theorem we derive the following partial effects on N.

Spouse Income on N

Letting $\tilde{U}_N = \frac{\partial \tilde{U}}{\partial N}$, then

$$\frac{dN}{dv} = -\frac{\frac{\partial \tilde{U}_N}{\partial v}}{\frac{\partial \tilde{U}_N}{\partial N}}$$

$\frac{\partial \tilde{U}_N}{\partial v} = w\left(\frac{\partial U_G}{\partial v}\right) + C_N\left(\frac{\partial U_O}{\partial v}\right) = w \cdot U_{GG} + C_N \cdot U_{CG} = (+)(-) + (-)(+) = (-)$

$\frac{\partial \tilde{U}_N}{\partial N} = w \cdot \left(\frac{\partial U_G}{\partial N}\right) + C_N \frac{\partial U_C}{\partial N} = w\left[U_{GG} \cdot w + U_{GC} \cdot C_N\right] + C_N\left[U_{CG} \cdot w + U_{CC} \cdot C_N\right]$

$\frac{\partial \tilde{U}_N}{\partial N} = (+)\left[(-)(+) + (+)(-)\right] + (-)\left[(+)(+) + (-)(-)\right] = (+)\left[(-)\right] + (-)\left[(+)\right]$

$= (-)$

Thus, $\frac{dN}{dv} = -\frac{(-)}{(-)} < 0$.

Since maternal care is of higher quality, an increase in v reduces work hours and N because the marginal utility of consumption falls while the marginal utility of child outcome increases. That is, the marginal rate of substitution between consumption and child outcome falls.

Mother's Wage on N

$$\frac{dN}{dw} = -\frac{\frac{\partial \tilde{U}_N}{\partial w}}{\frac{\partial \tilde{U}_N}{\partial N}} \tag{7.7}$$

Since $\frac{\partial \tilde{U}_N}{\partial N} < 0$, the effect of wage on child care (or work) hours is determined by the effect of higher wage on the marginal value of N, $\frac{\partial \tilde{U}_N}{\partial w}$.Evaluating this term, we get

$\frac{\partial \tilde{U}_N}{\partial w} = U_G + w\left(\frac{\partial U_G}{\partial w}\right) + C_N\left(\frac{\partial U_o}{\partial w}\right) = U_G + w\left(U_{GG} \cdot N\right) + C_N\left(U_{CG} \cdot N\right)$

$= (+) + (+)(-)(+) + (-)(+)(+) = (+) + (-) + (-) = (+/-)$

$\frac{dN}{dw} = -\frac{(+/-)}{(-)} = (+/-)$.

That is, $\frac{dN}{dw} \gtrless 0$ if $U_G \gtrless \left|w\left(U_{GG} \cdot N\right) + C_N\left(U_{CG} \cdot N\right)\right|$. This means that if the value of greater consumption, (the substitution effect) is greater than the decline in the marginal value of consumption (the income effect) plus the increase in the marginal value of child quality, then a higher wage would lead to greater work/child care hours.

This condition is akin to the substitution versus income effects of wage on work hours in the standard analysis of time allocation between labor and leisure. The term $C_N \cdot N\left(U_{CG}\right)$, represents the shift of preference towards child outcome because with the higher wage the household would already enjoy higher consumption. Thus, the mother would also like to "purchase" more child quality by spending more time with the child.

7.3.3 State 5 or 6

Since the household pays for child care, household can also choose the quality of child care to use aside from how much care to utilize. Therefore, the child outcome function is expressed as $C = C(Q, N)$, with $C_Q > 0$. Child care expenditure is now in the budget constraint but mother's wage is not since she is not working, i.e., $G = -p(Q) \cdot N + v$. The child care price function is assumed to be of the form $p = c + g(Q)$, where c is the quality-adjusted price component. Integrating these constraints into the utility function, the household's problem is to

$$\underset{N,Q}{Max}\ \tilde{U} = U\left[-p(Q) \cdot N + v, C(Q, N), N\right]$$

The first order conditions are:

$$\frac{\partial \tilde{U}}{\partial N} = U_G \cdot (-p(Q)) + U_C \cdot C_N + U_L = 0$$
$$\frac{\partial \tilde{U}}{\partial Q} = U_G \cdot (-p'(Q) \cdot N) + U_C \cdot C_Q = 0$$

The marginal benefit of non-maternal care hours is that it gives greater leisure to the mother (and higher child outcome if non-maternal care has a higher quality). The marginal cost is the reduction in household consumption (and child outcome if maternal care is of higher quality). The marginal benefit of child care quality is an improvement in child outcome, while the marginal cost is a decline in household consumption.

Comparative Statics

The partial effects of nonlabor income and quality-adjusted price, c_s, on child care quantity and quality were derived. These were determined from the first order conditions using the Implicit Function Theorem for two endogenous variables.

Let $\tilde{U}_N = \frac{\partial \tilde{U}}{\partial N}$and $\tilde{U}_Q = \frac{\partial \tilde{U}}{\partial Q}$. The following equations, and their signs, will be needed to determine the different partial effects.

$$\frac{\partial \tilde{U}_N}{\partial N} = \left(-p \cdot \frac{\partial U_G}{\partial N}\right) + C_N \frac{\partial U_C}{\partial N} + \frac{\partial U_L}{\partial N} \tag{7.8}$$

$\frac{\partial U_G}{\partial N} = \frac{\partial U_G}{\partial G}\frac{\partial G}{\partial N} + \frac{\partial U_G}{\partial C}\frac{\partial C}{\partial N} + \frac{\partial U_G}{\partial L}\frac{\partial L}{\partial N} = U_{GG}(-p) + U_{GC}C_N + U_{GL} = (-)(-) + (+)(-) + (+) = (+/-)$

$\frac{\partial U_C}{\partial N} = \frac{\partial U_C}{\partial G}\frac{\partial G}{\partial N} + \frac{\partial U_C}{\partial C}\frac{\partial C}{\partial N} + \frac{\partial U_C}{\partial L}\frac{\partial L}{\partial N} = U_{CG}(-p) + U_{CC}C_N + U_{CL} = (+)(-) + (-)(-) + (+) = (+/-)$

$\frac{\partial U_L}{\partial N} = \frac{\partial U_L}{\partial G}\frac{\partial G}{\partial N} + \frac{\partial U_L}{\partial C}\frac{\partial C}{\partial N} + \frac{\partial U_L}{\partial L}\frac{\partial L}{\partial N} = U_{LG}(-p) + U_{LC}C_N + U_{LL} = (+)(-) + (+)(-) + (-) = (-)$

Thus, the change in the marginal value of N due to an increase in N is ambiguous, i.e., $\frac{\partial \tilde{U}_N}{\partial N} = (+/-)$. However, $\tilde{U}_{NN} < 0$ is a condition for a maximum solution and thus would be assumed below. Such condition is satisfied if the cross partials of the utility function are sufficiently small.

$$\frac{\partial \tilde{U}_N}{\partial Q} = \left(-p\left(Q\right) \cdot \frac{\partial U_G}{\partial Q}\right) + U_G\left(-p'(Q)\right) + C_N \cdot \frac{\partial U_C}{\partial Q} + U_C\left(\frac{\partial C_N}{\partial Q}\right) + \frac{\partial U_L}{\partial Q} \tag{7.9}$$

The signs of the various terms above are as follows:

$\frac{\partial U_G}{\partial Q} = \frac{\partial U_G}{\partial G}\frac{\partial G}{\partial p}\frac{\partial p}{\partial Q} + \frac{\partial U_G}{\partial C}\frac{\partial C}{\partial Q} = U_{GG}\left(-N\right)p' + U_{GC} \cdot C_Q = (-)(-)(+) + (+)(+) = (+)$

$\frac{\partial U_C}{\partial Q} = \frac{\partial U_C}{\partial G}\frac{\partial G}{\partial p}\frac{\partial p}{\partial Q} + \frac{\partial U_C}{\partial C}\frac{\partial C}{\partial Q} = U_{CG}\left(-N\right)p' + U_{CC} \cdot C_Q = (+)(-)(+) + (-)(+) = (-)$

$\frac{\partial U_L}{\partial Q} = \frac{\partial U_L}{\partial G}\frac{\partial G}{\partial p}\frac{\partial p}{\partial Q} + \frac{\partial U_L}{\partial C}\frac{\partial C}{\partial Q} = U_{LG}\left(-N\right)p' + U_{LC} \cdot C_Q = (+)(-)(+) + (+)(+) = (+/-)$

The change in the marginal value of N due to an increase in quality is also ambiguous, i.e.,

$\frac{\partial \tilde{U}_N}{\partial Q} = (+)(-) + (-)(+) + (+)(+) + (-)(-) + (+/-) = (+/-)$.

Similarly, the change in the marginal value of Q due to an increase in N is also ambiguous, i.e.,

$$\frac{\partial \tilde{U}_Q}{\partial N} = \left(-p'\right)U_G + \left(-p' \cdot N\right)\frac{\partial U_G}{\partial N} + C_Q\frac{\partial U_C}{\partial N} \tag{7.10}$$

$\frac{\partial \tilde{U}_Q}{\partial N} = (-)(+) + (-)(+)(+/-) + (+)(+/-) = (+/-)$

$$\frac{\partial \tilde{U}_Q}{\partial Q} = U_G\left(-p'' \cdot N\right) + \left(-p' \cdot N\right) \cdot \frac{\partial U_G}{\partial Q} + U_C\left(\frac{\partial C_Q}{\partial Q}\right) + C_Q\frac{\partial U_C}{\partial Q} \tag{7.11}$$

Assuming that $p'' \geq 0$ and $\frac{\partial C_Q}{\partial Q} \leq 0$[2] then,

$\frac{\partial \tilde{U}_Q}{\partial Q} = (+)(0/-) + (-)(+) + (+)(0/-) + (+)(-) = (-)$

$$\frac{\partial \tilde{U}_N}{\partial v} = \left(-p \cdot \frac{\partial U_G}{\partial v}\right) + C_N \cdot \frac{\partial U_C}{\partial v} + \frac{\partial U_L}{\partial v} \tag{7.12}$$

[2]These conditions mean marginal cost of increasing child care quality is increasing, and that production function is concave in child care quality.

The signs of the various terms above are as follows:

$\frac{\partial U_G}{\partial v} = U_{GG}\frac{\partial G}{\partial v} + U_{GC}\frac{\partial C}{\partial v} + U_{GL}\frac{\partial L}{\partial v} = U_{GG}(1) + U_{GC}(0) + U_{GL}(0) = U_{GG} = (-)$

$\frac{\partial U_C}{\partial v} = U_{CG} = (+) \quad ; \quad \frac{\partial U_L}{\partial v} = U_{LG} = (+)$

The change in the marginal value of child care hours with an increase in spouse income is,

$\frac{\partial \tilde{U}_N}{\partial v} = (-)(-) + (-)(+) + (+) = (+/-)$. A positive effect occurs, however, if non-maternal care is of a higher quality, i.e., $C_N > 0$, or if cross partials of the utility function are sufficiently small.

The change in the marginal value of child care quality with an increase in spouse income is,

$$\frac{\partial \tilde{U}_Q}{\partial v} = (-p' \cdot N)\frac{\partial U_G}{\partial v} + C_Q\left(\frac{\partial U_C}{\partial v}\right)$$

and is positive, $\frac{\partial \tilde{U}_Q}{\partial v} = (-)(-) + (+)(+) = (+)$.

The change in the marginal value of child care hours with an increase in child care price is,

$$\frac{\partial \tilde{U}_N}{\partial c} = U_G\left(-\frac{\partial p}{\partial c}\right) + \left(-p \cdot \frac{\partial U_G}{\partial c}\right) + C_N\frac{\partial U_C}{\partial c} + \frac{\partial U_L}{\partial c} \tag{7.13}$$

The signs of the various terms above are as follows:

$\frac{\partial U_G}{\partial c} = \frac{\partial U_G}{\partial G}\frac{\partial G}{\partial p}\frac{\partial p}{\partial c} = U_{GG}(-N) = (-)(-) = (+)$

$\frac{\partial U_C}{\partial c} = \frac{\partial U_C}{\partial G}\frac{\partial G}{\partial p}\frac{\partial p}{\partial c} = U_{OG}(-N) = (+)(-) = (-)$

$\frac{\partial U_L}{\partial c} = \frac{\partial U_L}{\partial G}\frac{\partial G}{\partial p}\frac{\partial p}{\partial c} = U_{GG}(-N) = (+)(-) = (-)$

$\frac{\partial \tilde{U}_N}{\partial c} = (+)(-) + (-)(+) + (-)(-) + (-) = (+/-)$. If cross derivatives of the utility function are sufficiently small and/or non-maternal care has a higher quality, then $\frac{\partial \tilde{U}_N}{\partial c}$ would be less than zero.[3]

The change in the marginal value of child care quality with an increase in child care price is,

$$\frac{\partial \tilde{U}_Q}{\partial c} = (-p' \cdot N)\frac{\partial U_G}{\partial c} + C_Q\frac{\partial U_C}{\partial c} \tag{7.14}$$

and is negative, $\frac{\partial \tilde{U}_Q}{\partial c} = (-)(+) + (+)(-) = (-)$.

[3] Child enrichment would be a likely reason for using paid child care even if the mother does not work. If it is the case, then O_N will not be negative and thus $\frac{\partial \tilde{U}_N}{\partial c}$ would be less than zero.

Spouse Income on N

$$\frac{dN}{dv} = -\frac{\det\begin{pmatrix} \frac{\partial \tilde{U}_N}{\partial Q} & \frac{\partial \tilde{U}_N}{\partial v} \\ \frac{\partial \tilde{U}_Q}{\partial Q} & \frac{\partial \tilde{U}_Q}{\partial v} \end{pmatrix}}{\det\begin{pmatrix} \frac{\partial \tilde{U}_N}{\partial Q} & \frac{\partial \tilde{U}_N}{\partial N} \\ \frac{\partial \tilde{U}_Q}{\partial Q} & \frac{\partial \tilde{U}_Q}{\partial N} \end{pmatrix}}$$

$$\frac{dN}{dv} = -\frac{\left(\frac{\partial \tilde{U}_N}{\partial Q}\right)\left(\frac{\partial \tilde{U}_Q}{\partial v}\right) - \left(\frac{\partial \tilde{U}_Q}{\partial Q}\right)\left(\frac{\partial \tilde{U}_N}{\partial v}\right)}{\left(\frac{\partial \tilde{U}_N}{\partial Q}\right)\left(\frac{\partial \tilde{U}_Q}{\partial N}\right) - \left(\frac{\partial \tilde{U}_N}{\partial N}\right)\left(\frac{\partial \tilde{U}_Q}{\partial Q}\right)} \tag{7.15}$$

Since$\left(\frac{\partial \tilde{U}_N}{\partial Q}\right)\left(\frac{\partial \tilde{U}_Q}{\partial N}\right) - \left(\frac{\partial \tilde{U}_N}{\partial N}\right)\left(\frac{\partial \tilde{U}_Q}{\partial Q}\right) = -\left(\tilde{U}_{NN}\tilde{U}_{QQ} - \tilde{U}_{NQ}\tilde{U}_{QN}\right)$ and $\left(\tilde{U}_{NN}\tilde{U}_{QQ} - \tilde{U}_{NQ}\tilde{U}_{QN}\right) > 0$, is a condition for a maximum solution (and if $\tilde{U}$ is concave in N and Q), then the denominator of 7.15 is negative.

Therefore, $\frac{dN}{dv} = -\frac{(-/+)(+)-(-)(+/-)}{-(+)} = \frac{(-/+)(+)-(-)(+/-)}{(+)} = \frac{(-/+)(+)+(+/-)}{(+)} > 0$ if (i) $\frac{\partial \tilde{U}_N}{\partial Q} > 0$ and (ii) $\frac{\partial \tilde{U}_N}{\partial v} > 0$. If the cross partials of the marginal utilities of G, O and L are less than the own partials, then $\frac{\partial \tilde{U}_N}{\partial v}$ would be positive. $\frac{\partial \tilde{U}_N}{\partial Q} > 0$ is also likely if cross partials are less than own partials and if price is not very sensitive to an increase in quality.

Similar with state 2 (mother does not pay for care and does not work) but unlike states 3 and 4, the effect of an increase in v on N is not definite, since the impact of v on Q and Q's effect on N would also have to be considered. $\frac{dN}{dv}$ would be positive if (i) an increase in v would raise the marginal value of N,i.e., $\frac{\partial \tilde{U}_N}{\partial v} > 0$, and (ii) an increase in Q would raise the marginal value of N, i.e., $\frac{\partial \tilde{U}_N}{\partial Q} > 0$. The first condition is similar to the condition in state 2. There is an additional term, however, $(-p * U_{GG} > 0)$, which raises the marginal value of child care hours because of the decline in the marginal utility of consumption. Since child care is being paid for, demand for child care hours is also balanced against household consumption. A higher income therefore means the household has more resources to spend on child care. Whereas when child care was free, more financial resources has no bearing. This makes the possibility of a positive relationship between N and v more likely compared to when child care is free. It also suggests that if effects are negative in both cases, then the negative effect is weaker when the mother pays for care.

The second condition refers to how a higher income would affect child care quality and

how changes in child care quality can influence quantity. Since a higher income raises the marginal utility of child care quality, $\frac{\partial \tilde{U}_Q}{\partial v} > 0$, N and Q must be complementary for N to rise. This would likely occur if higher quality does not raise the cost of child care too much.

Quality-Adjusted Price on N

$$\frac{dN}{dc} = -\frac{\left(\frac{\partial \tilde{U}_N}{\partial Q}\right)\left(\frac{\partial \tilde{U}_Q}{\partial c}\right) - \left(\frac{\partial \tilde{U}_Q}{\partial Q}\right)\left(\frac{\partial \tilde{U}_N}{\partial c}\right)}{\left(\frac{\partial \tilde{U}_N}{\partial Q}\right)\left(\frac{\partial \tilde{U}_Q}{\partial N}\right) - \left(\frac{\partial \tilde{U}_N}{\partial N}\right)\left(\frac{\partial \tilde{U}_Q}{\partial Q}\right)} \tag{7.16}$$

$\frac{dN}{dc} = -\frac{(+/-)(-)-(-)(+/-)}{-(+)} < 0$ if $\frac{\partial \tilde{U}_N}{\partial Q} > 0$ and (ii) $\frac{\partial \tilde{U}_N}{\partial c} < 0$.

(or it should really be, $\frac{dN}{dc} = -\frac{(+/-)(-)-(-)(-)}{-(+)} = \frac{(+/-)(-)+(-)}{(+)} =< 0$ if $\frac{\partial \tilde{U}_N}{\partial Q} > 0$

An increase in the quality-adjusted price, c,would reduce non-maternal care hours if $\frac{\partial \tilde{U}_N}{\partial Q} > 0$. Non-maternal care hours would fall because the higher cost reduces the marginal utility of leisure and raises the marginal utility of consumption. The higher cost, however, could also lead to a reduction in the quality of child care used since the marginal rate of substitution between consumption and child outcome increases. The condition $\frac{\partial \tilde{U}_N}{\partial Q} > 0$ guarantees $\frac{dN}{dc} < 0$ if child care quality declines.

Spouse Income on Q

$$\frac{dQ}{dv} = -\frac{\left(\frac{\partial \tilde{U}_N}{\partial N}\right)\left(\frac{\partial \tilde{U}_Q}{\partial v}\right) - \left(\frac{\partial \tilde{U}_Q}{\partial N}\right)\left(\frac{\partial \tilde{U}_N}{\partial v}\right)}{\left(\frac{\partial \tilde{U}_N}{\partial N}\right)\left(\frac{\partial \tilde{U}_Q}{\partial Q}\right) - \left(\frac{\partial \tilde{U}_N}{\partial Q}\right)\left(\frac{\partial \tilde{U}_Q}{\partial N}\right)} \tag{7.17}$$

$\frac{\partial \tilde{U}_N}{\partial N} < 0$ and $\left[\left(\frac{\partial \tilde{U}_N}{\partial N}\right)\left(\frac{\partial \tilde{U}_Q}{\partial Q}\right) - \left(\frac{\partial \tilde{U}_N}{\partial Q}\right)\left(\frac{\partial \tilde{U}_Q}{\partial N}\right)\right] > 0$ are conditions for a maximum (and satisfied if $\tilde{U}$ is concave in N and Q). Therefore, $\frac{dQ}{dv} = -\frac{(-)(+)-(+/-)(+/-)}{(+)} > 0$ if (i) $\frac{\partial \tilde{U}_Q}{\partial N} > 0$ and (ii) $\frac{\partial \tilde{U}_N}{\partial v} > 0$. (i) is satisfied if quality is not a big factor in the price function and (ii) is satisfied if cross derivatives of the marginal utilities are less than own derivatives.

The effect of an increase in v on Q is not clear because the price of quality depends on how much quantity is going to be consumed. However, effect of v on Q would be positive if $\left(\frac{\partial \tilde{U}_Q}{\partial N}\frac{\partial \tilde{U}_N}{\partial v}\right) > 0$. The intuition behind this condition is that if a higher income raises the marginal value of non-maternal care hours (which can lead to higher N, all other things constant) then the higher N should make consuming more child care quality more appealing for Q to increase. When the mother does not work but pays for care, it is likely that an

increase in income raises the marginal utility of N (since she would like to have more leisure). Then child care quality would also increase if $\frac{\partial \tilde{U}_Q}{\partial N} > 0$.

Quality-Adjusted Price on Q

$$\frac{dQ}{dc} = -\frac{\left(\frac{\partial \tilde{U}_N}{\partial N}\right)\left(\frac{\partial \tilde{U}_Q}{\partial c}\right) - \left(\frac{\partial \tilde{U}_N}{\partial c}\right)\left(\frac{\partial \tilde{U}_Q}{\partial N}\right)}{\left(\frac{\partial \tilde{U}_N}{\partial N}\right)\left(\frac{\partial \tilde{U}_Q}{\partial Q}\right) - \left(\frac{\partial \tilde{U}_N}{\partial Q}\right)\left(\frac{\partial \tilde{U}_Q}{\partial N}\right)} \tag{7.18}$$

$\frac{dQ}{dc} = -\frac{(-)(-)-(+/-)(+/-)}{(+)} = \frac{(-)+(+/-)(+/-)}{(+)} < 0$ if $\frac{\partial \tilde{U}_Q}{\partial N} > 0$ and (ii) $\frac{\partial \tilde{U}_N}{\partial c} < 0$.
(or should it be $\frac{dQ}{dc} = -\frac{(-)(-)-(-)(+/-)}{(+)} = \frac{(-)+(-)(+/-)}{(+)} < 0$ if $\frac{\partial \tilde{U}_Q}{\partial N} > 0$.)

Since $\frac{\partial \tilde{U}_N}{\partial c} < 0$ is very likely to hold in this state[4], then quality falls if quantity and quality are complementary.

7.3.4 State 7 or 8

When the mother is working and pays for child care, her budget constraint is

$$G = (w - p(Q)) \cdot N - w\bar{L} + v$$

and leisure is fixed to $\bar{L}$. The household solves

$$\underset{N,Q}{Max}\ \tilde{U} = U\left[(w - p(Q)) \cdot N - w\bar{L} + v, C(Q, N), \bar{L}\right]$$

First order conditions are:

$$\frac{\partial \tilde{U}}{\partial N} = U_G \cdot (w - p) + U_C \cdot C_N = 0$$
$$\frac{\partial \tilde{U}}{\partial Q} = U_G \cdot (-p' \cdot N) + U_C \cdot C_Q = 0$$

The first order conditions tell us that the benefit of increasing non-maternal care hours is an increase in consumption, G, while the cost is lower child outcome (if maternal care is of higher quality). The second first order condition tells us that the benefit of buying more quality is to improve child outcome and the cost is lower household consumption.

[4] Child enrichment would be a likely reason for using paid child care even if the mother does not work. If it is the case, then O_N will not be negative and thus $\frac{\partial \tilde{U}_N}{\partial c}$ would be less than zero.

Comparative Statics

Solutions for the partial effects of v, w and c on N and Q were derived using the Implicit Function Theorem for two endogenous variables.

Let $\tilde{U}_N = \frac{\partial \tilde{U}}{\partial N}$and $\tilde{U}_Q = \frac{\partial \tilde{U}}{\partial Q}$. The following equations, and their signs, will be needed to determine the different partial effects.

$\frac{\partial U_C}{\partial N} = \frac{\partial U_C}{\partial G}\frac{\partial G}{\partial N} + \frac{\partial U_C}{\partial C}\frac{\partial C}{\partial N} = U_{CG} \cdot (w-p) + U_{CC} \cdot C_N = (+)(+) + (-)(-) = (+)$

$\frac{\partial U_G}{\partial N} = \frac{\partial U_G}{\partial G}\frac{\partial G}{\partial N} + \frac{\partial U_G}{\partial C}\frac{\partial C}{\partial N} = U_{GG} \cdot (w-p) + U_{GC} \cdot C_N = (-)(+) + (+)(-) = (-)$

$\frac{\partial U_C}{\partial Q} = \frac{\partial U_C}{\partial G}\frac{\partial G}{\partial Q} + \frac{\partial U_C}{\partial C}\frac{\partial C}{\partial Q} = U_{CG} \cdot (-N)(p') + U_{CC} \cdot C_Q = (+)(-)(+) + (-)(+) = (-)$

$\frac{\partial U_G}{\partial Q} = \frac{\partial U_G}{\partial G}\frac{\partial G}{\partial Q} + \frac{\partial U_G}{\partial C}\frac{\partial C}{\partial Q} = U_{GG} \cdot (-N)(p') + U_{GC} \cdot C_Q = (-)(-)(+) + (+)(+) = (+)$

The change in the marginal value of child care hours with an increase in quality is,

$$\frac{\partial \tilde{U}_N}{\partial Q} = -p' \cdot U_G + (w-p) \cdot \frac{\partial U_G}{\partial Q} + U_C\left(\frac{\partial C_N}{\partial Q}\right) + C_N \frac{\partial U_C}{\partial Q}. \tag{7.19}$$

The expected effect is ambiguous, i.e., $\frac{\partial \tilde{U}_N}{\partial Q} = (-)(+) + (+)(+) + (+)(+) + (-)(-) = (-) + (+) + (+) + (+) = (+/-)$. While the increase in quality reduces the negative effect of child care hours ($\frac{\partial O_N}{\partial Q} < 0$), and raises the marginal utility of consumption, both of which enhances the marginal value of working, the increase in quality, however, also raises the marginal cost of working given the higher cost of child care.

The change in the marginal value of child care quality with an increase in quality is,

$$\frac{\partial \tilde{U}_Q}{\partial Q} = (-p' \cdot N) \cdot \frac{\partial U_G}{\partial Q} + C_Q \frac{\partial U_C}{\partial Q} \tag{7.20}$$

and is negative, $\frac{\partial \tilde{U}_Q}{\partial Q} = (-)(+) + (+)(-) = (-)$, because an increase in quality raises the marginal utility of household consumption but reduces the marginal utility of child outcome.

The change in the marginal value of child care hours with an increase in hours is,

$$\frac{\partial \tilde{U}_N}{\partial N} = (w-p)\frac{\partial U_G}{\partial N} + C_N \frac{\partial U_C}{\partial N},$$

and is negative, i.e., $\frac{\partial \tilde{U}_N}{\partial N} = (+)(-) + (-)(+) = (-)$, because an increase in quantity reduces the marginal utility of household consumption but raises the marginal utility of child outcome.

The effect of higher child care hours on quality, given below, is ambiguous.

$$\frac{\partial \tilde{U}_Q}{\partial N} = (-p')\, U_G + (-p' \cdot N)\, \frac{\partial U_G}{\partial N} + C_Q \frac{\partial U_C}{\partial N}. \tag{7.21}$$

$\frac{\partial \tilde{U}_Q}{\partial N} = (-)(+) + (-)(-) + (+)(+) = (+/-)$. Whereas, an increase in N raises the marginal utility of child outcome and reduces that of household consumption, both of which improve the marginal value of child outcome, greater quantity, however, means that the implicit cost of raising child care quality has also increased (the term $-p'U_G$). The latter effect dampens the value of child care quality.

The change in the marginal value of child care hours due to an increase in spouse income is,

$$\frac{\partial \tilde{U}_N}{\partial v} = (w - p)\, \frac{\partial U_G}{\partial v} + C_N \frac{\partial U_C}{\partial v} \tag{7.22}$$

and is negative, i.e., $\frac{\partial \tilde{U}_N}{\partial v} = (+)(-) + (-)(+) = (-)$, in contrast to states 5 or 6 where it is positive. With higher family income, household consumption increases, and there is less need for the mother to work as much as before.

The change in the marginal value of child care quality due to an increase in spouse income is,

$$\frac{\partial \tilde{U}_Q}{\partial v} = (-p' \cdot N)\, \frac{\partial U_G}{\partial v} + C_Q \frac{\partial U_C}{\partial v} \tag{7.23}$$

and positive, i.e., $\frac{\partial \tilde{U}_Q}{\partial v} = (-)(-) + (+)(+) = (+)$, similar to states 5 or 6.

Similar to state 3 (non-paying-working state), the effect of higher wage on the marginal value of work/child care hours is ambiguous.

$$\frac{\partial \tilde{U}_N}{\partial w} = U_G + (w - p)\, \frac{\partial U_G}{\partial w} + C_N \frac{\partial U_C}{\partial w} \tag{7.24}$$

$\frac{\partial U_G}{\partial w} = \frac{\partial U_G}{\partial G}\frac{\partial G}{\partial w} = U_{GG} \cdot N = (-)(+) = (-)$
$\frac{\partial U_C}{\partial w} = \frac{\partial U_C}{\partial G}\frac{\partial G}{\partial w} = U_{CG} \cdot N = (+)(+) = (+)$
$\frac{\partial \tilde{U}_N}{\partial w} = (+) + (+)(-) + (-)(+) = (+/-)$.

The effect of higher wage on the marginal value of child care quality, on the other hand, is positive.

$$\frac{\partial \tilde{U}_Q}{\partial w} = (-p' \cdot N)\, \frac{\partial U_G}{\partial w} + C_Q \frac{\partial U_C}{\partial w} \tag{7.25}$$

$\frac{\partial \tilde{U}_Q}{\partial w} = (-)(-) + (+)(+) = (+)$. The higher income from the increase in wage raises the marginal utility of child quality but reduces the marginal utility of household consumption.

Similar to wage changes, the effect of a change in child care price on work hours is not clear.

$$\frac{\partial \tilde{U}_N}{\partial c} = U_G\left(-\frac{\partial p}{\partial c}\right) + (w-p)\frac{\partial U_G}{\partial c} + C_N\frac{\partial U_C}{\partial c} \tag{7.26}$$

$\frac{\partial U_G}{\partial c} = U_{GG}(-N) = (+)$

$\frac{\partial U_C}{\partial c} = U_{CG}(-N) = (-)$

$\frac{\partial \tilde{U}_N}{\partial c} = (+)(-)+(+)(+)+(-)(-) = (+/-)$. Whereas the higher price reduces the benefit of working (the substitution effect), the higher child care price makes the household poorer and encourages the mother to work more.

The effect on child care quality, on the other hand, is negative.

$$\frac{\partial \tilde{U}_Q}{\partial c} = (-p'N)\cdot\frac{\partial U_G}{\partial c} + C_Q\frac{\partial U_C}{\partial c} \tag{7.27}$$

$\frac{\partial \tilde{U}_Q}{\partial c} = (-)(+) + (+)(-) = (-)$

Spouse Income on N

$$\frac{dN}{dv} = -\frac{\left(\frac{\partial \tilde{U}_N}{\partial Q}\right)\left(\frac{\partial \tilde{U}_Q}{\partial v}\right) - \left(\frac{\partial \tilde{U}_N}{\partial v}\right)\left(\frac{\partial \tilde{U}_Q}{\partial Q}\right)}{\left(\frac{\partial \tilde{U}_N}{\partial Q}\right)\left(\frac{\partial \tilde{U}_Q}{\partial N}\right) - \left(\frac{\partial \tilde{U}_N}{\partial N}\right)\left(\frac{\partial \tilde{U}_Q}{\partial Q}\right)} \tag{7.28}$$

Since $\left(\frac{\partial \tilde{U}_N}{\partial Q}\right)\left(\frac{\partial \tilde{U}_Q}{\partial N}\right) - \left(\frac{\partial \tilde{U}_N}{\partial N}\right)\left(\frac{\partial \tilde{U}_Q}{\partial Q}\right) = -\left(\tilde{U}_{NN}\tilde{U}_{QQ} - \tilde{U}_{NQ}\tilde{U}_{QN}\right)$ and $\left(\tilde{U}_{NN}\tilde{U}_{QQ} - \tilde{U}_{NQ}\tilde{U}_{QN}\right) > 0$ if $\tilde{U}$ is concave in N and Q, then the denominator of 7.28 is negative.

Therefore, $\frac{dN}{dv} = -\frac{(-/+)(+)-(-)(-)}{-(+)} = \frac{(-/+)(+)-(+)}{(+)} < 0$ if $\frac{\partial \tilde{U}_N}{\partial Q} < 0$ or if $\left|\left(\frac{\partial \tilde{U}_N}{\partial Q}\right)\left(\frac{\partial \tilde{U}_Q}{\partial v}\right)\right| < \left|\left(\frac{\partial \tilde{U}_N}{\partial v}\right)\left(\frac{\partial \tilde{U}_Q}{\partial Q}\right)\right|$.

A higher spouse income will lower child care hours on the condition that child care quality and quantity are substitutes, $\frac{\partial \tilde{U}_N}{\partial Q} < 0$, in contrast to the non-paying-working state where an increase in v will definitely lead to lower child care hours. Nevertheless, even if this condition is not satisfied, the effect will still be negative so long as the $\left|\left(\frac{\partial \tilde{U}_N}{\partial Q}\right)\left(\frac{\partial \tilde{U}_Q}{\partial v}\right)\right| < \left|\left(\frac{\partial \tilde{U}_N}{\partial v}\right)\left(\frac{\partial \tilde{U}_Q}{\partial Q}\right)\right|$. This means that the fall in the marginal value of N, because of the decline

in the marginal utility of consumption and an increase in the marginal utility of child quality, should outweigh the improvement in the marginal value of N coming from a rise in child care quality. Because of this we expect that the negative impact of a higher spouse income on child care hours would be weaker when the household pays for care than when child care is used for free.

Wage on N

$$\frac{dN}{dw} = -\frac{\left(\frac{\partial \tilde{U}_N}{\partial Q}\right)\left(\frac{\partial \tilde{U}_Q}{\partial w}\right) - \left(\frac{\partial \tilde{U}_N}{\partial w}\right)\left(\frac{\partial \tilde{U}_Q}{\partial Q}\right)}{\left(\frac{\partial \tilde{U}_N}{\partial Q}\right)\left(\frac{\partial \tilde{U}_Q}{\partial N}\right) - \left(\frac{\partial \tilde{U}_N}{\partial N}\right)\left(\frac{\partial \tilde{U}_Q}{\partial Q}\right)} \tag{7.29}$$

$\frac{dN}{dw} = -\frac{(-/+)(+)-(-)(+/-)}{-(+)} = \frac{(-/+)(+)+(+/-)}{(+)} = \frac{(+/-)}{(+)}$.

A higher wage will raise work/child care hours if (i) $\frac{\partial \tilde{U}_N}{\partial w} > 0 \iff U_G > |(w-p)\cdot N\left(U_{GG}\right) + C_N \cdot N\left(U_{CG}\right)|$ and (ii) $\frac{\partial \tilde{U}_N}{\partial Q} > 0$. The first condition is similar to the condition when mother works but does not pay for care, which involves a substitution and income effects of working. The second condition, on the other hand, recognizes that the marginal value of child care quality increases with w. Thus for N to rise with Q,it must be that an increase in quality improves the marginal value of child care hours, $\frac{\partial \tilde{U}_N}{\partial Q} > 0$. If child care price is sufficiently low and if quality is not a big component of child care price then this condition would be satisfied. The reason is that the increase in Q would not raise the marginal cost of N too much.

When (ii) is satisfied but (i) is not, $\frac{dN}{dw}$ can still be positive so long as the positive impact of a higher child care quality on the marginal value of N, outweighs the negative effect of w on the marginal value of N. That is, if $\left(\frac{\partial \tilde{U}_N}{\partial Q}\right)\left(\frac{\partial \tilde{U}_Q}{\partial w}\right) > \left|\left(\frac{\partial \tilde{U}_N}{\partial w}\right)\left(\frac{\partial \tilde{U}_Q}{\partial Q}\right)\right|$.Thus it is more likely to observe $\frac{dN}{dw}$ to be positive when the household pays for child care than when they do not. The intuition is that because child care quality is not fixed when household pays for care, then the mother can raise the quality of child care used when their financial situation improves and this reduces the marginal cost of working.[5] When the mother does not pay for care this is not possible.

[5] The cost of work and non-maternal care hours is lower child outcome.

Quality-Adjusted Price on N

$$\frac{dN}{dc} = -\frac{\left(\frac{\partial \tilde{U}_N}{\partial Q}\right)\left(\frac{\partial \tilde{U}_Q}{\partial c}\right) - \left(\frac{\partial \tilde{U}_N}{\partial c}\right)\left(\frac{\partial \tilde{U}_Q}{\partial Q}\right)}{\left(\frac{\partial \tilde{U}_N}{\partial Q}\right)\left(\frac{\partial \tilde{U}_Q}{\partial N}\right) - \left(\frac{\partial \tilde{U}_N}{\partial N}\right)\left(\frac{\partial \tilde{U}_Q}{\partial Q}\right)} \tag{7.30}$$

$\frac{dN}{dc} = -\frac{(-/+)(-)-(-)(+/-)}{-(+)} = \frac{(-/+)(-)-(-)(+/-)}{(+)} = \frac{(-/+)(-)+(+/-)}{(+)}$. Thus $\frac{dN}{dc} < 0$ if (i) $\frac{\partial \tilde{U}_N}{\partial Q} > 0$ and (ii) $\frac{\partial \tilde{U}_N}{\partial c} < 0 \implies U_G\left(-\frac{\partial p}{\partial c}\right) + (w-p)\frac{\partial U_G}{\partial c} + C_N\frac{\partial U_O}{\partial c} < 0 \implies |-U_G| > (w-p) \cdot U_{GG}(-N) + C_N \cdot U_{CG}(-N)$.

An increase in the quality-adjusted price of child care, c, can have an ambiguous impact on child care hours similar to the wage effects. While it will reduce net wage and the rewards to working, there is a counteracting income effect (an increase in U_G) and a decline in U_C, which makes work/child care hours more attractive. Thus $\frac{dN}{dc} < 0$ if $\frac{\partial \tilde{U}_N}{\partial c} < 0$. The implication is that a negative price effect would be weaker when the mother is working than when she is not.

Spouse Income on Q

$$\frac{dQ}{dv} = -\frac{\left(\frac{\partial \tilde{U}_N}{\partial N}\right)\left(\frac{\partial \tilde{U}_Q}{\partial v}\right) - \left(\frac{\partial \tilde{U}_N}{\partial v}\right)\left(\frac{\partial \tilde{U}_Q}{\partial N}\right)}{\left(\frac{\partial \tilde{U}_N}{\partial N}\right)\left(\frac{\partial \tilde{U}_Q}{\partial Q}\right) - \left(\frac{\partial \tilde{U}_N}{\partial Q}\right)\left(\frac{\partial \tilde{U}_Q}{\partial N}\right)}$$

$\frac{dQ}{dv} = -\frac{(-)(+)-(-)(+/-)}{(+)} = \frac{(+)+(-)(+/-)}{(+)} > 0$ if $\frac{\partial \tilde{U}_Q}{\partial N} < 0$. This condition is the exact opposite of the condition when the mother is not working, since in this state $\frac{\partial \tilde{U}_N}{\partial v} < 0$, whereas in the non-working-paying states it is $\frac{\partial \tilde{U}_N}{\partial v} > 0$. The logic here is that since non-maternal care hours is likely to decline with an increase in v when the mother is working then $\frac{\partial \tilde{U}_Q}{\partial N}$ need to be negative for child care quality to increase. This reversal of condition stems from the change in the purpose for using non-maternal care. Whereas in the paying-non-working states, it is consumed for mother's leisure time and/or child improvement, while in the working states it is used to raise consumption.)

If this condition is not satisfied, then we can get an odd result where higher income leads to lower quality of child care used. The reason is that since N declines with v, child outcome can already be raised from this change alone. If the mother feels that the level of

child outcome achieved is sufficient, then she might cut back on child care quality to reduce her child care expense and thus raise household consumption further.

Wage on Q

$$\frac{dQ}{dw} = -\frac{\left(\frac{\partial \tilde{U}_N}{\partial N}\right)\left(\frac{\partial \tilde{U}_Q}{\partial w}\right) - \left(\frac{\partial \tilde{U}_N}{\partial w}\right)\left(\frac{\partial \tilde{U}_Q}{\partial N}\right)}{\left(\frac{\partial \tilde{U}_N}{\partial N}\right)\left(\frac{\partial \tilde{U}_Q}{\partial Q}\right) - \left(\frac{\partial \tilde{U}_Q}{\partial N}\right)\left(\frac{\partial \tilde{U}_N}{\partial Q}\right)} \tag{7.31}$$

$\frac{dQ}{dw} = -\frac{(-)(+)-(+/-)(+/-)}{(+)} = \frac{(+)+(+/-)(+/-)}{(+)}$.

Higher w leads greater quality of care used if $\left(\frac{\partial \tilde{U}_Q}{\partial N} \cdot \frac{\partial \tilde{U}_N}{\partial w}\right) > 0$. If $\frac{\partial \tilde{U}_N}{\partial w} < 0$, that is, the substitution effect of working outweighs the income effect, and if child care quality and quantity are complements, then we can observe situations where greater income leads to lower child care quality used.

Quality-Adjusted Price on Q

$$\frac{dQ}{dc} = -\frac{\left(\frac{\partial \tilde{U}_N}{\partial N}\right)\left(\frac{\partial \tilde{U}_Q}{\partial c}\right) - \left(\frac{\partial \tilde{U}_N}{\partial c}\right)\left(\frac{\partial \tilde{U}_Q}{\partial N}\right)}{\left(\frac{\partial \tilde{U}_N}{\partial N}\right)\left(\frac{\partial \tilde{U}_Q}{\partial Q}\right) - \left(\frac{\partial \tilde{U}_N}{\partial Q}\right)\left(\frac{\partial \tilde{U}_Q}{\partial N}\right)} \tag{7.32}$$

$\frac{dQ}{dc} = -\frac{(-)(-)-(+/-)(+/-)}{(+)} = \frac{(-)+(+/-)(+/-)}{(+)}$. Thus, $\frac{dQ}{dc} < 0$ if (i)$\frac{\partial \tilde{U}_Q}{\partial N} > 0$ and (ii) $\frac{\partial \tilde{U}_N}{\partial c} < 0$.

Similar to the argument above for the effect of child care price on child care hours, we anticipate that the negative effect of price on quality is weaker when the mother works than when she does not.