The Effect of Child Care Subsidies on the Employment of Mothers

by Miriam Larson-Koester

under the Direction of

Professor Michael Robinson

A Thesis

Submitted to the Faculty of Mount Holyoke College

in partial Fulfillment of the Requirements for the Degree of

Bachelor of Arts with Honors

Economics Department

Mount Holyoke College

South Hadley, MA 01075

May 2012

ACKNOWLEDGEMENTS

Above all I would like to thank Mike Robinson for advising this project, including sharing his passion and time through many insightful conversations. I would also like to thank the economics department for being wonderfully supportive throughout my career at Mount Holyoke, especially Dawn Larder for going above and beyond the call of duty in her work. I owe a special thank you to Jim Hartley for his helpful advice throughout the year, and to Sarah Adelman for her help and support. I would also like to express gratitude to Fran Deutsch in psychology and Janice Gifford in statistics for taking the time to talk with me and give me a new perspective on my work. Lastly, I thank my family and friends for all their support this year.

ABSTRACT

Women's labor force participation has skyrocketed in the past half-decade. With this shift, the demand for child care has also risen dramatically. Women increasingly need child care during work hours, whether it be from a relative, a family day-care or child care center. From an economic perspective, paid child care adds to the cost of employment. Thus child care cost may be a disincentive to employment especially affecting women as primary care-givers in the home.

Current welfare policy in the United States includes child care subsidies as a crucial tool intended to facilitate the employment of low-income mothers. Since the 1996 welfare reform, employment is a required goal for welfare participants, making child care subsidies ever more important to the extent that they may encourage or even enable employment.

Many past studies have tried to measure the effect of the price of child care on employment. However, subsidies are in many ways less effective than a reduction in the price of all child care. Not many people know about them, many people who apply are waitlisted or rationed out of the system even if they are eligible, there are bureaucratic delays, and there is stigma associated with taking up a subsidy. To find out whether or not subsidies increase employment in reality, I chose to examine the effect of actual subsidy receipt on employment.

Although the theoretical effect of subsidies on employment is clear, a causal effect is difficult to discern in the data. The difficulty lies in that women are often required to be employed to receive child care subsidies in the first place, and women who are likely to work may also be likely to get subsidies due to any number of unobserved personal characteristics, such as energy or intelligence.

Using data from the National Survey of America's Families of 2002, I applied a number of econometric models to explore the relationship between subsidies and employment. I found that obtaining a child care subsidy increases employment by 28% using a two-stage least squares model, 42% using a bivariate probit model, and 23% using propensity score matching, though the result was not significant for the first model. These results confirm for the most part a positive relationship that may be causal.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Child care subsidies are viewed as an important policy tool to increase the labor force participation of women, especially of low-income mothers. Economic theory predicts that child care cost is a deterrent to employment and empirically it has been observed women with children under the age of six are least likely to be employed compared to other women (Han and Waldfogel, 2001). This gap may be due to child care cost as a disincentive to employment, as predicted by theory. Assuming no market failures and an effective system of administering subsidies, child care subsidies should reduce the disincentive to be employed, and result in increased employment for mothers.

The role of child care subsidies as a tool to encourage employment has been further emphasized in recent years as a result of demographic shifts and the Personal Responsibility and Work Act (PRWORA) of 1996. The employment of single mothers with children has continued to increase (Hoffman, 2009), while an ever higher number of welfare recipients are single mothers. In addition, under PRWORA employment became a more central goal of welfare. Thus since 1996, welfare policy has focused intently on reducing the disincentive to work caused

by the cost of child care through child care subsidies (Han and Waldfogel, 2001). If subsidies do encourage employment, they also have the potential to reduce reliance on welfare, another central welfare goal, and improve the mental health of their recipients by allowing employment outside the home (Rosenfield 1989).

Given the large role of child care subsidies in welfare policy, and the potential positive benefits from the employment of low-income mothers, it is important to study whether or not and to what extent subsidies actually increase employment. A number of factors could temper or even eliminate the expected effect on employment, including rationing, a difficult application process and preferences. In this thesis I test whether and to what extent child care subsidies increase the employment of mothers of children under six. Data from the 2002 National Survey of America's Families (NSAF) were used in order to estimate a direct effect of subsidy receipt on employment rather than an indirect price elasticity, as often done in the literature. This analysis adds to the literature in that it included a bivariate probit and propensity matching model, which are very rare within the literature measuring the direct effect of subsidy receipt[1]. These models, respectively, may give better probability estimates of the effect of subsidies on employment, and more effectively control for self selection.

In addition, this analysis attempts to capture the effect for a specific demographic: mothers of children under the age of six. This group should

[1] Cox (2009) used a bivariate probit model, but in the larger context of Full Information Maximum Likelihood and a rationing equation. Propensity score matching has not been attempted to the knowledge of the author.

theoretically be more sensitive to the cost of child care because of the lack of free public school for children under five. The sample also includes both single and married mothers, uncommon in the literature. The models were also run for samples of single mothers, and poor mothers and fathers, offering interesting motivation for future work.

The results of the three models indicate that subsidy receipt increases the probability of employment of mothers by a positive, but not necessarily significant, amount. Effects of subsidy receipt on employment obtained from the two-stage least squares, bivariate probit and propensity score matching models were 28%, 42% and 23% respectively, but insignificant in the case of the two-stage least squares model. A positive effect is in line with the vast majority of previous literature on this subject. Thus this thesis is in agreement with previous literature in suggesting that child care subsidies may be an effective tool to encourage the employment of mothers.

The structure of the thesis is as follows: Section 1.1 gives a brief history and overview of child care policy in the U.S.; Section 1.2 establishes an economic model of child care; Section 1.3 mentions several criticisms of child care subsidy policy in an economic framework; Chapter 2 reviews the literature on this topic; Section 2.1 review literature that treats relevant related questions; Section 3.1 describes the NSAF data; Section 3.2 introduces the difficulties in determining the effects of subsidies on employment empirically; Section 3.3 describes the models using instrumental variables to capture the relationship; Section 3.4 introduces a

propensity score matching model to address the same question; Section 3.5 estimates the models on different populations; Chapter 4 analyzes the results of the empirical section; and Chapter 5 concludes with a discussion of the relevance of the results.

1.1 Overview of U.S. Child Care Policy

Policy to reduce child care cost comes either in the form of government provision of child care or subsidies to the private market. Unlike many countries in Europe (Blau and Tekin, 2007), the U.S. government is not a supplier of child care, but rather funds demand-side means-tested subsidies under the order of the Personal Responsibility and Work Opportunity Act (PRWORA) and through the Child Care and Development Fund (CCDF). These programs are operated by each state individually, with considerable freedom with regard to eligibility requirements, amount of subsidy (usually a means-tested sliding-scale), and characteristics of eligible providers, including measures of quality. Unfortunately, only about 15% of children nationwide eligible to receive subsidies actually receive them. The gap is due partly to lack of information about subsidies and partly to rationing (Cox, 2009).

The PWRORA is part of the welfare reform act of 1996. It replaced various previous child care funding programs, such as Aid to Families with Dependent Children (AFDC) and the Child Care Development Block Grant with the single CCDF funding source (Connelly and Kimmel, 2001). The PWRORA is

strongly pro-employment, meaning that many people who could have received welfare without working before the reform are more likely to need to work to continue on welfare. Thus it is important to study the effects of subsidies on employment after the welfare reform, as we would expect them to be larger than the previous effects.

Other policies in place to encourage employment of the low-income single mother demographic include the Earned Income Tax Credit and other child-based tax incentives. Such policies can be compared in terms of effectiveness and cost-efficiency to the child care subsidy program, and the literature on this topic is reviewed below, however this comparison is not the primary focus of this paper.

Child care costs comprise a large proportion of the budget of low-income families who pay for care, 25% according to Blau (2001). Thus child care costs could be an especially critical factor in discouraging employment among low-income women with children in comparison to higher income women. Thus subsidies in the U.S. are means-tested to target those in the lower income brackets, for whom the cost of child care is most prohibitive to employment.

The ultimate welfare policy goal of subsidies is to move low-income families off of welfare and to allow them to achieve self-sufficiency.[2] Therefore the value of employment for low-income single mothers merits some discussion.

[2] Two studies have been done on the effect of subsidies on welfare receipt using national data. Blau and Tekin 2007 found no significant effect of subsidies on welfare participation. Connelly and Kimmel 2001 however found that an decrease in the price of child care through AFDC subsidy does lead to lower welfare participation. For a more comprehensive review see Connelly and Kimmel 2001.

It is unclear as to whether the type of work available to this population without further training has an impact on long-term welfare and income growth, given that it is low-paying and with little possibility of promotion[3] (Blau, 2001; Tekin, 2004). However the connection to long-term welfare is only the second link in the chain. First we must determine to what extent child care subsidies increase employment in this subgroup.

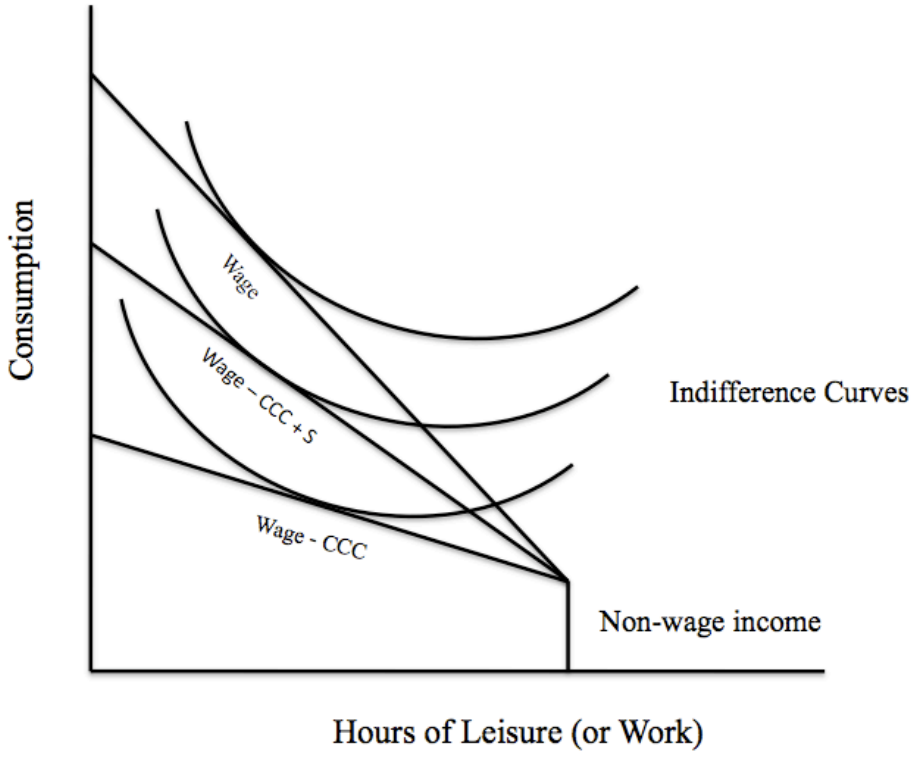
1.2 Theoretical Model

A very simple labor supply model (see Figure 1) assumes that all mothers must purchase child care in order to work (there is no free informal care available) and pay a fixed cost per hour of child care. The mother then chooses a bundle of consumption and leisure to maximize her utility given a budget constraint based on the relative price of leisure (wage) and consumption. In this model the wage is effectively lowered by the price per hour of child care, lowering the budget constraint and thus the consumption benefit of working more hours. A child care subsidy counters this effect to the extent that it eliminates the extra cost of working imposed by paying for child care. Usually subsidies do not cover 100% of the cost of child care, however, and thus the effect is only a partial return to the labor supply decision before the child.

[3] There may also be short term benefits to employment, notably improved mental health from some work outside the home
(Rosenfield, 1989).

This simple labor supply model can be made more realistic by relaxing the assumptions made above and including a number of complicating factors. One aspect of reality that should be taken into consideration in the model is the fact that subsidies are generally non-linear (Blau, 2003). Means-tested subsidies, being sliding-fee, decrease with increasing household income. Thus the reduction in the disincentive to work is different for women at different income levels.

Figure 1
Basic Labor Supply Model with Child Care Cost (CCC) and Subsidies (S)



In addition the eligibility requirements for subsidies produce a number of non-linearities in the budget constraint. First, states set a maximum income level, usually as a percentage of the poverty line by family size, as well as certain employment or education requirements to determine eligibility. Thus mothers close to the income cut-off may have an incentive to reduce their work hours (to some arbitrary threshold) in order to keep their income low enough to be eligible, and mothers close to the employment requirement threshold may have an incentive to keep employment above the cut-off. There are also other issues would alter or invalidate this model, such as rationing and difficult to measure costs of subsidy take-up, which will be discussed in more detail below.

Another key assumption of the simple model is that there is no informal care available. In reality, informal care is often available, and in this case the mother's choice between the simple budget constraints of Figure 1 is more complicated. In this case she is simultaneously deciding how much to pay for care and how much to work, and the subsidy may induce her to move from informal care to paid care because of the opportunity cost of informal care (e.g. husband or other relative is at home and not earning).

This example also illustrates that if the labor supply decision is made at a household level, the outcome may differ from the decision that would be made at the individual level. For instance the household budget constraint includes the income of other members of the household and other sources of non-wage income

available to the mother, as well as the preferences of other household members for leisure and consumption and taking care of children.

Another complicating factor is variation in the utility of the mother (and household) based on the perceived quality of care from different sources. For example, if the perceived quality of subsidized care is higher (perhaps because centers are required to meet certification standards to accept subsidies) the mother is more likely to work than if the quality of mother-care is higher.

There is also the possibility that the mother will choose to use subsidized center care without working due to preferences for leisure and center care and if eligibility requirements are not strictly enforced.

1.2.1 Criticisms of the Child Care Subsidies Approach

One of the main criticisms of using child care subsidies to encourage employment is that doing so could be detrimental to another important policy goal, which is promoting child development through high quality child care. Theoretically, policies to increase employment are unlikely to increase the use of high quality care and vice versa. For example, a subsidy only to high quality care centers may not increase employment if the subsidized price is still higher than the price of low quality care. A subsidy across all levels of quality (the most efficient way to encourage employment) may actually increase the use of low quality care if quantity and quality are substitutes (Blau, 2003). In agreement with

this proposition, Blau and Hagy (1998) found that lowering the price of care causes substitution away from quality care.

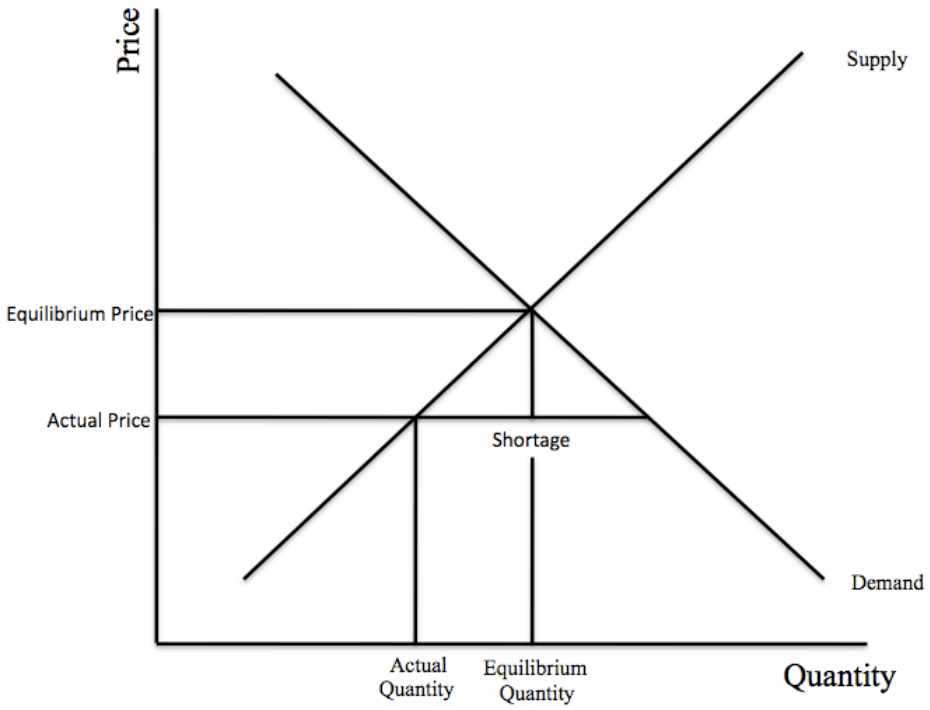
However, most evidence indicates that subsidies to promote employment increase or do not alter the quality of care demanded. Michalopoulos, Robins and Garfinkel (1992) find a significant although minor increase in the overall quality of care demanded with a price decrease. Berger and Black (1992) also find an increase in the mother-reported quality of care with a subsidy that can be used at any licensed facility. Finally, Han and Waldfogel (2001) found that women are more likely to be employed in states with more child care regulation and more frequent inspection of providers, implying that quality can encourage employment. Thus the idea that increasing employment through child care subsidies could have negative effects on child development is not a compelling concern, at least not within the scope of this thesis.

Another potential problem with increasing employment through child care subsidies is the existence of problems in the child care market. Primarily two market failures are suspected in the child care market: shortage and imperfect information.

In economics a shortage is a market failure in which supply does not meet demand at the market price, often indicating that the price is below equilibrium price (see Figure 2). However, this economic definition of shortage is not the type of shortage discussed in child care policy debate. In this context the concern is

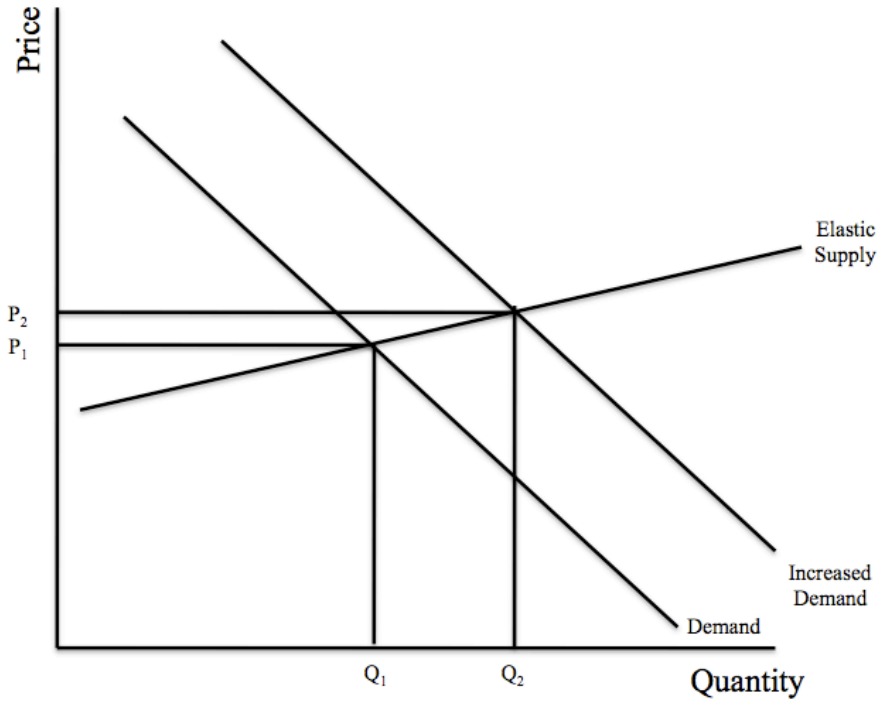
that the cost of child care is too high to be affordable to the majority of people who want to purchase it.

Figure 2
An Economic Shortage



Demand for child care has increased enormously in the second half of the 20th century a result of increased women's labor force participation and a shift from informal care to formal (paid) care. However, the price of child care has remained relatively stable, indicating either that the supply of child care is highly elastic or that the price of child care has been held arbitrarily low (perhaps causing a shortage in the economic sense).

Figure 3
Price Increase with Very Elastic Demand



The latter is unlikely because there is no reason to believe that the price of child care is below equilibrium price. Child care markets in the U.S. are only regulated for minimal quality standards that should not interfere significantly with the functioning of the market. Evidence in fact points to the supply of child care being highly elastic (see Figure 3). Blau finds that there is a large supply of women willing to work for low wages in the child care industry, presumably because they have a preference for taking care of children. It is this supply that has kept child care costs from rising with demand, given that labor is the main factor in child care production (Blau, 2001).

The price of child care may be considered too expensive, but this is not a market failure, and rather implies lower demand. One could also consider a shortage in the child care market if child care is viewed as a merit good, or a good that should be available to everyone because of its positive qualities, in which case the price of child care should be close to zero. However under normal assumptions neither an economic nor a general type of shortage is likely to exist in the child care market.

The second market failure suspected of the child care market is imperfect information. Imperfect information implies that for whatever reason, economic actors are not able to make decisions with full information about their choices, whether it be availability, quality, price or any other factor that could affect the decision.

First, there may be a lack of referral agencies to help parents identify care suppliers, which would artificially lower demand. But more importantly, there is an obvious lack of quality rating systems for care providers. As a result, it may be nearly impossible for parents to identify accurately the quality of the care their children are receiving while they are at work. Therefore very little price premium can be charged for high-quality care without better information, potentially lowering the overall quality of supply in the market. However, evidence suggests that in reality parents do not value quality of care, and therefore such a market failure is unlikely to exist. Low prices are better explained by a lack of preference for quality (Blau 2001).

Another reason that the role of child care subsidies in the labor supply model may not be as clear as portrayed in Figure 1 is that it is noted in the literature (see below) that subsidies encourage mothers to move from informal unpaid non-maternal care to formal paid care. In such cases, the subsidies may be encouraging employment, but only to the extent that there is a preference for paid care and employment. In this case subsidies are actually lowering the marginal consumption benefit of working in the simple model. However in a more realistic model there is little reason to believe that child care subsidies would discourage employment as people simultaneously make a care mode and employment decision. They may, however, be less effective in encouraging employment that other methods (such as an earned income tax credit) because of this effect.

Thus this thesis can safely ignore child development and market failure issues while focusing on the effectiveness of subsidies in encouraging employment. Policy goals of promoting child development through high quality child care and promoting employment through cheap child care are generally found not to be opposed. Shortages are found to be unlikely, and imperfect information not to matter. This thesis also is unconcerned with movement between modes of care and policy cost-efficiency, although these issues are interesting and interrelated.

The employment question was chosen because of its relevance to welfare policy and the self-sufficiency argument developed above. Under current welfare policy, employment is by far the primary goal of child care subsidies in the U.S.

today. Therefore it is of paramount importance that we carefully establish and study the causal relationship between subsidies and employment. It is the goal of this thesis to contribute to the body of literature already addressing this important question.

CHAPTER 2

LITERATURE REVIEW

There is a fairly large body of literature on the effects of child care subsidies on employment written over the past 25 years, which is summarized in the chart in the Appendix. There are three main sources of evidence exploited in the literature: demonstration programs, estimates of the elasticity of employment with respect to the price of child care, and estimates of the direct effect of subsidy receipt on employment.

Demonstration programs are organized as randomly assigned trials in which a treatment group will receive of a number of services to help them rise out of poverty, often including child care subsidies. The outcomes of the treatment group can be compared with a outcomes of the control group. The advantage of this type of study is that it avoids self-selection into subsidy receipt by setting up a randomized trial. However, the difficulty in using these programs as evidence of the effect of child care subsidies is the need to distinguish between the effect of the child care subsidies and the effects of all other provisions of the programs (Blau, 2003, Cox 2009). In 2005, Abt. Associates conducted a demonstration project in Washington State to measure the effect of varying child care subsidies

alone. Families were randomly assigned to groups with different child care copayment schemes, and administrative data on employment and welfare receipt were used to measure outcomes (Collins, 2005). The report found that reducing child care payments did not increase employment (Michalopoulos, 2010).

The most prevalent type of study of this problem estimates the price elasticity of employment with respect to child care. The price elasticity is meant to be an indirect measure of subsidy effect, essentially the percent change in probability of being employed over the percent change in the price of child care. Usually, expenditure on child care is used to predict market price. Regardless of dataset or model, studies find a zero or negative elasticity, although there is significant variation in size (from zero to close to -1).

By far the most common data set used to estimate price elasticity models is the Survey of Income and Program Participation. The data was produced by the Census Bureau and is comprised of nationally representative panels beginning between 1984 and 2004. The following studies use the SIPP to estimate the effect of the price of child care on employment: Anderson & Levine (2000), Connelly (1992), Connelly and Kimmel (2001), Connelly and Kimmel (2003), Herbst (2010), Kimmel (1995), Kimmel (1998), Michalopoulos Robins and Garfinkel (1992), Ribar (1992) and Ribar (1995).

Again, there is wide variation in estimates of the price elasticity despite similar models and data. Anderson and Levine (2000), Connelly (1992), Connelly and Kimmel (2001), Herbst (2010) and Ribar (1992) all use probit models

controlling for self-selection, but obtain elasticities ranging from -0.20 to -1.03 (Connelly, 1992; Connelly and Kimmel, 2001). Anderson and Levine (2000) found that varying the method of cost measurement led to elasticities between 0.000 and -0.413 or -0.055 to -0.35 depending on the specification chosen. One can conclude that results are fairly sensitive to assumptions. Anderson and Levine find that the wage effects are less sensitive, perhaps because such models are standard in the literature.

Michalopoulos et al. (1992) and Ribar (1995) use SIPP and specify a structural model to estimate employment and child care expenditure simultaneously. In Michalopoulos et al. the mother maximizes utility between three options: to work and pay for care, to work and use free care, or not to work and care for the child The effect of the price of child care on hours worked is very small at .0014, whereas the elasticity of child care expenditures is estimated at .2984 (for single mothers). The model used by Ribar (1995) is fully structural and estimated with full information maximum likelihood. Ribar (1995) found results similar to Michalopoulos et al. (1992): a very small employment elasticity with respect to child care cost of -0.024 and a much larger elasticity of child care expenditure with respect to cost of -.248. A structural approach may lead to lower estimates. Geographic variation may affect both the price of child care as well as many other prices affecting employment, thus using geographic variation in the price of care to determine its price effect on employment, as in non-structural

models, leads to an overestimate of the price of care elasticity of employment. (Anderson and Levine, 2000).

Other studies estimating price elasticities and using datasets other than the SIPP include Averett (1997), Blau and Robins (1988), Han and Waldfogel (2001), Tekin (2002) and Tekin (2007). Averett (1997) uses the 1986 National Longitudinal Surveys of Labor Market Experience of Youth and found a relatively large elasticity of -0.78, whereas Blau and Robins (1988) used data from the Employment Opportunity Pilot Projects of 1980 and found an elasticity of -0.38. Han and Waldfogel (2001) used March Current Population Survey data merged with SIPP data and found an elasticity ranging from -0.30 to -0.73.

Tekin (2002) and Tekin (2007) used the National Survey of America's Families to study the price elasticity of employment with respect to child care. Both used multinomial (NSAF) choice models and found price elasticities of -.121 and -.148 respectively, which are on the low end of the range of elasticity estimates discussed below. In addition, in Tekin (2002) the model predicts that if child care were subsidized at the 50% level, overall employment would increase by 5.8 percent, a very small effect.

There are several reasons that the elasticity may not be a good measure of the effect of subsidies on employment. Firstly, there may be high take-up costs to receiving a subsidy, ranging from extensive red-tape bureaucracy to the social stigma of state support (Blau and Tekin, 2003; Cox, 2009). In addition, not all those who apply for subsidies can receive one. The presence of waitlists for

subsidies and freezes on accepting new recipients are evidence of subsidy rationing in about half of all states (Cox, 2009). The models of Cox (2009) and Blau and Tekin (2003) include factors that would affect the probability of being rationed out in their equations predicting subsidy receipt. Cox (2009) in particular emphasizes the cost of uncertainty in subsidy receipt. Mothers must take up jobs in order to become eligible for an employment-based child care subsidy, but there is no certainty that they will receive a subsidy even once employed.

Even if receipt of a subsidy were guaranteed for all those eligible, maintaining eligibility may pose an additional barrier. If the cost of child care poses a barrier to employment, as implied by the presence of subsidies, remaining employed while applying for a subsidy may be difficult if not impossible, especially if the application process or waitlist takes a long time (Cox, 2009). Thus all of these factors point to the idea that a price elasticity would may overestimate the effectiveness of subsidy programs in encouraging employment.

Most studies of actual subsidy receipt are done using large household survey data variables on child care subsidy receipt. All such studies must control for self-selection in order to compare the population receiving subsidies and the population not receiving subsidies. Just as there is no clear control group for those who pay for care in the price elasticity studies, there is no clear control group for subsidy recipients in a subsidy receipt model. To address this issue, an equation predicting subsidy receipt is generally incorporated into an employment probit or multinomial choice model. The advantage of the multinomial choice model is that

employment, care mode and payment can be simultaneously estimated. The data set most frequently used for this type of study is the National Survey of America's Families (NSAF), conducted by the Urban Institute in 1997, 1999 and 2002. The following studies use this data set and include employment as a primary dependent variable: Tekin (2002), Tekin (2005), Tekin (2007), Blau and Tekin (2007), Cox (2009) and Crawford (2006).

Results from studies using the NSAF data are somewhat varied, implying that the results may be sensitive to specification. Blau and Tekin (2007) found that actual subsidy receipt increases employment by 13% using OLS and 32% using two-stage least squares, which is the maximum result from this type of study. Tekin (2005) found an increase of 15.3% using a multinomial choice model. Crawford (2006) found an increase of 21% for part-time work and 15% for full-time work using a binary logit model. Cox (2009) found an increase of 17.5% using a univariate probit and no significant effect using full information maximum likelihood.

There are two other studies of this type: Berger and Black (1992), Meyers, Heintze and Wolf (2002). Berger and Black (1992) used the waitlist for a subsidy as a control group, while Meyers, Heintze and Wolf (2002) modeled subsidy receipt, similar to many studies below, but with a small California sample. Berger and Black (1992) found a 12% increase in employment due to the subsidy and Meyers et al. (2002) found a significant and positive effect as well.

Also worthy of mention is Gelbach (2002). Gelbach (2002) did a unique study of child care and employment in which he viewed the provision of free public school to five-year-olds as a child care subsidy to mothers of five-year-olds. This creative approach bypassed extensive selection issues faced by all other studies, and lead to a positive and significant effect of eligibility for kindergarten on employment .

Thus overall the vast majority of studies on the effect of child care subsidies on employment find a significant and positive impact. The effects, whether in terms of subsidy effect or price effect, vary but are generally very small. The distribution of estimates seem imply that the true value for the elasticity is around -0.20 or -0.30, and that a subsidy effect may be around 20%.

2.1 Related Questions in the Literature

Many studies of the effect of subsidies on employment also address specific subtleties of the problem. This literature, and the questions it raises, is important to consider, even though the analysis in this thesis does not explore beyond the basic question of whether subsidies encourage employment. Aspects of the problem addressed in the literature but not in this thesis include full-time and part-time work, shifts between care modes, quality of work, single women and poor women as separate populations, and comparison of employment policies.

A number of studies investigate labor force participation as a choice between no employment, part-time employment and full-time employment, since the child care needs of these subsets may be very different. For instance, the child care needs of full-time workers may be more inflexible, making them more likely to pay for center care as opposed to a more informal and probably cheaper arrangement. The correlation between full-time employment and use of paid care is noted in the literature (Connelly and Kimmel, 2003; Ribar, 1995).

Not only are full-time workers more likely to use paid care, they are also more sensitive to the price of care, and therefore probably to child care subsidies. Most studies estimate full- and part-time employment as discrete choices rather than a continuous number of hours, as this model is found to better fit the labor market (Connelly and Kimmel, 2003). Connelly and Kimmel (2003) found that mothers employed full-time are the more responsive to price changes, with elasticity of -0.2772 as opposed to -0.0166. Tekin (2002) and Tekin (2007) treat the issue of full-time vs. part-time work in multinomial choice models, and find that full-time employment is about twice as elastic with respect to the price of care as part-time employment. Powell (1998) obtained a result of three times more elastic using Canadian data.

It is also interesting to note that in addition to the shift to paid care with increasing employment, child care subsidies themselves encourage paid modes of care, implying a normal price relationship. This shift toward center care with subsidies is noted in the literature (Tekin, 2005; Blau, 2001; Cox, 2009; Blau and

Robins, 1988). Thus assuring the quality of formal care becomes increasingly important as child care subsidization and other pro-employment policies are pursued.

Another important impact of child care policy is on the quality of work obtained by mothers, as measured in the literature by working standard hours. Working nonstandard hours generally means fewer benefits and fewer opportunities for promotion among other disadvantages (Tekin, 2004). Tekin (2004) finds that child care subsidies increase the probability of single mothers working standard hours by 6.1%, while Cox (2009) found an increase of 27%.

In addition, there are several subgroups for whom the effects of child care subsidies are distinguished in the literature. These subgroups are single women and poor women. A study by the U.S. General Accounting Office in 2004 found that there is a larger child care price effect for poor and near-poor women. In a hazard model, Baum (2002) found that low-income mothers were more sensitive to the price of child care as it affected their decision to return to work within two years of giving birth. In a similar vein, Anderson and Levine (2001) estimated that the child care price elasticity of employment is significantly more negative for low-skill women than high-skill women (-0.35 to -0.05) after controlling for income.

Earlier studies of child care subsidies and employment were focused on married mothers. More recently, the focus has shifted toward single mothers, the primary target demographic of the 1996 welfare reform (Tekin, 2007). One would

expect single mothers to be more responsive to subsidies as they are less likely to have an alternative source of income and child care from a partner. Two studies find evidence to support this idea. Han and Waldfogel (2001) and Connelly and Kimmel (2003) both find that single mothers are more responsive to changes in the price of care. One study, however, Kimmel (1998), found married women's employment to be more elastic with respect to the price of child care than single women's. Perhaps this is a result of the delayed impact of welfare reform in encouraging women to work. The analysis in this paper also finds a higher price elasticity for married mothers than single mothers, as reported in Section 3.4.

A broader goal of studies of child care subsidies is to evaluate their value as a policy tool to increase employment and compare them with other tools. To do so, a study must include in its model variables other than subsidies that could be changed through government policy. The study must also be able to predict the effects of varying various policy variables on employment as well as to measure the efficiency of each in terms of cost to the government. Three studies have produced results in this area.

Ribar (1995) examined married mothers and found that making the child care tax credit (CDCTC) refundable would have no effect on employment while eliminating it would have a minimal effect on employment. In addition, adding a flat subsidy of 25% on child care cost would have a minimal effect on employment. Of other policies proposed in the late 80's and assessed by Ribar (1995), doubling tax exemptions for children would have the greatest impact in

terms of increase in full-time employment. Thus Ribar concluded that subsidies are relatively ineffective in encouraging employment. Averett (1997), on the other hand, found subsidies to be an effective tool relative to changing the tax credit structure or subsidy expenditure limits. Tekin (2007) concluded that child care subsidies are more cost-effective in increasing employment than wage subsidies since subsidies increase employment but go only to those who work and pay for care.

Analysis of these related and interesting aspects of the child care and employment question would be very interesting; however; in this paper I address only the simple question of whether subsidies increase employment of mothers.

CHAPTER 3

METHODOLOGY

I perform my analysis using the work of Tekin 2005 and Blau and Tekin 2007 as a starting point to estimate the direct effect of subsidy receipt on employment using data from the National Survey of America's Families (NSAF). The estimation of direct effect of subsidy receipt was chosen over a price elasticity analysis because it is a better measure of the effectiveness of subsidies in encouraging employment if self selection and endogeneity issues can be dealt with econometrically. I use a two-stage least squares instrumental variables model similar to Blau and Tekin 2007 and with instruments similar to Tekin (2005) and (Cox 2009). I also use a bivariate probit model with the same instrumental variables, and a propensity score matching model to emulate a natural experiment. The two-stage least squares model estimated an effect of subsidy receipt on employment of 28%, similar to Blau and Tekin 2007, but insignificant. The bivariate probit model resulted in a significant effect of 42%. Lastly, the propensity score matching estimated an effect of 23%. The results from these three models are all positive and are in line with the literature (Tekin 2005, Blau and Tekin 2007, Cox 2009).

3.1 Data

The data used is from the 2002 cross-section of the National Survey of America's Families (NSAF). The survey was conducted in 1997, 1999 and 2002 by Westat for the Urban Institute to study the process of devolution of social programs to the states. The 2002 panel contains data from extended interviews of 39,798 households, including extensive information regarding household demographics, health care use, participation in government programs such as health care, family well-being, and child care (Abi-Habib, 2002).

A subsample of 2852 mothers of children under the age of six was selected such that all relevant variables were non-missing. Mothers of children under the age of six were chosen specifically because this age group is the most needy in terms of child care. After the age of five, almost all children will have free day care during the day in the form of public school and therefore the goal of subsidies to facilitate employment seems less relevant to the population with no children below the age of six. The sample is not representative of any particular group or region. Subpopulations specifically oversampled in the NSAF include low-income households and households in the 13 focus states[4] for the study. The majority of the sample was taken using random digit dialing, but a smaller

[4] States oversampled in order to obtain state-representative estimates were Washington, California, Colorado, Texas, Minnesota, Washington, Michigan, Mississippi, Alabama, Florida, New York, Massachusetts, and New Jersey.

proportion was taken using a clustered area sample. Weights are not used in the analysis because results do not need to be nationally representative.

Descriptive statistics for this sample are summarized in Table 1 below. About 45% of mothers are employed, which is low for similar samples in the literature (Blau and Tekin 2007, Tekin 2005), and about 10% receive subsidies, which is in line with coverage estimates in the literature (Tekin 2005, Cox 2009). Of those in the sample who received a subsidy, 69.59% are employed whereas of those in the sample who did not receive a subsidy, only 42.53% are employed, a statistically significant difference that does not contradict the hypothesis that subsidy receipt increases employment.

The main advantage of the NSAF data in addressing the child care subsidy-employment question is the existence of a subsidy receipt variable in the data. Interviewees were asked whether or not they received government help in paying for child care and the answers were coded as yes or no. This variable allows us to attempt to measure the effect of actual subsidy receipt on employment, rather than the price elasticity as done in the majority of studies. The price effect and the direct effect of subsidy receipt can be expected to differ considerably as noted in the previous section, with the subsidy effect being a more precise measure of to what extent subsidies promote employment.

Table 1
Descriptive Statistics of Sample

Variable	Sample Mean	Standard Error
Worked at least part time this year	0.451	0.498
Received child care subsidy	0.096	0.294
Has high school diploma	0.435	0.496
Completed some college	0.216	0.411
Has bachelors degree*	0.113	0.317
Has a health condition that limits work	0.116	0.320
Black	0.174	0.379
Hispanic	0.266	0.442
Age	29.978	6.882
Foreign born	0.246	0.431
Married	0.603	0.489
Income excluding earnings from employment (in thousands)	2.997	5.606
Number of children in under 6 years	1.439	0.660
Number of children between 6 and 17	1.007	1.198
Number of relatives in household	3.325	1.592
Lives in northeast	0.241	0.428
Lives in south	0.270	0.444
Lives in west	0.222	0.416
Spanish needed for interview	0.170	0.376
In state with waitlist for subsidies**	0.662	0.473
In state that uses mass media to advertise subsidies	0.910	0.287
State eligibility for subsidies as percent state median income**	0.562	0.117
State CCDF expenditure per child	218.663	83.440
State mean copay on subsidies (as percentage of income of a familty of three at the poverty line)**	0.043	0.026

*Omitted categories are less than a high school diploma and lives in Midwest.
**As of December 2001
Sources of data: 2002 NSAF, U.S. Department of Human Health and Services, and the National Women's Law Center

3.2 Econometric Issues

Despite the attractiveness of estimating the effect of subsidy receipt directly, this chosen method unleashes a number of empirical problems. The primary difficulty arises from the fact that employment is often a prerequisite for subsidy receipt because, in line with the goals of PRWORA, subsidies are viewed as a tool to achieve employment. Thus the decision to receive a subsidy may either be made simultaneously with the decision to be employed, in which case our estimate of the effect of subsidy receipt will be good, or the decision to apply for a subsidy will be conditional on already being employed, in which case our estimate is capturing reverse causality, or the effect of being employed on receiving a subsidy. The reverse causality introduces a positive bias in estimates that is difficult to tease out. However, only about 70% percent of mothers who receive a subsidy are employed, implying that employment is not an absolute requirement for subsidy receipt (or that it is there are ways to circumvent the requirement).

In addition, another source of positive bias is omitted variable bias from unobserved personal characteristics. Specifically, the type of mother receives a subsidy may be fundamentally different from the type of mother who doesn't receive a subsidy in a way that is both correlated with employment outcome and unobservable. For instance, if a mother has specific unobservable skills that help her get through the application process for subsidies, these skills are also likely to help her in a job application process. Similarly, mothers who are well-connected,

energetic, or in specific situations conducive to leaving the home, may be more likely both to get a subsidy and to be employed. Without variables or some other method to control for these characteristics, the effect of subsidy receipt will be systematically overestimated due to self-selection.

There is one possible scenario that would attenuate the positive bias in our estimate of the effect of subsidy receipt on employment. Some mothers may become employed in order to be eligible for a subsidy and then wait many months or in fact never being able to receive a subsidy due to rationing, which is fairly common (Cox 2009). Thus an unknown part of our sample may be employed in order to receive a subsidy without actually receiving a subsidy. To the extent that we want to include this effect as the subsidy policy encouraging employment, our estimate will be biased downward. However, this situation would seem to be less prevalent than the one above because the advertisement of subsidies and eligibility requirements is very limited. In addition, this effect is a byproduct of the structure of the subsidy system rather the direct result of subsidy receipt. Thus overall, our main concern remains that the estimate will be biased upward due to the reverse causality and unobserved personal characteristics explained above.

Three models were used to estimate the effect of child care subsidy receipt on employment while accounting for this bias: a two-stage least squares instrumental variable regression, a instrumental variables bivariate probit, and propensity score matching. The propensity score matching model is previously unseen in the literature on this topic. The next section will explain and give results

for the two instrumental variables econometric models used to estimate the effect of subsidy receipt on employment.

3.3 Instrumental Variables Models

In the first two models, the principle method of controlling for the reverse causality bias between employment and child care subsidy receipt as well as omitted variable bias is instrumental variables. Instrumental variables are important econometric tools frequently used to eliminate bias by cleaning up correlation between covariates (endogeneity).

An instrumental variable must be correlated with the endogenous variable, and be uncorrelated with the error term in a simple ordinary least squares regression. As a result of these requirements, an instrumental variable is uncorrelated with the dependent variable of interest except through its correlation with the endogenous variable, and thus can be excluded from the main employment equation. Thus by using instrumental variables as an estimation mechanism, other effects that are not of interest can be eliminated from the coefficient of the endogenous variable.

In this model, subsidy receipt is endogenous because of the reverse causality with employment and omitted variable bias from missing personal characteristics variables. The instruments chosen are state level variables that affect subsidy receipt but should not be correlated with the error term, similar to Tekin (2005). These instruments are: a binary indicator of whether the mother

lives in a state where there are wait lists for subsidies; a binary indicator of whether the mother lives in a state that uses mass media to advertise subsidies; and the eligibility cut-off for subsidies as percent state median income of the state in which the mother lives; the mean subsidy co-pay in the state in which the mother lives; and expenditure per child by state.

Theoretically these five variables will affect subsidy receipt and only be correlated with employment through subsidy receipt. First we test their relationship with subsidy receipt. In an ordinary least squares regression on subsidy receipt including all other covariates, only three of the five instruments were found to have a significant effect on subsidy receipt at the 10% level. The indicator of use of mass media advertising of subsidies by state, presence of wait list by state, and the stringency of income eligibility by state were significant while state expenditure per child[5] and state mean co-pay on subsidies were not significant. Full results are in Table 2.

An F-test of the hypothesis that the these instruments are jointly zero yields a statistic of 3.25 and a p-value of .0063, while if only the three significant instruments are included in the model, the F-statistic becomes 5.33 and the p-value drops to .0012. The R-squared value for the model including all five instruments is 0.0952 while the R-squared value for the model containing the three strongest instruments is 0.0951, indicating that the three strongest instruments are explaining the majority of the variation in subsidy receipt

[5] The expenditure variable may be insignificant due to measurement error, as it is difficult to determine which funds were spent in which years.

explained by the five instruments. All instruments have the expected sign even if they are insignificant[6].

Table 2
Results of individual Significance of Instrumental Variables in Predicting Subsidy Receipt (All Other Covariates Included)

Instrumental Variable	Coefficient	Standard Error
In state with waitlist for subsidies	**-0.043	0.016
In state that uses mass media to advertise subsidies	**0.084	0.027
State eligibility for subsidies as percent state median income	*0.106	0.064
State CCDF expenditure per child	0.00003	0.00007
State mean co-pay on subsidies	0.055	0.304

** Indicates significance at the 5% level*
*** Indicates significance at the 10% level*

It seems clear that the instrumental variables have no direct effect on the dependent variable, here employment, both theoretically and empirically. It is difficult to make the case for any of these state-level variables having any direct effect on employment. Perhaps one could make an argument that states with good subsidy programs were able to fund these programs through high tax revenues facilitated by high employment rates, but any such connection is purely speculative and hard to accept. Empirically, in an ordinary least squares

[6] Although the eligibility criteria could be expected to have either a positive or negative coefficient. Looser eligibility criteria could imply a more generous system; on the other hand Cox (2009) notes that more eligible applicants means that few subsidies are spread over more people, perhaps actually decreasing probability of subsidy receipt.

regression of employment on the instruments and all covariates, none were significant. Furthermore, the test of overidentifying restrictions in the next section failed to reject the null hypothesis that the instruments are not correlated with the error term.

In summary, the instruments are good in that they are correlated with subsidy receipt but not with the error term, and that they may also be safely excluded from the main model.[7] However, with an F-test of only 5.33, they are not strong, and a number of issues could arise from their weakness.

3.3.1 Ordinary Least Squares Model

Before moving on to a two-stage instrumental variable model, it is valuable first to examine the result of a simple ordinary least squares regression, including all covariates (excluding instruments) and subsidy receipt itself as regressors. Seven of the regressors were insignificant: Black, Hispanic, Spanish spoken in interview, foreign born, lives in the Northeast, lives in south, and the number of children between the ages of six and seventeen. Other variables do have a significant effect on employment in the OLS model, and the signs of the coefficients are generally plausible. Full results are in Table 3.

[7] Although in this case (binary response model) a two-stage least squares model is identified without exclusion restriction on the instruments (Wooldridge 2010).

Table 3
Simple OLS Regression of Subsidy Receipt on Employment with Covariates

Regressor	Coefficient	Standard Error
Received child care subsidy	*0.204	0.031
Has high school diploma	*0.153	0.024
Completed some college	*0.190	0.029
Has bachelors degree	*0.176	0.035
Has a health condition that limits work	*-0.228	0.028
Black	0.047	0.026
Hispanic	0.018	0.033
Age	*0.004	0.001
Foreign born	-0.050	0.031
Married	*-0.123	0.022
Income excluding earnings from employment	*-0.009	0.002
Number of children in under 6 years	*-0.060	0.017
Number of children between 6 and 17	0.016	0.014
Number of relatives in household	-0.026	0.011
Lives in northeast	-0.033	0.026
Lives in south	-0.033	0.025
Lives in west	*-0.074	0.026
Spanish needed for interview	-0.014	0.039
Constant	*0.504	0.054

** indicates significance at the 5% level.*

The coefficient on receiving a child care subsidy in this regression is 0.204 and significant at the 1% level. However, as explained above, there is much reason to believe that child care subsidy receipt is endogenous and therefore than the simple OLS model will be biased. To address this issue the next section introduces the two-stage least squares instrumental variable model, which should eliminate this bias.

3.3.2 Two-Stage Least Squares Linear Probability Model

In two-stage least squares, instrumental variables are used to eliminate correlation between regressors. In a first stage, subsidy receipt is predicted using the instruments and all covariates and in the second stage the predicted values from the first stage are used to predict employment. The first and second stage regressions will look like this:

$$\hat{S} = \gamma_0 + \beta_1 X + \beta_2 Z + \epsilon_0$$

$$E = \gamma_1 + \beta_3 X + \beta_4 \hat{S} + \epsilon_1$$

where $\hat{S}$ is subsidy receipt as predicted by X, the vector of covariates of personal and household characteristics and Z is the vector of instruments. Gammas are constants and epsilons are error terms.

The results of this model appear in Tables 4 and 5 below. Robust standard errors are reported because heteroscedasticity was observed in the OLS regression. Only the three strongest instruments were included in the model. This should attenuate the bias that results from weak instruments. However, even only using the stronger instruments, the result of the F-test (value of 5.33) is not high enough to eschew the problem of weak instrument bias, especially given the relatively low sample size (Staiger and Stock 1997). Comparison to the the Stock

and Yogo[8] critical values indicates that the model only limits the bias to about 30% of the bias that exists in the OLS model.

However, the Sargan-Hansen test of overidentifying restrictions fails to reject the null hypothesis that the instruments are valid, as in not correlated with the error term and the Kleibergen-Paap LM underidentification test allows us to reject the null hypothesis that the model is underidentified.

The R-squared in the first stage is 10% and the second stage 15%. This model will be correctly specified if subsidy receipt is in fact endogenous as predicted by common sense and the literature. To test for endogeneity, a Hausman test was performed comparing the OLS and TSLS models. The hypothesis that the models are the same was rejected with a p-value of 0.03, implying that the TSLS model is eliminating substantial bias from the OLS model.

[8] For more information: Stock, James H. and Motohiro Yogo. (2002). *Testing for Weak Instruments in Linear IV Regression*. NBER Technical Working Paper No. 284. Retrieved from http://www.nber.org/papers/t0284

Table 4
Results of the First Stage Regression on Subsidy Receipt

Regressor	Coefficients	Standard Error
Has high school diploma	0.0074	0.0138
Completed some college	*0.0704	0.0186
Has bachelors degree	0.0091	0.0177
Has a health condition that limits work	0.0151	0.0190
Black	*0.0751	0.0202
Hispanic	-0.0125	0.0183
Age	*-0.0030	0.0009
Foreign born	*-0.0179	0.0156
Married	-0.1180	0.0142
Income excluding earnings from employment	0.0003	0.0009
Number of children in under 6 years	0.0087	0.0113
Number of children between 6 and 17	0.0090	0.0086
Number of relatives in household	-0.0065	0.0072
Lives in northeast	0.0003	0.0191
Lives in south	0.0378	0.0224
Lives in west	0.0161	0.0172
Spanish needed for interview	-0.0068	0.0218
In state with waitlist for subsidies	*-0.0418	0.0167
In state that uses mass media to advertise subsidies	*0.0861	0.0256
State eligibility for subsidies as percent state median income	0.1058	0.0663
Constant	0.1060	0.0615

** indicates significance at 5% level.*

Table 5
Results of Two-stage Least Squares Instrumental Variable Regression on Employment

Regressor	Coefficients	Standard Error
Received child care subsidy	0.2779	0.4235
Has high school diploma	*0.1520	0.0240
Completed some college	*0.1851	0.0414
Has bachelors degree	*0.1751	0.0354
Has a health condition that limits work	*-0.2290	0.0260
Black	0.0423	0.0389
Hispanic	0.0187	0.0326
Age	*0.0041	0.0020
Foreign born	-0.0484	0.0324
Married	*-0.1141	0.0545
Income excluding earnings from employment	*-0.0087	0.0015
Number of children in under 6 years	*-0.0603	0.0172
Number of children between 6 and 17	0.0155	0.0144
Number of relatives in household	*-0.0255	0.0114
Lives in northeast	-0.0301	0.0290
Lives in south	-0.0319	0.0250
Lives in west	*-0.0751	0.0272
Spanish needed for interview	-0.0130	0.0393
Constant	*0.4861	0.1145

** indicates significance at the 5% level*

The only difference in the signs of the coefficients of the OLS and TSLS models is that Hispanic becomes positive instead of negative but remains insignificant. The only coefficients that become insignificant between the OLS and TSLS models are foreign born and lives in South, although many variables become less significant. The coefficient on subsidy receipt actually increases from

the OLS model to the TSLS model from 0.204 to 0.278, which is unexpected given that we are controlling for positive bias. However, the much larger standard errors is probably the cause. The OLS estimate is significant with a t-statistic of 6.20, while the TSLS estimate is insignificant with a t-statistic of only .66. Standard errors are expected to rise from an OLS to a TSLS model (Wooldridge, 2010). These estimates are also consistent with the results of Blau and Tekin (2007), who obtained an OLS estimate of 13% and a TSLS estimate of 33%, which were both significant[9].

We must be wary in interpreting the coefficients of the TSLS model. Although it is a linear probability model, it incorrectly assumes that the average partial effects do not vary as one moves from a probability of zero to one, and may also produce probabilities above one. To correct for this flaw, a bivariate probit model was estimated.

3.3.3 Bivariate Probit Model

Although bivariate probit models are frequently used to address correlation of the error terms in two binary response equations, the advantage of the bivariate probit model in this context is that it allows for the prediction of average partial probabilities in models including a binary endogenous variable, in this case subsidy receipt (Wooldridge, 2010). In other words, instrumental

[9] Blau and Tekin (2007) used the 1999 cross-section of the NSAF and added a number of lagged variables from the 1997 cross-section. They also included additional state and county level variables from other data sources. Otherwise the analysis is similar.

variables can be used to control for endogeneity in the bivariate probit, just as in the TSLS model. In addition, with the bivariate probit model we should have a more accurate estimate of the effect of subsidy receipt on the probability of being employed because we are now estimating a probability model instead of a linear probability model. Probit models are designed for binary variables and allow us to estimate the marginal effect of every variable on the probability of employment at any point in their distributions through the cumulative normal distribution function.

First let us examine the results of a simple one-equation probit model, not accounting for the endogeneity of subsidy receipt or correlation of the error terms between equations. See Table 6 below.

Table 6
Results From a Single Probit Model of Employment

Regressor	Coefficient	Standard Error	Marginal Effect
Received child care subsidy	*0.601	0.091	0.235
Has high school diploma	*0.433	0.068	0.170
Completed some college	*0.540	0.081	0.213
Has bachelors degree	*0.500	0.098	0.197
Has a health condition that limits work	*-0.681	0.085	-0.247
Black	0.129	0.074	0.051
Hispanic	0.039	0.092	0.015
Age	*0.011	0.004	0.004
Foreign born	-0.135	0.088	-0.053
Married	*-0.346	0.062	-0.137
Income excluding earnings from employment	*-0.028	0.005	-0.011
Number of children in under 6 years	*-0.174	0.049	-0.069
Number of children between 6 and 17	0.046	0.038	0.018
Number of relatives in household	*-0.073	0.031	-0.029
Lives in northeast	-0.082	0.072	-0.032
Lives in south	-0.089	0.069	-0.035
Lives in west	*-0.199	0.074	-0.078
Spanish needed for interview	-0.037	0.112	-0.014
Constant	0.023	0.153	

** indicates significance at the 95% level*

All coefficients are significant except for black, Hispanic, foreign-born, number of children between the ages of six and seventeen, lives in Northeast or South, and Spanish used in interview. This is fairly similar to the OLS model. The only difference in the signs of coefficients is that now living in the various region

are negative (and insignificant) instead of positive. The coefficients cannot be interpreted directly as in an OLS regression, but marginal effects can be computed. The marginal effect of subsidy receipt on employment in the simple probit model is 0.235, slightly less than in the TSLS model.

Between the probit model and the bivariate probit model very little changes except that the indicator for black becomes significant and most coefficients generally become more significant while retaining the same sign. The results of the bivariate probit model with the same sample and instruments as the TSLS model are in Tables 8 and 9. Note that the coefficients cannot be interpreted directly as in a linear probability model. However, the marginal effects were computed in STATA and are reported in Tables 7 and 8.

The correlation of the error terms in the two equations is not significant, which poses no problem. We do not expect them to be correlated, but rather are using the bivariate probit to account for a binary endogenous variable. Accounting for any correlation that does exist will not hurt the estimation.

The coefficients that were significant in the simple probit regression continue to be significant in the bivariate probit. The marginal effect of subsidy receipt on the probability of employment is was estimated to be a significant 0.416, higher than the estimate using TSLS. The bivariate probit model without instrumental variables yielded an effect of 0.494 with standard error of 0.078.

Table 7
Results of the Bivariate Probit Model with Instrumental Variables, Subsidy Receipt Equation

Received child care subsidy	Coefficient	Standard Error	Marginal Effect
Has high school diploma	0.067	0.100	0.009
Completed some college	*0.432	0.112	0.066
Has bachelors degree	0.026	0.164	0.003
Has a health condition that limits work	0.152	0.105	0.021
Black	*0.350	0.092	0.053
Hispanic	-0.056	0.136	-0.007
Age	*-0.019	0.006	-0.002
Foreign born	-0.155	0.145	-0.019
Married	*-0.752	0.089	-0.109
Income excluding earnings from employment	0.001	0.007	0.000
Number of children in under 6 years	0.055	0.068	0.007
Number of children between 6 and 17	0.034	0.056	0.004
Number of relatives in household	-0.038	0.043	-0.005
Lives in northeast	-0.058	0.130	-0.007
Lives in south	0.214	0.125	0.029
Lives in west	0.102	0.111	0.014
Spanish needed for interview	-0.142	0.186	-0.017
In state with waitlist for subsidies	*-0.210	0.101	-0.028
In state that uses mass media to advertise subsidies	*0.500	0.172	0.046
State eligibility for subsidies as percent state median	0.604	0.406	0.076
Constant	*-1.324	0.398	

** indicates significance at the 95% level*

Table 8
Results of the Bivariate Probit Model with Instrumental Variables, Employment Equation

Worked at least part time this year	Coefficient	Standard Error	Marginal Effect
Received child care subsidy	*1.155	0.572	0.416
Has high school diploma	*0.422	0.069	0.166
Completed some college	*0.494	0.098	0.195
Has bachelors degree	*0.487	0.099	0.192
Has a health condition that limits work	*-0.679	0.085	-0.246
Black	0.089	0.086	0.035
Hispanic	0.044	0.091	0.018
Age	0.013	0.004	0.005
Foreign born	-0.124	0.089	-0.049
Married	*-0.275	0.101	-0.109
Income excluding earnings from employment	*-0.027	0.005	-0.011
Number of children in under 6 years	*-0.178	0.049	-0.070
Number of children between 6 and 17	0.040	0.039	0.016
Number of relatives in household	*-0.068	0.031	-0.027
Lives in northeast	-0.064	0.074	-0.025
Lives in south	-0.081	0.069	-0.032
Lives in west	*-0.205	0.074	-0.080
Spanish needed for interview	-0.030	0.111	-0.012
Constant	-0.109	0.205	

** indicates significance at the 95% level*

This estimate is insignificantly different from the estimate using instrumental variables, but is still higher, suggesting that the instrumental variables may be reducing some of the positive bias from the endogeneity of subsidy receipt.

Unfortunately the author does not know if identification and instrument tests can be extended in some form to the probit or bivariate probit models.

3.4 Propensity Score Model

The last model is very different from the instrumental variables models. In a propensity score model, individuals are matched according to observable characteristics and assigned a probability, or propensity score, of receiving treatment, in this case subsidies. An average treatment effect on the treated can then be calculated by comparing the outcomes of individuals with very similar propensity scores where only one of the individuals received the treatment for whatever reason[10]. Thus propensity score matching is essentially a way of simulating a randomized experiment. Although in reality individuals self-selected into subsidy receipt based on any number of unobserved characteristics correlated with employment, when we are comparing only individuals with similar propensity scores, we can assume that subsidy receipt was close to random. Thus most of the bias from self-selection is eliminated, and this model is most similar to the demonstration projects in the literature review section.

Generally the propensity score is estimated by a probit or logit regression over a large number of covariates. Then one of a number of techniques may be used to match individuals by propensity score, including nearest neighbor, radius,

[10] As long as the treatment and the outcomes are independent conditional on the covariates (called the ignorability of treatment assumption), the model is identified (Wooldridge, 2010).

stratification or kernel (Chen and Zeiser, 2008). Kernel matching is a procedure that selects counterfactuals by weighting the distances between propensity scores. Kernel matching was used to obtain an estimate of average treatment effect of 0.23, which is significant with a standard error of 0.03[11]. The average treatment effect is not very sensitive to the type of matching chosen because other matching methods produced very similar estimates.

This method should control for much of the bias from self-selection into subsidy receipt, especially to the extent that observed characteristics affect the probability of subsidy receipt. The main disadvantage of this model is that it is not clear to what extent the positive bias, especially resulting from reverse causality between subsidy receipt and employment, has been controlled for. Nevertheless, the estimated effect of 23% is in line with those estimated in the literature and by the other models.

3.5 Estimated Effects for Other Subgroups

Much can be learned both about the effectiveness of the models and the true effect of subsidy receipt on employment by estimating the effect for subgroups other than mothers of children under the age of six using the same models. Subgroups examined in this section are mothers below twice the poverty line, single mothers, and fathers of children under the age of six. Results from all

[11] All covariates were included in the propensity model, although Hispanic and Northeast did not satisfy the balancing property. The condition of common support was met.

subgroups and models are in Table 9 below, with the main sample of all mothers of children under the age of six included for comparative purposes.

It would seem plausible that the effect of subsidy receipt on employment would be more pronounced if the sample were limited to mothers in households with income less than twice the poverty line. Such a result would be in line with GAO (1994), who found a higher price elasticity for poor and near-poor mothers. Theoretically this makes sense because households above twice the poverty line are not eligible for subsidies in most states, and would likely have less interest in subsidies. Only ten percent of subsidy recipients are in households with income over twice the poverty line, and even this is surprisingly high.

For the sample of mothers in households with income under twice the poverty line the estimates of the effect of subsidy receipt on employment are similar to the estimates on the full sample in the TSLS and propensity score models. The bivariate probit model, however, produces a much smaller effect for this subgroup.

As discussed above, separating married and single women into separate samples is commonplace in the literature. One would expect the effect of subsidy receipt on employment to be much higher among single women, especially given the strongly negative coefficients on the married indicator variable in the models above. However, running the models on single women alone does not result in higher estimates in any of the models, and in fact results in a much smaller effect in the bivariate probit model.

An interesting question is whether fathers' employment responds at all to subsidy receipt. One would expect the effect to be minimal or non-existent because fathers are not the primary care givers in the home. This prediction is confirmed empirically, as all models show an insignificant and negative relationship between subsidy receipt and the employment of men.

Potential causes for a negative relationship include increased household income from cheaper child care or female employment. Such effects may outweigh any incentive to work fathers receive from cheaper child care outside the home. The lack of a positive relationship also reflects an overall very high employment rate for fathers (91% in the fathers sample as opposed to 45% in the mothers sample). The rate of subsidy receipt is also lower for fathers, at a mere 4.5% compared to the almost 10% among mothers.

Table 9
Comparison of Subsidy Effect on Employment in Subpopulations Across Models (Standard Errors in Parentheses)

Model/ subpopulation[12]	TSLS	Bivariate Probit Marginal Effect	Propensity Score	Sample Size
Mothers income <2x poverty line	0.146 (0 .434)	0.014 (0.466)	*0.248 (0.031)	2389
Single mothers	0.388 (0.420)	0.035 (0.356)	*0.231 (0.034)	1133
Fathers	-0.566 (0.572)	-0.394 (0.235)	-0.083 (0.032)	2791
Mothers	0.278 (0.424)	*0.416 (0.158)	*0.229 (0.030)	2852

** indicates significance at the 95% level*

[12] All subpopulations have children less than six years of age.

In terms of what we can learn about the models from the sample comparisons, it is interesting to note that the propensity score model changes minimally between the all-mother samples. The lack of sensitivity of the propensity score model is suspicious, perhaps indicating that its estimates are not as relevant. On the other hand, the bivariate probit model is different for the single and poor mother samples in a way not predicted by theory and previous literature. Only Kimmel (1998) found married women to have a higher elasticity, and no study has found poor women to have a lower elasticity. These results are not impossible, however, given the error in estimating such models. The TSLS model remains similar for all mother samples, perhaps due to its high standard error. However, the father sample produces point estimates outside the confidence intervals of the estimates for the mother samples across all models, indicating that this may truly be a different effect.

CHAPTER 4

SUMMARY OF RESULTS

The results of all three models are not mutually exclusive in that their estimates do not lie outside each other's confidence intervals, except for the bivariate probit and the confidence interval of the propensity score model. However, the range of possible estimates in this analysis is very large. The tightest confidence interval comes from the least-explored propensity score model, while the estimates TSLS and bivariate probit models are less precise. Results of all three models are summarized in Table 10.

Table 10
Summary of Results of All Models on Sample of Mothers of Children Under Six

Model	Estimate	95% Confidence Interval	
TSLS	0.2779	-0.5522	1.1079
Bivariate Probit	*0.4155	0.1067	0.7244
Propensity Score	*0.229	0.1708	0.2876

** indicates significance at the 95% level*

The analysis suffers from both measurement error and the difficult statistical problems of reverse causality and unobserved personal characteristics. There is reason to believe that both variables of interest, subsidy receipt and employment, are not very precise. For example, as noted above, about a third of people who receive subsidies are unemployed, and about 12% have income above twice the poverty line, indicating perhaps that some of the people coded as receiving "government help to pay for child care" are not receiving the subsidies we are trying to study. The employment variable may too lack in precision because the number of weeks of employment in the last year necessary to elicit a "yes" response are left up to the interpretation of the respondent. Thus there may be people (who are not identifiable) in the sample who worked earlier in the year and therefore are coded as employed, but who are now unemployed and receiving a subsidy. Similar ambiguity exists in the time period of subsidy receipt, although TSLS may help to reduce this measurement error.

One of the main problems with addressing the statistical issues of reverse causality and omitted variable bias in the TSLS and bivariate probit models is that the state-level instruments are weak. Good, strong instruments are often very difficult to find in these sorts of analyses, and this thesis is no exception. The Stock and Yogo test mentioned above indicated that the TSLS model still contained about 30% of the bias of the OLS model, which is still high. The bias in the bivariate probit and propensity score models is unknown, but may be near to that of the TSLS model.

Given the difficulty in dealing with measurement error and the other statistical issues, the true effect of subsidy receipt on employment may be impossible to tease out of this data, especially without additional instruments and data. However, the results of the analysis are encouraging and merit further study, especially including other issues such as full-time and part-time employment, choice of care mode, and cost-efficiency.

CHAPTER 5

CONCLUSION

Both economic theory and empirical evidence give reason to believe that child care costs are a disincentive to employment. Given the centrality of child care subsidies in post-PRWORA welfare policy to encourage employment, and the potential benefits of employment to the mother and the welfare system, especially self-sufficiency, it is very important to try to determine how effective child care subsidies really are at increasing employment. This analysis was a contribution to the literature on this important subject in that it expanded on the TSLS model of Blau and Tekin (2007) to include a bivariate probit model, and included a propensity score model, which has not been applied to this problem, to estimate the effect of child care subsidies on employment. The estimated effects were 28%, 42% and 23% with TSLS, bivariate probit and propensity score matching respectively.

Although this analysis is not conclusive as to the effect of subsidies on employment because the results are dependent on model specification and subject to high standard errors, the results do suggest a positive relationship within the broad range set forth in previous literature. In fact, the bivariate probit model, in

many ways the best model, produces a result higher than much of the literature. Thus it is likely that subsidies do cause their recipients to be more likely to be employed. If employment continues to be viewed as an important goal of welfare, as it likely will to further the self-sufficiency goal developed above, then child care subsidies may continue to be an important part of welfare in order to increase employment[13]. This analysis has contributed to the body of knowledge of to what extent subsidies do increase employment, thus perhaps better informing policymakers of the effectiveness of subsidies in pursuing their goals of employment and self-sufficiency.

[13] Unfortunately, a cost-efficiency comparison of subsidies with other tools to encourage employment, or whether employment leads to leaving welfare are not within the scope of this thesis.

APPENDIX

CHART OF CHILD CARE LITERATURE

Study	Data	Question	Methods	Result
Anderson & Levine 2000	SIPP wave 3 from 1990, 1991 and 1993	Differences in utilization and price elasticity by skill level (proxied for by education).	Market price of care and wage are estimated using selection correction terms, and included in a probability of employment equation estimated by probit.	A price elasticity between -0.05 and -0.35, decreasing with skill level.
Averett 1997	1986 National Longitudinal Surveys of Labor Market Experience of Youth (NSLY)	Price elasticity for married women with children under 6, and policy simulations with comparison to tax credits.	Effect of wage net child care cost and subsidy on employment estimated using tobit, IV and dual error model. Child Care Tax Credit included in the budget constraint.	Price elasticity of -0.78 and subsidies significantly increase labor supply, more than changing tax credit or expenditure limit.

CHART OF CHILD CARE LITERATURE (Continued)

Study	Data	Question	Methods	Result
Baum 2002	National Longitudinal Survey of Youth, low-income women who gave birth 1988-1994, n=694	Work decisions of low-income mothers within 2 years of giving birth.	Hazard model, dynamic decisions.	Low-income women have the largest negative elasticity of probability to work. 30% subsidy means 15% more women will work within one year of birth.
Berger and Black 1992	Kentucky survey	Participation in subsidy program and employment.	Probit. Sample selection as in Heckman (1979).	12% increase in employment from subsidy program and an increase in quality.

CHART OF CHILD CARE LITERATURE (Continued)

Study	Data	Question	Methods	Result
Blau and Hagy 1998	National Child Care Survey and Profile of Child Care Settings	Effects of price on labor and hours used, includes demand for quality.	Binomial Logit, multinomial choice model to simultaneously estimate joint decision of employment, child care use and type of child care. Price by hedonic price function. Wage and price vary by discrete choice. FIML to jointly estimate discrete choice and continuous outcome variables of discrete choice, with random effects to smooth 14 choices.	Subsidies increase demand for paid care by 19% and decrease demand for quality of care. They increase employment by 10%.
Blau and Robins 1988	Employment Opportunity Pilot Projects 1980	Response to price in employment and use of market care.	Multinomial probit	Price elasticity of -0.38, probability of married women working, any form of care.

CHART OF CHILD CARE LITERATURE (Continued)

Study	Data	Question	Methods	Result
Blau and Robins 1991	National Longitudinal Survey of Youth	Trends in employment and fertility in young women.	Descriptive study	Employment and use of non-relative child care increase with age.
Blau and Tekin 2007	NSAF 1999	Determinants of subsidy receipt, and effect of subsidy receipt on employment, school attendance, job search, and welfare participation	OLS and two-stage least squares using county dummies as instruments	OLS 13% and TSLS 32% increase in employment with subsidy receipt
Connelly 1992	SIPP 1984	Cost and labor supply	Generalized Tobit Model for child care cost, estimated with a Heckman (1974) two-stage method. Structural bivariate probit model of labor participation and paying for care	Price elasticity of -0.20

CHART OF CHILD CARE LITERATURE (Continued)

Study	Data	Question	Methods	Result
Connelly and Kimmel 2003	SIPP 1992-1994	Full-time vs. part-time employment among single and married women.	1st model: ordered probit of no, part-time and full-time employment . 2nd model: effect of full-time employment on mode choice. 3rd model: multinomial logit of care choice. Bivariate selection correction was used in the estimation of child care price, weighted by probability of having to pay for care.	Price elasticity of -0.0166 for part-time workers and -0.2772 for full-time workers. Effect is larger for single than married mothers.
Connelly and Kimmel 2001	SIPP 1992 and 1993	Probability of working and receiving welfare by child care expenditure	Probit equations with Heckit correction to predict child care cost and wages. Full structural bivariate probit.	Price elasticity of -0.28. Price elasticity with respect to welfare of 0.60.

CHART OF CHILD CARE LITERATURE (Continued)

Study	Data	Question	Methods	Result
Cox 2009	NSAF 1999, 2002	Effect of subsidy receipt on employment and quality of employment, measured by working normal hours.	Full Information Maximum Likelihood approach. Univariate probit for rationing and bivariate probit for decision to apply and to work, estimated simultaneously. Semi-reduced specification.	No effect of subsidy receipt on employment, but switch to normal hours and to formal care.
Crawford 2006	NSAF 1997	Effect of Receipt of subsidy on employment, working more than 15 and more than 35 hours per week.	Binary logit and OLS for hours model	21% for part-time 15% full-time 6.56 to 11.20 hours increase
Gelbach 2002	1980 Census	Effect of public school enrollment on employment (by quarter of birth of child)	Instrumental variables.	Significant increase

CHART OF CHILD CARE LITERATURE (Continued)

Study	Data	Question	Methods	Result
Han and Waldfogel 2001	March CPS 1991-1994 merged with SIPP	Quality of care and employment, single and married mothers with pre-school-aged children	Similar to Anderson and Levine 2000. Probit to get correction term for sample selection bias in the cost equation. Included state controls and variation in workers' wages. Another probit was estimated for mother's employment (binary).	Price effect on employment was higher for single than married. Price elasticity in range of −.30 to −.40 for married women and −.50 to −.73 for unmarried women.
Herbst 2010	1990 SIPP matched with 1990-2004 March CPS	Effect of child care expenditures (CCDF) and wages on employment, controlling for subsidies and EITC.	Simultaneously estimated probits	Largest EITC effect for low-wage mothers, largest subsidies effect for those facing high child care costs

CHART OF CHILD CARE LITERATURE (Continued)

Study	Data	Question	Methods	Result
Kimmel 1995	SIPP 1987-88	Single mothers' employment	Similar to Ribar 1992 and Connelly	White single mothers have highest response. Sliding scale fee is still effective. Price elasticity of -0.346 for all mothers, more for white than black
Kimmel 1998	1987 SIPP	Employment of single and married women.	Probit of labor force participation. Similar to Ribar 1992 and Connelly	Higher price elasticity for married mothers than single mothers. Single -0.22 Married -0.92

CHART OF CHILD CARE LITERATURE (Continued)

Study	Data	Question	Methods	Result
Meyers, Heintze and Wolf 2002	California welfare recipients	Effect of probability of receiving a subsidy on employment for low-income single mothers.	Two stage model predicting probability of subsidy receipt conditional of child care usage with a censored probit, then employment effects	Significant and positive and large. 10% increase in probability of receiving a subsidy leads to 9% increase in probability of employment

CHART OF CHILD CARE LITERATURE (Continued)

Study	Data	Question	Methods	Result
Michalopoulos Robins and Garfinkel 1992	SIPP 1984	Effect of child care expenditure and federal child care tax credit on labor supply in hours of work.	Structural Model in which quantity and quality of child care decision is estimated simultaneously as the employment decision. Certain parameters are estimated with bivariate probit.	Subsidies have a minimal effect on employment, and more of an effect on expenditure and quality of care. Simulation of refundable tax credit and progressive tax credit shows these better for low-income families.
Mroz 1987	Michigan Panel Study of Income Dynamics for 1975	Specification tests	Testig tobit assumptions to control for self-selection, tax rate, exogeneity of variables especially wage rate.	40-150 hours per year increase in labor supply per dollar increase in wage

CHART OF CHILD CARE LITERATURE (Continued)

Study	Data	Question	Methods	Result
Powell 1998	1988 Canadian National Child Care Survey and the 1988 Labour Market Activity Survey.	Price and part-time and full-time employment	Ordered probit	Price elasticities of -0.21 for part-time workers and and -0.71 for full-time workers.
Ribar 1992	SIPP 1984	Price effects on employment of married women and mode choice. Allows for different types of child care to be used at once.	Reduced form for hours worked, hours of paid care and hours of unpaid care. Work is estimated by probit. Use of paid and unpaid care is joint tobit estimation. There are five states allowed.	Price elasticity of -0.47 with respect to employment.

CHART OF CHILD CARE LITERATURE (Continued)

Study	Data	Question	Methods	Result
Tekin 2002	NSAF 1997	Price effect on full-time and part-time employment.	Wage and price of care estimated jointly with employment decision in a multinomial choice model (including full and part time) using full information maximum likelihood. A semi-parametric random effects estimator deals with correlation of error terms (not allowed for in multinomial logit). Gaussian quadrature for smoothing distribution in case of unobserved cases. Discrete choice indicator is included in utility fct. to measure fixed cost, eg. stigma of subsidy.	Full-time employment is more elastic with respect to price of care (-0.198) than part-time (-0.103), but both are more elastic with respect to wage, especially full-time wage.

CHART OF CHILD CARE LITERATURE (Continued)

Study	Data	Question	Methods	Result
Tekin 2004	NSAF 1999	Effect of subsidies on working standard hours among welfare recipients and non-recipients.	Discrete factor model (random effects) to simultaneously estimate binary subsidy receipt, standard hours and employment using full information maximum likelihood.	Subsidies cause a 6% increase in single mothers working standard jobs, and 14% increase in welfare recipients.
Tekin 2005	NSAF 1999	Effect of subsidy receipt on employment, and care mode.	Multinomial choice model. Discrete random effects specification for correlation of disturbances across modes.	Subsidies increased employment by 15.3%, and there is a shift toward center care.
Tekin 2007	NSAF 1997	Price of care and wage effects on part-time and full-time employment of single mothers.	Multinomial choice model after predicting price and wage. Simulations of wage subsidy and eligibility as alternatives to child care subsidies done using probability models.	Price elasticity of -0.139 for full-time and -0.068 for part-time employment. Estimates indicate that a child care subsidy is more cost-effective than a wage subsidy.

CHART OF CHILD CARE LITERATURE (Continued)

Study	Data	Question	Methods	Result
U.S. GAO 1994	National Child Care Survey, Urban Institute	Effect of price of care on the probability of working of poor, near-poor, and nonpoor mothers.	Structural probit with sample selection control from two stage Heckman (inverse mills ratio.)	Greatest price effect for poor and near-poor mothers (15% and 14% respectively).

BIBLIOGRAPHY

Abi-Habib, Natalie, Adam Safir, and Timothy Triplett. (2002). *NSAF Public User's Guide, Report No. 11.* The Urban Institute.

Anderson, Patricia M., and Philip B. Levine. (2000). Child care and mothers' employment decisions. In Finding jobs: Work and welfare reform, ed. Rebecca M. Blank and David Card. pp. 420–62. New York: Russell Sage Foundation.

Averett, Susan L., H. Elizabeth Peters, and Donald M. Waldman. (1997, February). "Tax Credits, Labor Supply, and Child Care." *Review of Economics and Statistics*. Retrieved from http://www.jstor.org/stable/pdfplus/2951439.pdf

Baum, Charles L. II. (2002, February). A Dynamic Analysis of the Effect of Child Care Costs on the Work Decisions of Low-Income Mothers with Infants. *Demography*, 39(1), 139-164. Retrieved from http://www.jstor.org/stable/3088368

Berger, Mark C. and Dan A. Black. (1992, November). Child Care Subsidies, Quality of Care, and the Labor Supply of Low-Income, Single Mothers. *The Review of Economics and Statistics*, 74(4), 635-642. Retrieved from http://www.jstor.org/stable/2109377

Blau, David M. (2001). *The child care problem : an economic analysis*. New York : Russell Sage.

----------. (2003) Child care subsidy programs. In: Moffitt R (ed) *Means-tested transfer programs in the United States*. University of Chicago Press for the NBER, Chicago, pp 443–516. Retrieved from http://www.nber.org/books/moff03-1

Blau, David M. and Alison P. Hagy. (1998). The demand for quality in child care. *Journal of Political Economy,* 106(1), 104–46. Retrieved from http://www.jstor.org/stable/10.1086/250004

Blau, David M. and Philip K. Robins. (1988, August). Child-Care Costs and Family Labor Supply. *The Review of Economics and Statistics*, 70(3), 374-381. Retrieved from http://www.jstor.org/stable/1926774

Blau, David M. and Philip K. Robins. (1991, August). Demand and Labor Supply of Young Mothers Over Time. *Demography*, 28(3), 333-351. Retrieved from http://www.jstor.org/stable/2061460?origin=JSTOR-pdf

Blau, David, and Erdal Tekin. (2007). The Determinants and Consequences of Child Care Subsidies for Single Mothers. *Journal of Population Economics,* 20, 719-741. Retrieved from http://www.springerlink.com/content/p607m616150105t1/?MUD=MP

Chen, Vivian W. and Krissy Zeiser. (2008). Implementing Propensity Score Matching Causal Analysis with Stata. Population Research Institute, Penn State University. Retrieved from http://help.pop.psu.edu/help-by-statistical-method/propensity-matching

Cohen, Philip N. & Suzanne M. Bianchi. (1999, December). "Marriage, children and women's employment, what do we know?". Bureau of Labor Statistics, Monthly Labor Review. Retrieved from http://www.google.com/url?q=http://bls.gov/mlr/1999/12/art3full.pdf&sa=U&ei=ogPNTumNL8LZtgeA5_lw&ved=0CBAQFjAG&client=internal-uds-cse&usg=AFQjCNFZ0PlBIpgyOWmx_CTEnO7WMH5m_w

Collins, Ann. (2011, May 27). Evaluation of Child Care Subsidy Strategies: Washington Site Public Use Files, 2005 [Computer file]. ICPSR29002-v1. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor]. doi:10.3886/ICPSR29002.v1

Connelly, Rachel. (1992). The effects of child care costs on married women's labor force participation. *Review of Economics and Statistics,* 74(1), 83–90. Retrieved from http://www.jstor.org/stable/2109545

Connelly, Rachel, and Jean Kimmel. (2001). The effect of child care costs on the labor force participation and welfare recipiency of single mothers: Implications for welfare reform. Working Paper no. 01-69. Kalamazoo, Mich.: Upjohn Institute, March. Retrieved from http:// www.upjohninstitute.org/publications/wp/01-69.pdf

----------. (2003, May 10). Marital status and full-time/part-time work status in child care choices. *Applied Economics*, 35(7), 761-778. Retrieved from Gale Cengage General Business File ASAP

Cox, J. Guzman. (2009, March). Child Care Subsidies and the Work Effort of Single Mothers. Retrieved from University of Chicago Lending Library. Working version retrieved from: http://www.google.com/url?sa=t&source=web&cd=4&ved=0CEEQFjAD&url=http%3A%2F%2Fwww.dii.uchile.cl%2F~cea%2Fsitedev%2Fdoc%2Fseminarios%2FJG_14_09_07.pdf&rct=j&q=Child%20Care%20Subsidies%20and%20the%20Work%20Effort%20of%20Single%20Mothers&ei=bw9-TqudAYLY0QHQ-_j8Dw&usg=AFQjCNHpAErtCB8Cdq_KC6oc8DGabfI0iw&cad=rja

Crawford, A. (2006). The Impact of Child Care Subsidies on Single Mothers' Work Effort. *Review of Policy Research*, 23(3), 699-711. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1541-1338.2006.00224.x/full

Gelbach, Jonah B. (2002, March). Public Schooling for Young Children and Maternal Labor Supply. *The American Economic Review* , 92(1), 307-322. Retrieved from http://www.jstor.org/stable/3083335

Han, W., & Waldfogel, J. (2001). Child Care Costs and Women's Employment: A Comparison of Single and Married Mothers with Pre-School-Aged Children. *Social Science Quarterly*, 82(3), 552-568. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/0038-4941.00042/abstract

Heckman, James J. (1979, January). Sample Selection Bias as a Specification Error *Econometrica*, Vol. 47, No. 1. pp. 153-161. Retrieved from http://links.jstor.org/sici?sici=0012-9682%28197901%2947%3A1%3C153%3ASSBAAS%3E2.0.CO%3B2-J

Herbst, C. M. (2010). The Labor Supply Effects of Child Care Costs and Wages in the Presence of Subsidies and the Earned Income Tax Credit. *Review of Economics of the Household*, 8(2), 199-230. doi:http://dx.doi.org/10.1007/s11150-009-9078-1

Hoffman, Saul D. (2009, February). The changing impact of marriage and children on women's labor force participation. Bureau of Labor Statistics, Monthly Labor Review. Retrieved from

http://www.google.com/url?q=http://www.bls.gov/opub/mlr/2009/02/art1full.pdf&sa=U&ei=ogPNTumNL8LZtgeA5_lw&ved=0CBIQFjAH&client=internal-uds-cse&usg=AFQjCNHcu6qP3UTBrxtOhj1DyoCq_iVM7w

Kimmel, Jean. (1995, May). The Effectiveness of Child Care Subsidies in Encouraging the Welfare-to-Work Transition of Low-Income Single Mothers. *American Economic Review*, 85(2), 271-275. Retrieved from http://www.jstor.org/stable/2117931

----------. (1998). Child care costs as a barrier to employment for single and married mothers. *Review of Economics and Statistics*, 80(2), 287–99. Retrieved from http://www.jstor.org/stable/2646639

MDRC. (2011). Evaluation of Child Care Subsidy Strategies. http://www.mdrc.org/project_11_38.html

Meyers, Marcia K., Theresa Heintze, and Douglas A. Wolf. (2002). Child care subsidies and employment of welfare recipients. *Demography*, 39(1), 165–80. Retrieved from http://www.jstor.org/stable/3088369

Michalopoulos, Charles. (2010). Effects of Reducing Child Care Subsidy Copayments in Washington State. Office of Planning, Research and Evaluation. Retrieved from http://www.mdrc.org/publications/580/overview.html

Michalopoulos, Charles, Philip K. Robins, and Irwin Garfinkel. (1992, Winter). "A Structural Model of Labor Supply and Child Care Demand." *Journal of Human Resources*. 166-203. Retrieved from http://www.jstor.org/stable/145916

Mroz, Thomas A. (1987, July). The Sensitivity of an Empirical Model of Married Women's Hours of Work to Economic and Statistical Assumptions. *Econometrica* , 55(4), 765-799. Retrieved from http://www.jstor.org/stable/1911029

National Women's Law Center. (2004, September). Child Care Assistance Policies 2001-2004: Families Struggling to Move Forward, States Going Backward. Retrieved from http://www.nwlc.org/our-resources/reports_toolkits/state-child-care-assistance-policies-report

Powell, L. M. (1998). Part-Time versus Full-Time Work and Child Care Costs: Evidence for Married Mothers. *Applied Economics*. 30(4), 503-511. Retrieved from Gale Cengage Academic Onefile

Rosenfield, Sarah. (1989, March). The Effects of Women's Employment: Personal Control and Sex Differences in Mental Health. *Journal of Health and Social Behavior*. 30(1), 77-91. Retrieved from http://www.jstor.org/stable/2136914

Ribar, David. (1992). Child care and the labor supply of married women: Reduced form evidence. *Journal of Human Resources,* 27(1), 134–65. Retrieved from http://www.jstor.org/stable/145915

----------. (1995). A structural model of child care and the labor supply of married women. *Journal of Labor Economics*, 13(3), 558–97. Retrieved from http://libres.uncg.edu/ir/uncg/f/D_Ribar_Structural_1995-2.pdf

Staiger, Douglas and James H. Stock. (1997, May). Instrumental Variables Regression with Weak Instruments. *Econometrica*, 65(3), 557-586. Retrieved from http://www.jstor.org/stable/2171753

Tekin, Erdal. (2002, May). Child care subsidies, wages, and employment of single mothers. Georgia State University, Department of Economics. Working Paper. http://www.econstor.eu/dspace/bitstream/10419/21424/1/dp517.pdf

----------. (2004). Single Mothers Working at Night: Standard Work, Child Care Subsidies, and Implications for Welfare Reform. NBER Working Paper No. 10274. Retrieved from http://www.nber.org/papers/w10274

----------. (2005). Child Care Subsidy Receipt, Employment, and Child Care Choices of Single Mothers. *Economics Letters*, 89(1), 1-6. Retrieved from Elsevier SD Freedom Collection. Or http://www.nber.org/papers/w10459

----------. (2007). Childcare Subsidies, Wages, and Employment of Single Mothers. *The Journal of Human Resources*, 42(2), 453-487. Retrieved from http://www.jstor.org/stable/40057313

U.S. Department of Health and Human Services. (2006). FFY 2002 CCDF Data Tables and 2002 CCDF State Expenditures. Administration for Children and Families. Retrieved from http://www.acf.hhs.gov/programs/occ/data/index.htm

Vasisht, A.K. "Logit and Probit Analysis". I.A.S.R.I., Library Avenue, New Delhi – 110 012 amitvasisht@iasri.res.in

Wooldridge, Jeffrey M. (2010). Econometric Analysis of Cross Section and Panel Data, Second Edition. Cambridge, MA: The MIT Press.