

# Child Support and Remarriage

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## Abstract

This paper models father's child support transfer and mother's remarriage decision jointly in a Stackelberg game setup, assuming father's type is unknown to the mother after divorce. When solved at the equilibrium, lower transfer and higher chance of remarriage are expected than with symmetric information. Using income volatility as an approximate measure of information asymmetry, empirical evidence from the Panel Study of Income Dynamics (PSID) and supplemental datasets is found to support the transfer statement, even with a series of alternative hypotheses ruled out. Associated with 1% increase in the income variation/level ratio, the annual reduction in child support transfer is estimated to be \$6-23 in amount or 0.7-1.3% in likelihood, depending on the measure of information asymmetry used. As a by-product, the model also points to a positive bias in the conventional estimate of remarriage-transfer relationship, which could be the reason for lack of consistent evidence in the literature.

**JEL Classification Numbers:**

**Keywords:** child support, remarriage, information asymmetry

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# 1 Introduction

Single-parent female-headed families are a large and growing proportion of all families and comprise a disproportionately large share of the poor population. According to U.S. Census, in 2007, 23% of children less than 18 years old lived with their mother only, and 3% lived with their father only. Among those female-headed families, 40% children lived under poverty and only 30% received child support from divorced fathers <sup>1</sup>. The failure of many divorced fathers to comply with court-mandated child support awards has been identified as a major reason why a growing number of children live in poverty in female-headed households (Beller and Graham 1985).

A variety of reasons have been identified for inadequate transfer by divorced father, but few of them considers the endogenous role of mother's remarriage and is unsatisfactory in some way. Single mothers have several options to counteract their decline in economic well-being upon divorced, including joining the labor force and living on social welfare benefits. Faced with constrained options in the labor market by low experience levels or high need for children care, and inadequate or short term welfare benefits, however, the surest one is remarrying someone to share the burden of supporting family (Folk, Graham, and Beller 1992). Therefore, one might expect child support and remarriage to be correlated. However, both theoretical and empirical research provides inconclusive answers to the relationship between father's transfer and mother's remarriage in both direction and magnitude, while treating remarriage decision as exogenous.

In this paper, I jointly analyze the size of divorced father's transfer and its relationship with single mother's remarriage decision in a Stackelberg game model. Assuming father has private information after divorce affecting his transfer behavior, he would strategically underpay to send twisted signal of his type to his ex-wife. In this way, father encourages mother's remarriage decision and therefore circumvents his own transfer obligation. Results from this model predict that higher degree of information asymmetry about father's type is associated with lower amount of child support transfer. To test this prediction empirically, five measures of father's income variation are created as instruments for private information: scaled standard deviation, mean squared change, recent mean squared change, self-employed dummy, and

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<sup>1</sup>U.S. Census, American's Families and Living Arrangements, 2007, table C3, available at <http://www.census.gov/population/www/socdemo/hh-fam/cps2007.html>.

squared residual of income equation. Both child support amount and dummy received by mother are fitted using OLS and Probit model on these measures separately, and significantly negative impact of income variation on both transferred amount and frequency are obtained. These results are robust to alternative hypotheses, because similar results survive even with the additional controls of father's divorced income level, degree of precautionary saving motive, and frequencies of activities with the child.

The plan of the paper is as follows. Section 2 briefly reviews the literature background. In Section 3, I provide an exposition of modeling assumptions and divorced parents' equilibrium behavior in a structural model. The analysis leads to two statements about optimal transfer, remarriage probability, and information asymmetry. After describing the PSID and supplemental datasets in Section 5, I present reduced form evidence on the statement of optimal transfer in Section 6.2. Results in this section are shown to be robust, as alternative hypotheses are ruled out. Finally, Section 7 offers some concluding remarks.

## **2 Literature**

### **2.1 Noncustodial Parent's Flexibility to Pay**

Analysis of agent's optimal behavior requires freedom in decision making. This is also the case for noncustodial parent's child support payment. Although legislation have been enacted to enforce court-ordered award, noncustodial parents can always have some freedom in paying.

By law, the noncustodial parent is required to pay child support based on the needs of the child, the income of the custodial parent, and the paying parent's ability to pay, until the child reaches the age of 18 years old. When the noncustodial parent fails to pay, the law enacts various methods of enforcement through The Child Support Enforcement Program. Enforcement methods include interception of tax refunds, wage attachments, seizing property, and as a last resort, the court can even hold the payer in contempt and impose a jail term.

In practice, however, the payer can always have some degree of freedom in choosing whether and how much to pay. For one thing, a person may petition the court for a reduction, if he/she becomes unable to pay support for whatever reason. For another, he/she can move in a different state than his/her ex, where interstate support order enforcement is very less likely due to the process complexity and the low priority assigned. Last, the contempt

power is sparingly exercised by courts, because most judges would rather keep the payer out of jail where he/she has a chance of earning the income necessary to pay the support. Such transfer flexibility in legal system enables analysis of transfer pattern as a rational behavior result.

## 2.2 Theoretical Explanations for Low Child Support Transfer

Focusing on the female-headed families, a variety of possible reasons have been proposed to explain why so many divorced fathers allow their children's welfare to suffer as a consequence of divorce (Weiss and Willis 1985).

Among the poor and near poor, the existence of AFDC/TANF welfare program obviously creates a disincentive for child-support transfer from father because it will be offset by reductions in welfare transfer. The Child Support Amendments of 1984 entitled the custodial family on AFDC to receive only the first \$50 collected in child support each month, referred to as the "\$50 pass through" or the "\$50 disregard," as this \$50 was not to be included in the determination of AFDC eligibility or payment amounts (Barnow, Dall, Nowak, and Dannhausen 2000). When covered by the welfare program, each additional dollar transferred from father to mother would increase her well-being and therefore reduce welfare benefits entitled by the same amount.

However, the problem of inadequate transfer and noncompliance by divorced father is not confined to the poorest segments of society. Even fathers who have a considerable "ability to pay" often do not comply with court awards, and the amounts awarded are often of fairly modest magnitude (Cassetty 1978, Chambers 1979, Sorenson and MacDonald 1983). This evidence suggests another possibility that divorce itself results in a reduction of the joint real income of the couple, so that the living standards of the couple and their children achieved under marriage are no longer feasible. Such income losses may be due to the costs of divorce itself, to the loss of gains from the division of labor and scale economies associated with marriage, or to labor market reversals caused by or resulting in divorce.

While divorce doubtless inflicts economic costs, there is evidence that the living standards of (noncustodial) divorced father tend to suffer far less than do the living standards of the (custodial) mother and her children (Hoffman 1977, Weitzman 1981, Bane and Ellwood 1983b). To interpret such phenomenon, Weiss and Willis (1985) model children as collective

consumption goods from the father's and mother's point of view. Within marriage, proximity and altruism serve to overcome the "free-rider" problem associated with the provision of public goods. Upon divorce, however, the noncustodial parent suffers a loss of control over the allocation decisions of the custodial parent, and therefore reveals a reduced interest in the welfare of their children.

To my knowledge, the only study that interprets this phenomenon taking mother's remarriage as endogenous is by Chiappori and Weiss (2007). Because of potential conflict with the new husband who cares less about the child, a transfer that guarantees that the custodial wife, if single, would be restored to the same level of child expenditure as under marriage is insufficient to maintain that level of child expenditure if she remarries. There is thus room for additional payment by the father to boost her bargaining power on child expenditure with the new husband. A higher transfer level, however, also reduces his own utility; therefore the optimal transfer is solved by maximizing his expected utility upon separation. Furthermore, a symmetric equilibrium where all agents act in the same way is solved to match divorce probability with remarriage probability in the marriage market. Without empirical evidence, they conclude that the higher expectations for remarriage following from higher divorce rates can trigger an equilibrium in which divorced father makes more generous transfers than what guarantees the same level of child expenditures as under marriage to benefit both this child and the mother in the aftermath of divorce. Such a conclusion is apparently inconsistent with the fact that child always suffer from lower living standards than under marriage.

### **2.3 Empirical Relationship between Remarriage and Child Support**

Using cross-sectional data from March/April match file of the Current Population Survey, Folk, Graham, and Beller (1992) indicate that child support receipt is not related to remarriage for those divorced women who remarry quickly (within the first five years). For those who are not married five years after their divorce child support does lower the probability of remarriage but the effect is very small. However, as the authors indicate, those who are unmarried five years or more after their divorce may differ from women who remarry more quickly on unobservable factors that also affect their probability of remarrying. Those who remain unmarried after five years may be negatively selected on, for example, income, which would raise their child support, *ceteris paribus*, and provide the observed result.

Using four longitudinal datasets <sup>2</sup>, Yun (1992) undertakes event history analysis and finds that the relationship between child support transfer and remarriage is nonlinear. Receiving any child support makes remarriage more likely, but the strength of this influence wanes as the amount of child support paid grows. Additionally, continuity in transfer is important. Those mothers who do not receive regular amounts of transfer on a steady basis are more likely to remarry. Yun also examines the quality of the new partners as proxied by their income and education level. Theory would predict that those who do not receive child support marry men of lower quality, for they must marry more quickly for economic security reason and can only undertake a short search. This prediction is upheld when income is used to measure men's quality, but not when education is used.

In short, researchers tend to find a mild negative effect of child support on remarriage. But they do not provide conclusive answers to the issue of either direction or magnitude.

### 3 Theoretical Model

The model built in this paper describes the mechanism through which father's optimal transfer and mother's remarriage decision are made jointly on the **household** level. The introduced concept of father's information asymmetry to the mother enables him to strategically choose transfer amount through a Stackelberg game. Suppose the mother is more likely to get remarried, if the father pays less (could be the other way around). Then the father would intentionally pay less to encourage her remarriage, if remarriage makes him better off by transferring the burden of child rearing to the stepfather. Otherwise, if he is worse off by the remarriage as he enjoys lower psychic returns from the child, he would want to pay more.

As a comparison, Chiappori and Weiss (2007) also study optimal transfer and remarriage decision jointly, but through an **aggregate** remarriage market equilibrium with **symmetric** information. Compared with the general remarriage market, the micro characteristics of divorced partners are more likely to be the influential factors in their decision making. To relate the level of payment with clearing of overall remarriage market might be too strong an assumption to impose. Furthermore, the assumption of symmetric information after divorce

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<sup>2</sup>The Court Record Database (CRDB), tax records, welfare records, and the Parent Survey. The first three are administrative records collected by counties of the state of Wisconsin. The fourth dataset is conducted by the Institute for Research on Poverty, University of Wisconsin-Madison.

is also a strict restriction to impose, as divorced partners are only loosely related to each other both physically and mentally. The idea that “far from sight is far from heart” reflects reduced interest in child by an unknown magnitude. Therefore in this paper, transfer and its relationship with remarriage are modeled on a household level, with the assumption of symmetric information relaxed. The following sub-sections describe modeling assumptions and partners’ equilibrium behavior.

In the rest of the paper, I assume:

**Assumption 1.** The mother is child’s custodial parent.

**Assumption 2.** Both father and mother live for two periods after divorce. The father never remarries, and pays child support only when she remains single. The mother remains single in the first period, and considers remarriage in the second.

**Assumption 3.** The remarriage proposal arrives at beginning of second period. The stepfather decides on child expenditure exogenously, without bargaining with mother. The mother decides whether to accept remarriage offer or not.

**Assumption 4.** Father’s and stepfather’s utility are linear in adult good and quadratic in child good:  $U_{it}(c_{it}, a_{it}) = a_{it} + \beta(c_{it} - \frac{c_{it}^2}{2\alpha_i})$ , where  $i = \{f, s\}, t = \{1, 2\}$ , father’s type  $\alpha_f$  is unknown to the mother after divorce, and stepfather’s type  $\tilde{\alpha}_s \sim U(0, \frac{1}{k})$ . Mother’s utility depends on child good alone:  $U_{mt}(c_t) = c_t, t = \{1, 2\}$ .

**Assumption 5.** Father and stepfather have fixed income level  $Y_f$  and  $Y_s$ , respectively. Mother has no income. No saving is allowed.

### 3.1 Legal Framework, Timing and Matching

Without loss of generality, I assume the mother is child’s custodial parent.

By assumption, both parents live for two periods after divorce. The father is assumed to never remarry after divorce, and pays child support only if the mother is single<sup>3</sup>. The mother, on the other hand, is assumed to remain single in the first period, and consider remarriage only in the second. These assumptions are made for theoretical simplicity, while the main results of this paper will not be changed upon relaxation of these assumptions.

At the beginning of second period, she receives a remarriage proposal with a random type

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<sup>3</sup>Previous studies have found that remarried mothers are less likely to receive child support and receive significantly less than do other eligible mothers (Beller and Graham 1985; Cassetty 1978).

in child preference, the value of which is unknown until the proposal arrives. To focus on the play between biological parents, bargaining between mother and new spouse is assumed away, so that stepfather alone gets to decide how much to spend on the child after remarriage, based on his exogenously random type. When he proposes such offer to the mother, she responds by either accepting or rejecting the offer, depending on whether her expected second period utility is improved. If she's better off with the new husband, remarriage occurs. Otherwise, remarriage proposal is rejected.

### 3.2 Preferences and Endowments

Following Chiappori and Weiss (2007), I assume in each period both father's and stepfather's utility depends on two goods, an adult good  $a_{it}$  and a child good  $c_{it}$ , where  $i = \{f, s\}$  denotes father and stepfather, and  $t = \{1, 2\}$  denotes periods. There are two parameters  $\alpha_i, \beta$  that govern their preference:

$$U_{it}(c_{it}, a_{it}) = a_{it} + \beta(c_{it} - \frac{c_{it}^2}{2\alpha_i}) \quad (1)$$

where  $\beta$  is a discount factor for proximity from Chiappori and Weiss (2007)<sup>4</sup>, and  $\alpha_i$  is my metric for how much father or stepfather cares about the child—the type. They allocate their exogenous income  $Y_i$  between  $a_{it}$  and  $c_{it}$  in each period, and no saving is allowed. The unit price of child's goods is assumed to be 1. All this information is common knowledge, so that the mother knows it as well as the father and the stepfather.

The main difference between father's and stepfather's behavior stems from the different assumptions about  $\hat{\alpha}_f$  and  $\tilde{\alpha}_s$ . In particular, I assume stepfather's type  $\tilde{\alpha}_s$  is a random draw from  $U(0, \frac{1}{k})$  distribution, where  $k$  is a parameter evaluating the inverse of mother's remarriage propensity. Neither mother nor father can predict the potential stepfather's type, until the beginning of the second period when remarriage proposal is made. By contrast, father's type after divorce,  $\hat{\alpha}_f$ , is his private information, and varies across fathers. Whether far from sight is far from heart or to what degree the father wants to compensate the child for the loss of

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<sup>4</sup>By analyzing questionnaire data from 2,247 respondents, Wilson, Zurcher, McAdams, and Curtis (1975) find little differences between natural children and stepchildren. Duberman (1973), using a random sample of stepparents who married during the years 1965-68 in Ohio, find 18, 18, and 64 percent rated their stepparent-stepchild relationships as "poor", "good", and "excellent". Such observations may not be surprising, as higher marital quality is found to be associated with more positive stepparent-stepchild relationship in Brand and Clingempeel (1987).

an intact family is a personal matter to himself, and may not be observable to the mother. In other words, I'm assuming  $\hat{\alpha}_f$  as the source of information gap between mother and father.

To focus analysis on the father's strategic behavior, I assume away the complexity involved in mother's resource allocation, so that her utility is solely dependent on child's consumption  $c_t, t = \{1, 2\}$ . This is equivalent to assume no income of mother's after divorce. As a result, her second period utility is either father's child support transfer if she remains single or stepfather's child expenditure if she remarries.

### 3.3 Time Line

Figure 1 describes the procedures involved in this two-period model. In the first period, the father starts with a transfer level  $c_{f1}$ , and in the second period, a potential stepfather arrives with an exogenous altruism level  $\tilde{\alpha}_s$ . If the mother agrees to remarry with him, he promises to pay  $c_{f2}$  on child expenditure in the second period, which is a function in  $\tilde{\alpha}_s$ . The mother, being unable to forecast father's second period payment beforehand because of information asymmetry, forms some expectation of father's next payment based on what he paid previously, and compares it with the stepfather's potential transfer in making remarriage decision. Since her own utility is also child's utility, the decision is based on whoever favors the child more and promises better child welfare.

On one hand, if she remarries, father doesn't have to pay anything and enjoys the free-rider benefit of stepfather's transfer through the child's welfare. Therefore his second period optimal utility when she remarries indirectly depends on stepfather's type  $\tilde{\alpha}_s$ . On the other hand, if she decides to accept the remarriage offer, the father would have to decide on his second period payment optimally given his own preference  $\hat{\alpha}_f$ . Knowing all these rules of mother's remarriage and stepfather's resource allocation, the father would have incentive to strategically pick his transfer level  $c_{f1}$  in the first period so as to maximize his lifetime utility through manipulating mother's remarriage decision.

### 3.4 Backward Induction Algorithm

This two-period model is solved following the backward induction algorithm, by going backward from the second period. Both stepfather's and father's second period resource allocation problems when mother remarries or not are solved in the first place, followed by mother's sec-

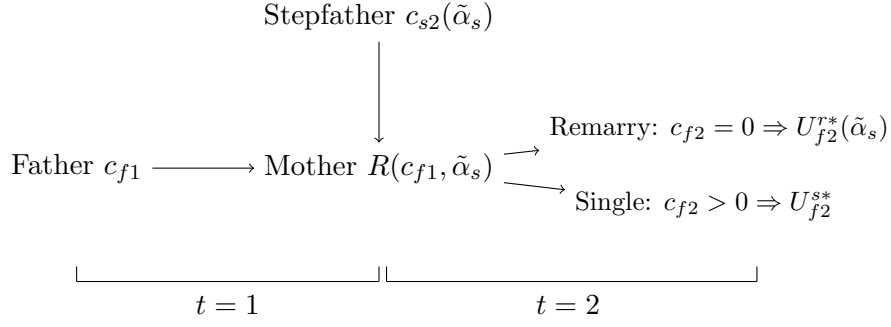


Figure 1: Time Line

second period remarriage problem given father's first period payment and stepfather's potential transfer in the future. Finally, with all these intermediate outcomes taken into account, an optimal level of  $c_{f1}$  is picked by the father to maximize his lifetime utility.

### 3.4.1 Stepfather's Second Period Problem

In the second period, if mother decides to accept the remarriage proposal, the stepfather's optimization problem is to allocate his income  $Y_s$  between adult good  $a_{s2}$  and child good  $c_{s2}$ , in order to maximize his current utility under income constraint:

$$\begin{aligned} \text{Max } U_{s2}(c_{s2}, a_{s2}) &= a_{s2} + \beta(c_{s2} - \frac{c_{s2}^2}{2\tilde{\alpha}_s}) \\ \text{s.t. } c_{s2} + a_{s2} &= Y_s \end{aligned} \quad (2)$$

The quadratic nature of his preference leads to an optimal transfer linear in his type:

$$\begin{cases} c_{s2}^*(\tilde{\alpha}_s) &= \tilde{\alpha}_s(1 - \frac{1}{\beta}) \\ a_{s2}^*(\tilde{\alpha}_s) &= Y_s - \tilde{\alpha}_s(1 - \frac{1}{\beta}) \end{cases} \quad (3)$$

To make meaningful sense, I assume  $\beta(\tilde{\alpha}_s)$  is larger than 1 so that  $c_{s2}^* > 0$ .

The same child expenditure indirectly affects father's second period utility through child's welfare. By spending all his income on adult goods and enjoying a free-rider benefit of stepfather's transfer, the father ends up having an optimal second period utility when she

remarries as a function in stepfather's type  $\tilde{\alpha}_s$ :

$$U_{f2}(c_{s2}^*, Y_f) = Y_f + \beta[\tilde{\alpha}_s(1 - \frac{1}{\beta}) - \frac{\tilde{\alpha}_s^2}{2\dot{\alpha}_f}(1 - \frac{1}{\beta})^2] \equiv U_{f2}^{r*}(\tilde{\alpha}_s) \quad (4)$$

### 3.4.2 Father's Second Period Problem

In cas the mother declines the remarriage proposal and remains single, however, the father would have to solve a similar problem and allocate his income  $Y_f$  optimally between adult good  $a_{f2}$  and child good  $c_{f2}$  in the second period. Only that now income constraint becomes  $Y_f$ , and type of altruism towards child becomes  $\dot{\alpha}_f$ :

$$\begin{aligned} \text{Max } U_{f2}(c_{f2}, a_{f2}) &= a_{f2} + \beta(c_{f2} - \frac{c_{f2}^2}{2\dot{\alpha}_f}) \\ \text{s.t. } c_{f2} + a_{f2} &= Y_f \end{aligned} \quad (5)$$

The quadratic nature of his preference again leads to an optimal transfer linear in his type:

$$\begin{cases} c_{f2}^* &= \dot{\alpha}_f(1 - \frac{1}{\beta}) \\ a_{f2}^* &= Y_f - \dot{\alpha}_f(1 - \frac{1}{\beta}) \end{cases} \quad (6)$$

Substituting the solutions back into father's utility function generates his optimal second period utility when she remains single:

$$U_{f2}(c_{f2}^*, a_{f2}^*) = Y_f - \dot{\alpha}_f(1 - \frac{1}{\beta}) + \beta[\dot{\alpha}_f(1 - \frac{1}{\beta}) - \frac{\dot{\alpha}_f}{2}(1 - \frac{1}{\beta})^2] \equiv U_{f2}^{s*} \quad (7)$$

This fixed amount  $U_{f2}^{s*}$  is the best he can do under the circumstances, once she remains single in the second period.

### 3.4.3 Mother's Second Period Problem

The mother's remarriage decision at the beginning of second period is made by maximizing her expected second period utility. Since mother's utility is simply child good by assumption,

to make the remarriage decision is simply to pick whoever favors the child more:

$$R = \begin{cases} 1 & \text{if } c_{s2}^* \geq c_{f2}^* \\ 0 & \text{if } c_{s2}^* < c_{f2}^* \end{cases} \quad (8)$$

From the optimal child support expressions obtained in Equation (3) and (6), the criterion reduces to a comparison between father and stepfather's type:

$$R = \begin{cases} 1 & \text{if } \tilde{\alpha}_s \geq \dot{\alpha}_f \\ 0 & \text{if } \tilde{\alpha}_s < \dot{\alpha}_f \end{cases} \quad (9)$$

only that  $\dot{\alpha}_f$  is father's private information and unknown to the mother.

The key innovation of this paper is to introduce a functional form  $g(\cdot)$  which links father's first period payment  $c_{f1}$  and his type  $\dot{\alpha}_f$ , from the mother's perspective. This represents a mechanism through which, she believes, his previous payment and type are related. Notice that this ex ante expectation needs to coincide with eventually at equilibrium, but for the time being, it can be anything and doesn't have to coincide with anything, including the true formula derived in Equation (6).

Substituting  $g(\cdot)$  back into mother's remarriage decision, the threshold value of stepfather's type that makes her indifferent between remaining single and remarriage is a function in father's first period payment and stepfather's type, and so is her remarriage decision:

$$R(c_{f,1}, \tilde{\alpha}_s) = \begin{cases} 1 & \text{if } \tilde{\alpha}_s \geq g(c_{f1}) \\ 0 & \text{if } \tilde{\alpha}_s < g(c_{f1}) \end{cases} \quad (10)$$

By introducing  $g(\cdot)$ , I've modeled mother's second period remarriage problem as an endogenous function in father's first period payment. Knowing such remarriage rule beforehand, the father would be not only capable of but also motivated to control her decision making to his own interest through strategic first period payment.

#### 3.4.4 Father's First Period Problem—Equilibrium

Given his second period utility formulas in Equation (7) and (4), and mother's reaction function in Equation (10), father's problem at the beginning of first period is to pick the

optimal level of  $c_{f1}$  so as to maximize his lifetime utility subject to the budget constraint:

$$\begin{aligned}
\max_{a_{f1}, c_{f1}} \quad & U_{f1}(c_{f1}) + \rho E_{\tilde{\alpha}_s} [U_{f2}(\tilde{\alpha}_s)] \equiv a_{f1} + \beta(c_{f1} - \frac{c_{f1}^2}{2\dot{\alpha}_f}) + \\
& \rho \left\{ \int_{\tilde{\alpha}_s > g(c_{f1})} U_{f2}^{r*}(\tilde{\alpha}_s) f(\tilde{\alpha}_s) d\tilde{\alpha}_s + U_{f2}^{s*} F_{\tilde{\alpha}_s} [g(c_{f1})] \right\} \tag{11} \\
\text{s.t.} \quad & Y_f = c_{f1} + a_{f1} \\
& \dot{\alpha}_f = g(c_{f1}) \\
\text{where} \quad & U_{f2}^{s*} \equiv Y_f - \dot{\alpha}_f(1 - \frac{1}{\beta}) + \beta[\dot{\alpha}_f(1 - \frac{1}{\beta}) - \frac{\dot{\alpha}_f}{2}(1 - \frac{1}{\beta})^2] \\
& U_{f2}^{r*}(\tilde{\alpha}_s) \equiv Y_f + \beta[\tilde{\alpha}_s(1 - \frac{1}{\beta}) - \frac{\tilde{\alpha}_s^2}{2\dot{\alpha}_f}(1 - \frac{1}{\beta})^2] \\
& f(\tilde{\alpha}_s) \equiv k, \text{ for } \tilde{\alpha}_s \in [0, \frac{1}{k}] \\
& g(\cdot) \text{ is unknown}
\end{aligned}$$

The appended  $U_{f2}^{s*}$  and  $U_{f2}^{r*}(\tilde{\alpha}_s)$  expressions are obtained from backward induction algorithm in Equation (7) and (4).  $f(\cdot)$  is density function for  $\tilde{\alpha}_s$ . Functional form of  $g(\cdot)$  is unknown and needs to be solved.

The targeted  $c_{f1}$  affects value function not only through his instant utility but also his subsequent expected utility via the integration bound for remarriage and likelihood of remaining single. The second link-form restriction is imposed, as equilibrium requires all agents in the game to act optimally, given their expectations, and those expectations are realized. In a hypothetical world with infinite horizon, the mother would keep updating her expectation until it's matched with the father's true type. In particular, if her guess was too high, she would have remained single too often, missing the opportunity to take the advantage of a better new spouse; if her guess was too low, she would have remarried too often and could've done better by remaining single. The two period assumption simplification is only for analytical convenience, and nothing special about it prohibits the original model from being extended into infinite horizon.

It's worth noting that from the perspective of the father, the equality restriction simply implies that to choose an optimal value of  $c_{f1}$  is equivalent to choose an optimal functional form of  $g(\cdot)$ , as  $\dot{\alpha}_f$  is nothing but a known constant to the father. However, one must resist the temptation to substitute it right into the integration bound of objective function before taking derivatives, because the bounds should be viewed as a function through which  $c_{f1}$  impacts second period utility, and substitution of equality restriction into the integration

bound would reduce the whole integration term into a mere fixed amount, and drop it out of the first order condition entirely. Apparently, that will eliminate the necessary mechanism through which father manipulates mother's decision. With that being said, application of the equality restriction is valid only for cancellation purpose, as opposed to differentiation.

### 3.4.5 Equilibrium Solution and Statements

From the constrained first order condition, two equilibrium levels of  $c_{f1}$  are solved<sup>5</sup>. One is higher and the other is lower than the innocent level without information asymmetry as obtained in Equation (6):

$$c_{f1}^* = \dot{\alpha}_f \left(1 - \frac{1}{\beta}\right) \left(1 \pm \sqrt{1 + \frac{2k\rho(\dot{\alpha}_f - C)}{1 - \beta}}\right) \quad (12)$$

where  $C$  is any constant. So in mathematic terms, it's equally profitable for him to either strategically underpay or overpay child support, compared to the amount without information asymmetry.

Unfortunately, neither of them could be ruled out by second order condition, which is always negative as long as  $\beta > 1$ . However the first order derivative reveals that only the lower amount indicates a positive comovement between what he pays and how much he cares about the child:

$$g'(c_{f1}^*) = \frac{\beta^2}{k\rho\dot{\alpha}_f^2(1 - \beta)} [c_{f1}^* - \dot{\alpha}_f \left(1 - \frac{1}{\beta}\right)] > 0 \quad (13)$$

while the higher amount implies a negative correlation. The negative correlation is obviously against the common sense and derived formula in Equation (6), therefore the higher solution is excluded by means of economic meanings.

That leaves the unique economically sensible equilibrium solution:

$$c_{f1}^* = \dot{\alpha}_f \left(1 - \frac{1}{\beta}\right) \left(1 - \sqrt{1 + \frac{2k\rho(\dot{\alpha}_f - C)}{1 - \beta}}\right) \quad (14)$$

which is lower than the innocent level under symmetric information in Equation (6). The decreased amount is used to signal and pretend he is this careless father that he is really

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<sup>5</sup>See Appendix for mathematic derivation.

not. Even though the father does care about his child, he would not want the mother to think this way, as convincing the mother that he is a bad type would increase her remarriage likelihood and his chance of enjoying the free-rider benefit from the stepfather. Here comes the statement of this paper:

**Statement.** *With information asymmetry, the father’s optimal transfer is lower than it would be under symmetric information.*

From mother’s remarriage reaction function in Equation (10), the mother’s remarriage likelihood is the difference between upper bound of  $\tilde{\alpha}_s$  distribution and her threshold value  $g(c_{f1}^*)$ :

$$\Pr(\text{remarry}) = \frac{1}{k} - g(c_{f1}^*) \quad (15)$$

Two corollaries about remarriage likelihood can be derived from this formula.

**Corollary 1.** *With information asymmetry, the mother is more likely to remarry than she would be under symmetric information.*

**Corollary 2.** *Conventional causal effect estimates of fathers transfer on mothers remarriage suffer from upward endogeneity bias.*

First of all, lower transfer also implies higher remarriage likelihood with asymmetric information than under symmetric information. Secondly, in view of Equation (13), child support should be negatively correlated with remarriage ceteris Paribas, but conventional estimate of its causal effect on remarriage may have suffered from an unobserved bias, as the unobserved  $k$  parameter in remarriage equation also enters the equilibrium formula of  $c_{f1}^*$  as in Equation (14). In particular,  $c_{f1}^*$  and  $k$ , and remarriage probability and  $k$  are both negatively correlated, so that failure to explicitly control  $k$  would bias the estimates upward. This perhaps explains the lack of consistent evidence in the empirical literature. Such a bias could be removed by using instrumental variables for father’s transfer that are not related to mother’s remarriage propensity, which holds its own interest and is beyond the scope of current paper.

## 4 Empirical Estimation

### 4.1 Information Asymmetry Measurement

Although the theoretical model is all about the uncertainty in how much the father cares about the child, one could easily imagine that uncertainty in father's income level is equivalent to uncertainty in altruism in creating the same necessary information gap through which father's manipulation is made possible. Which one to assume information asymmetry about will not change the main results, and is only a matter of analytical convenience. In the theoretical part, information asymmetry about altruism is adopted because the specific utility functional form predicts a linear optimal payment in type. In the empirical test, however, measures on emotional attitudes are usually difficult to obtain<sup>6</sup>, and income volatility is always a readily available measure that also reflects mother's difficulty in predicting his allocable resources. Therefore uncertainty in income level is adopted to measure information asymmetry in the following.

In order to test the main statement, scaled measures of father's income volatility are constructed within marriage. Father's income volatility after divorce is not observable to the mother, and therefore irrelevant to the analysis. Here is a list of all income volatility measures adopted:

1. Mean accumulated scaled standard deviation of labor income in logarithm:

$$\frac{1}{T} \sum_{t=1}^T \frac{[\sum_{s=1}^t (y_s - \bar{y}_s)^2]}{t * \bar{y}}$$

where  $y_s$  is logarithm of father's labor income at period  $s$ ,  $\bar{y}_s = \frac{\sum_{s=1}^t y_s}{t}$  is the accumulated mean up until period  $s$ , and  $\bar{y} = \frac{\sum_{s=1}^T y_s}{T}$  is the averaged level over all  $T$  years when father was married with this woman;

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<sup>6</sup>Even in finance literature where information asymmetry is extensively analyzed, information asymmetry has to be approximated by some proxy variables, for instance, firm's investment opportunity set and consensus analysts' forecasts of earnings per share. See Clarke and Shastri (2000) for a summary on proxies for information asymmetry in finance literature.

2. Mean accumulated scaled mean squared change of logarithm labor income:

$$\frac{1}{T} \sum_{t=1}^T \frac{[\sum_{s=2}^t (y_s - y_{s-1})^2]}{(t-1) * \bar{y}};$$

3. Mean accumulated scaled mean squared change of logarithm labor income over the last three available years:

$$\frac{1}{T} \sum_{t=1}^T \frac{[\sum_{s=t-2}^t (y_s - y_{s-1})^2]}{3 * \bar{y}};$$

4. Mean accumulated frequency for being self-employed:

$$Mode_{t=1}^T [Mode_{s=1}^t (\mathbf{1}(\text{Self-employed})_s)]$$

5. As an exception, the only measure of information asymmetry built through father's divorced records is the scaled squared residual from fitting his divorced logarithm labor income on historical records within marriage:

$$\ln(y_{ft}^D) = \alpha_1 X_f^M + \epsilon_t \Rightarrow \hat{\epsilon}_t \Rightarrow \frac{\hat{\epsilon}_t^2}{\bar{y}} \quad (16)$$

where  $y_{ft}^D$  is father's labor income at period t in divorce.  $X_f^M$  contains constant and his averaged demographic attributes within the previous marriage, including labor income, age, education, race, number of kids, residence within a Primary Metropolitan Statistical Area (PMSA) and within the central city, state, region, and year dummies.  $\epsilon_t$  is an idiosyncratic error term.  $\alpha_1$  is coefficient vector to be estimated.

A practical problem with the last information asymmetry measure is that data on divorced spouses upon separation seldom coexist. This is because micro surveys are usually carried out on a household basis, and divorced spouse always moved away. For instance, in the PSID dataset to be used here, only family unit of either spouse but not both are covered in a divorce or separation, depending on who was found first for the interview. Consequently, any information on the absent spouse after divorce needs to be simulated. In the following, I take female sample as basis and simulate missing

divorced father’s information from his within marriage historical records based on coefficient estimates from male sample. To do that, the following equation will be first estimated using male sample:

$$\frac{\hat{\epsilon}_t^2}{\bar{y}} = \alpha_2 X_f^M + \zeta_t \quad (17)$$

where  $\alpha_2$  is coefficient vector to be estimated from father’s subsample and  $\zeta$  is an i.i.d error term. Then the last measure is obtained by  $\hat{\alpha}_2 X_f^M$ , with  $X_f^M$  being father’s averaged within-marriage historical records in female sample.

## 4.2 Transfer Statement

With the above constructed information asymmetry measures, the main statement can be tested by estimating the following regression:

$$Transfer_{mt}^D = \beta_1 Asym_f^M + \beta_2 X_{mt}^D + \eta_t \quad (18)$$

where  $Transfer_{mt}^D$  is child support received by mother,  $Asym_f^M$  is father’s marriage-specific information asymmetry measure as defined in Section 4.1, and  $X_{mt}^D$  contains mother’s characteristics in divorce at period  $t$ , including age, race, education, total income, welfare participation status, number of kids, marriage duration, the number of years since divorce, residence within a Primary Metropolitan Statistical Area (PMSA) and within the central city, state, region, and year dummies.  $\eta_t$  is an i.i.d. error term.  $\beta$ ’s are coefficient vectors to be estimated. Equation (18) will be fitted by both OLS and Probit, with dependent variable being received amount and dummy.

Variation in key explanatory regressor  $Asym_f^M$  could be driven by fathers’ different risk aversion taste, and the remaining variation in error term  $\eta_t$  could be due to the varying magnitude of discount factor  $\beta$  in Equation (1) among different fathers.

## 4.3 Alternative Hypotheses

Approximating information asymmetry with income volatility is not error proof, because income volatility may have some other negative impact on child payment, even without strategic consideration. Therefore one should be cautious in drawing conclusions on the transfer statement based solely on a negative  $\hat{\beta}_1$  estimate from Equation (18). The multiple channels that

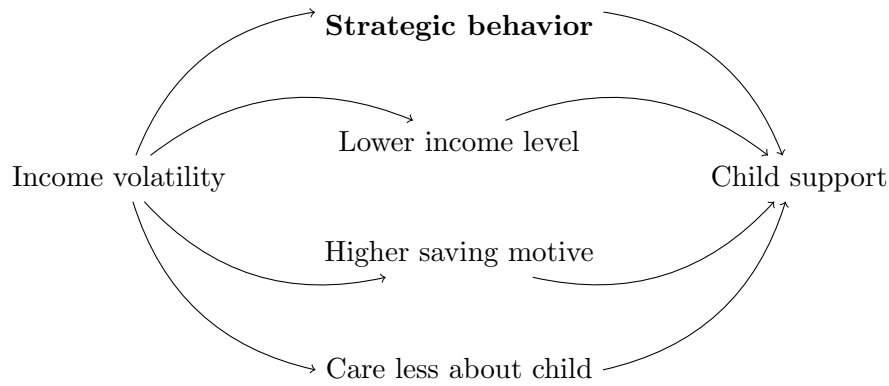


Figure 2: Alternative Hypotheses

income volatility may have negatively impacted father's transfer identified include:

- Alternative 1 (A1): father with more unstable income may have lower income levels, and poorer father tends to transfer less regardless of information asymmetry;
- Alternative 2 (A2): father with more unstable income may have a higher precautionary saving motive, and more prudential father transfers less regardless of information asymmetry;
- Alternative 3 (A3): father with more unstable income may care less about the child, and less concerned father transfers less regardless of information asymmetry.

Each of these leads to lower child support payment, regardless of strategic behavior. Figure 2 presents the multiple possible channels through which high income volatility and low child support might be correlated. In other words, there could be alternative explanations for a negative relationship, including but not restricted to strategic behavior. As a result, conclusive evidence on the statement requires not only finding a negative relationship between income volatility and child support, but also ruling out the above alternative explanations.

To rule out such alternative possibilities, ideally I would wish to run a regression of child support on income volatility, with additional controls for all these alternatives to tease out their effects. But again, the missing data problem about absent father in female sample after divorce, makes this strategy impossible. Alternatively, these alternative could also be ruled out by cutting off the linkage between income volatility and alternative controls as in Figure 2. The logic comes from the fact that establishment of alternative rationalities require not

only a positive correlation between additional controls and child support, but also a negative correlation between them and income volatility. The lack of relationship in either direction would be sufficient to rule out a certain hypothesis in favor of the strategic story, regardless of how they might be correlated on the other side.

This ruled-out strategy turns out to be feasible in practice, since there exists some other sample space where father's information throughout marriage and divorce is observable. This would be the male sample which is consisted of all fathers whose family units are covered by PSID core even in the aftermath of divorce. In this space, both father's labor income under marriage and other attributes after divorce are observable, so that it's possible to construct their income volatility measured under marriage, and test how they are related with a series of alternatives controls in divorce.

In particular, five additional variables are constructed in divorce to control these alternatives. They are divorced labor income for lower income level hypothesis; divorced food expenditure/income ratio for higher precautionary save motive hypothesis; divorced frequency of indoor and outdoor activities with child, and whether mother relocated upon divorce for care less about child hypothesis. In lack of detailed information about saving or overall consumption, the food expenditure/income ratio roughly controls his overall consumption rate, the complement of which measures his saving motive. Frequencies of activities with child and mother's relocation reflect how close the father was to his child after divorce, both physically and mentally.

To sum up, the empirical estimation of this paper involves not only proving the existence of negative relationship between income volatility and child support in female sample, but also no relation between income volatility and additional controls elsewhere.

## 5 Data

As income volatility measures require multiple observations of the same person over time, empirical test of the statement requires a panel data to begin with. In this paper, the 1968-2007 Panel Study of Income Dynamics (PSID) is used, in view of its longitudinal design and supplemental datasets in providing marital specific information.

During the years of coverage, interviewees may have experienced multiple marriages and/or

divorces, so that any marriage specific analysis, including the current one, needs to mark out the beginning and end of each marriage, and construct marriage-specific measures accordingly. In order to facilitate such access to individual specific retrospective marriages histories, PSID supplements its core data with Marriage History File which contains marriage information about adults living in a PSID family at the time of the interview in any wave between 1985 and 2007. Each record contains all past-year detail about the timing and circumstances (and spouse identification number) of a marriage up to and including 2007. With the help of MH, it is possible to assign marriage and divorce order for each individual's records over time, identify ever divorced population, and create father's income volatility measures within each marriage accordingly.

Another supplemental dataset involved is Geocode Match File 2000. Although state and region information is also covered in PSID core, any further detail about the neighborhood in which household resides is not available. This Geocode file includes the 2000 Census geographical identifiers for the neighborhood in which household resides, to link PSID core with Census and other data and investigate effects of nonfamily context variables on family and individual outcomes. These geographical identifiers include 2-digit state code, 3-digit county code, and 5-digit city/town code. For current research, residence in the central country/city/town of a Metropolitan Statistical Area and Primary Metropolitan Statistical Area are merged in from Census 2000 through geographical identifiers<sup>7</sup>.

Furthermore, in an effort to study the dynamic process of early human capital formation, PSID supplemented its main data collection with additional information on 0-12 year-old children and their parents in CDS. Among others, questions about the targeted child's contact with father in 1997 and 2002 were investigated:

- About how often does (CHILD) spend time with (his/her) (father/stepfather/adoptive father/father-figure) in indoor activities? <sup>8</sup>
- About how often does (CHILD) spend time with (his/her) (father/stepfather/adoptive father/father-figure) in outdoor activities?

Offered multiple choices include “Never”, “A few times a year or less”, “About once a month”,

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<sup>7</sup>For Census 1999 Metropolitan Areas and Components, see <http://www.census.gov/population/estimates/metro-city/99mfips.txt>.

<sup>8</sup>In CDS-I, this question focused on time in general.

Table 1: Individual Sample Size

	Basis Female	Ruled-out	
		Male	Child
Head/Wife	18,604	16,893	
Ever married	10,531	10,108	
Ever divorced	3,464	3,057	
Followed up	1,899	1,574	
Ever remarried	392		
----- Total	-----	-----	3,563
Parents id			1,805
Merged			1,539
Final	1,077	519	937

“A few times a month”, “About once a week”, “Several times a week”, and “At least once a day”. These will be used as the ruled-out controls for “care less about child” alternative hypotheses. These outcomes were obtained from the primary caregiver, a secondary caregiver, and others. As the most often primary and second caregivers are targeted child’s biological parents, the personal identification number designed for each caregiver makes it possible to identify and merge in child’s parents’ information from the PSID core data. It’s worth noting that year 2002 is not covered in PSID core. In order to merge them together, I assume the same person’s attribute won’t change much within one year, and merge records from PSID 2001 with records from CDS 2001. But parents’ marital status in 2002 is still coded correctly according to their MH file records.

## 5.1 Individual Sample Size

The sample size limitation problem of panel datasets gets worse in current research, as the key variable of child support concerns the ever divorced population only. Table 5.1 shows the evolution of sample sizes by source. Female sample is used primarily for child support statement test. Among the three alternative hypotheses to be ruled-out, “lower income level” and “higher precautionary saving motive” are ruled out using male sample, and “care less about child” is ruled out partly by using child sample and partly by using female sample.

Generally speaking, only around 10% of original sample space can be used for current empirical test. This is obtained by 60% marriage rate times 30% divorce rate times 50% survey follow up rate ( $60\% \times 30\% \times 50\% = 9\%$ )<sup>9</sup>. From 1968 to 2007, the PSID core sample covers 14,818

<sup>9</sup>See <http://www.cdc.gov/nchs/fastats/divorce.htm>.

households over a mean of 15 and maximum of 35 years. Since the key economic questions are available for household head and wife only, the relevant female and male adult subsamples consisting of either household head or his wife contain 18,604 and 16,893 individuals separately. Among these adults, about 60% individuals ever get married ( $10,108/16,893=0.598$ ), with the male's rate slightly higher than female's. Among the ever married, around 30% experienced divorce at least once. Furthermore, as only family unit of either spouse but not both are covered in a divorce or separation, only half of the remaining male and female adult samples are successfully followed up, leaving 1,899 females and 1,574 males respectively. Finally, when controlled for demographic characteristics both under marriage and during divorce, the final sample sizes are reduced to 1,077 females and 519 males. Among these 1,077 mothers in female sample, 40% of them ever remarried at 392 people.

The last column shows sample size evolution of child sample. In 1997 and 2002, CDS surveyed 3,563 children in total, but only half of them had complete parents' id information converted from primary and secondary caregiver's identities. When merged with parents' information in 1997 and 2001 from the PSID core, 1,539 children are successfully linked with both parents but only 937 with complete parents' information. These observations are all from year 2002 of CDS, as region variable is not available in PSID core between 1994 and 1998, including CDS year 1997.

## 5.2 Basis Sample Summary

Table 2 displays the mean and standard deviation of relevant variables in basis female sample, for both child support statement test and ruling out the "care less about child" hypothesis. The relevant sample is those years when the mother was divorced or separated and reported non missing child support amount. Except father's income volatilities that are constructed from father's historical records within marriage, all other mother's attributes are controlled while she is in divorce.

The continuous information asymmetry measures of scaled standard deviation, mean squared change, recent mean squared change are all averaged at 5-6% of logarithm labor income, and similar is true for the discrete measure of self-employed dummy, which is also averaged at 5% of the time. The simulated scaled squared income residual is not something that you can directly observe from the rawdata, but needs to be simulated in the first place,

so it's not listed in here or any other sample summary tables.

The dependent variable of received child support amount is measured in terms of monetary transfers only and doesn't include in-kind transfers of food, clothing, or child care that may have been provided by some absent fathers. The averaged received amount is \$730 annually, which is well below the cost of raising children. The receipt proportion of 23% is also reasonably close to the 30% reported in Census 2007.

Mother's average age, when divorced, are 42 years old. White and Black are equally likely to be covered in female's sample. Education is a key factor in both income and child support determination, and is coded into categories rather than total number of years to allow a nonlinear effect. Mothers are mostly centered around high school diploma with 12 grades. 40% of people lived in PMSA and 90% in central areas where surveyed units are more convenient to locate and reach. Mother's divorced total income consists of both labor income and welfare transfer if any, and is averaged at \$12,697 per year. Nonmissing child support report is controlled in female's sample, so that every mother is eligible to participate in AFDC welfare program. However, only 11% of them are covered. Number of kids and length of previous marriage measure marital-specific capital from the marriage and would be expected to have a positive relation with child support. Number of kids is averaged at 1.1, and marriage duration is averaged at 12 years. The same marriage capital accumulated may have a depreciation rate over time, so that the further away the marriage and divorce are the weaker the bond between ex-family members is. Therefore I decide to add in this new control of number of years since divorce to capture the time varying pattern of father's contribution. On average, 6 years had passed since divorce in female sample. Finally, the additional control to rule out "care less about child" hypothesis is appended at the bottom. Only 6% of divorced mother changed region of living upon broken marriage. In terms of the sample size, the 1,077 mothers in first column of Table 5.1 each has 4-5 observations in divorce, so that the final sample size is 4,617.

### **5.3 Male Sample Summary**

An innocent negative correlation alone doesn't necessarily imply the existence of strategic behavior in child support payment, unless alternative channels of income volatility's impact have been ruled out. In order to rule out alternatives through lower divorced income level

Table 2: Basis Female Sample Summary Statistics

	Pre-divorce Father		Post-divorce Mother	
	Mean	St.Dev	Mean	St.Dev
<u>Information asymmetry</u>				
Standard deviation	0.046	[0.045]		
Mean squared change	0.057	[0.171]		
Recent mean squared change	0.047	[0.123]		
Self-employed dummy	0.054	[0.226]		
<u>Child support</u>				
Child support amount			707.226	[1899.12]
Child support dummy			0.23	[0.421]
<u>Demographics</u>				
Age			41.872	[11.331]
Race-White			0.487	[0.5]
Race-Black			0.492	[0.5]
Race-Other			0.021	[0.143]
Education-0-5 grades			0.017	[0.129]
Education-6-8 grades			0.04	[0.197]
Education-9-11 grades			0.186	[0.389]
Education-12 grades			0.386	[0.487]
Education-College, no degree			0.258	[0.438]
Education-College, bachelors degree			0.077	[0.267]
Education-College, advanced degree			0.035	[0.185]
PMSA status			0.469	[0.499]
Central city status			0.943	[0.233]
Total income			12697.63	[15231.08]
Welfare participation status			0.109	[0.311]
Number of children			1.129	[1.272]
Marriage duration			11.75	[8.187]
Years since divorce			6.913	[6.241]
Whether relocated			0.063	[0.243]
<u>Sample size</u>				
Obs.	4617			

and lower divorced consumption rate, relationship between additional controls and income volatility are examined in male sample. Except for the two dependent variables of labor income and food expense/income ratio, all other independent regressors are constructed from within marriage records. Table 3 presents mean and standard deviation of relevant variables in male sample.

Similar to the basis female sample, in male sample various information asymmetry measures are averaged at 5%, except the slightly higher self-employed dummy. Father's labor income increases upon divorce, as a result of age and experience growth over the time. Father's food expense/income ratio is computed to roughly control the overall consumption rate of income, the complement of which measures his saving motive. The listed 28% does not necessarily suggest that the actual saving rate of divorced fathers in U.S. is anywhere close to 72%, since I am chopping off food consumption only, not the overall consumption. However, I believe this ratio is highly correlated with the real saving rate and could serve as a good mimic. Father's average age, when still married, is 31 years old. Similar to female sample, White and Black are equally likely to be covered. They are mostly centered around high school diploma with 12 grades. 40% of people lived in PMSA and 90% in central areas. The average number of children when father is still married is 1.7, and the total number of observation is 2,210, meaning each father has 4-5 observations in divorce.

#### **5.4 Child Sample Summary**

In addition to the dummy of whether mother relocated, frequencies of father's indoor and outdoor activities with child are also used to rule out the "care less about child" hypothesis using child sample. Summary statistics for relevant dependent and independent variables are shown in Table 4. Except for outcome variables of contact frequencies and explanatory variable of information asymmetry, all other attributes are merged in from mother's concurrent record in 2002.

As usual, continuous information asymmetry measures are averaged at 4%, except the remarkably higher self-employed dummy. The frequency outcomes of father's indoor and outdoor activities with child are each recorded in seven categories, ranging from "Never" to "At least once a day". Almost half of interviewed fathers engaged in indoor activities with the child for at least once a day, and another 40% for at least once a week. Frequencies of

Table 3: Male Simulation Sample Summary

	Pre-divorce Father		Post-divorce Father	
	Mean	St.Dev	Mean	St.Dev
<u>Information asymmetry</u>				
Standard deviation	0.045	[0.041]		
Mean squared change	0.049	[0.138]		
Recent mean squared change	0.043	[0.109]		
Self-employed dummy	0.062	[0.241]		
<u>Income and food expense/income ratio</u>				
Labor income	11962.38	[8921.339]	20864.16	[18021.84]
Food expense/income ratio			0.281	[1.292]
<u>Demographics</u>				
Age	31.204	[8.293]		
Race-White	0.565	[0.496]		
Race-Black	0.403	[0.491]		
Race-Other	0.033	[0.178]		
Education-0-5 grades	0.017	[0.13]		
Education-6-8 grades	0.074	[0.261]		
Education-9-11 grades	0.233	[0.423]		
Education-12 grades	0.343	[0.475]		
Education-College, no degree	0.204	[0.403]		
Education-College, bachelors degree	0.095	[0.293]		
Education-College, advanced degree	0.034	[0.182]		
PMSA status	0.407	[0.491]		
Central city status	0.947	[0.224]		
Number of children	1.749	[1.268]		
<u>Sample size</u>				
Obs.	2210			

outdoor activities are a little lower than indoor activities, where the majority of frequencies are only several times a week. This is kind of as expected, as outdoor activities often require more physical strength and adults may feel reluctant to do it. So the contrastive frequency distribution does not necessarily imply that one control is superior over the other in measuring father-child intimacy.

Mothers are generally younger than in female sample, at 39 years old on average. White mothers are more likely to be covered in CDS than other race groups. Compared with female sample, mothers in child sample tend to be better educated, with the majority centered around college level without degree. Again, 40% of people lived in PMSA and 90% in central areas. Her total income consisting of labor income and welfare transfer if any is significantly higher than that amount in female sample, maybe because of better education and larger share of White people. The average number of children is slightly larger at 2.3.

In CDS, children are surveyed regardless of their parents' marital status, but mostly when they are still with each other. To control both biological parents' marital status and allow the degree of father's intimacy with his child to depend on such status, a divorced dummy is created by comparing the child' birth year with timing of parents' marriage at the time of survey. Technically, if the child was born within the duration of current marriage in 2002, divorced dummy is 0, otherwise it is 1. It turns out only 9% parents of covered children were separated when surveyed by CDS. Finally, boys and girls are equally likely to be covered. The total number of observation is 937, with unique entry in 2002 for each child in the sample.

## 6 Results

### 6.1 Simulation for Scaled Labor Income Residual

Simulation results from Equation (16) and (17) are reported in Appendix Table A-1 column (1) and (2). All regressors are controlled as mean value within marriage. In column (1), there exists a strong persistence between father's earning when married and divorced. The estimated elasticity of income in divorce with respect to income under marriage is 0.631, significant at 1% level. Black people tend to earn 28.2% less than White people do. Higher education level increases income earning ability, as fathers with college advanced degree earn 33% than the default group with 12 grades. When the scaled squared residuals are in turn

Table 4: Child Simulation Sample Summary

	Father		Mother	
	Mean	St.Dev	Mean	St.Dev
<u>Information asymmetry</u>				
Standard deviation	0.041	[0.033]		
Mean squared change	0.038	[0.109]		
Recent mean squared change	0.034	[0.075]		
Self-employed dummy	0.09	[0.286]		
<u>Frequency of father's activities with child</u>				
Indoor activities–Never	0.031	[0.173]		
Indoor activities–A few times a year or less	0.048	[0.214]		
Indoor activities–About once a month	0.041	[0.197]		
Indoor activities–A few times a month	0.137	[0.344]		
Indoor activities–About once a week	0.182	[0.386]		
Indoor activities–Several times a week	0.386	[0.487]		
Indoor activities–At least once a day	0.175	[0.38]		
Outdoor activities–Never	0.045	[0.207]		
Outdoor activities–A few times a year or less	0.095	[0.293]		
Outdoor activities–About once a month	0.095	[0.293]		
Outdoor activities–A few times a month	0.203	[0.402]		
Outdoor activities–About once a week	0.236	[0.425]		
Outdoor activities–Several times a week	0.302	[0.459]		
Outdoor activities–At least once a day	0.025	[0.155]		
<u>Demographics</u>				
Age			39.209	[5.924]
Race–White			0.641	[0.48]
Race–Black			0.222	[0.416]
Race–Other			0.137	[0.344]
Education–0-5 grades			0.011	[0.103]
Education–6-8 grades			0.03	[0.17]
Education–9-11 grades			0.079	[0.27]
Education–12 grades			0.247	[0.431]
Education–College, no degree			0.315	[0.465]
Education–College, bachelors degree			0.234	[0.423]
Education–College, advanced degree			0.085	[0.28]
PMSA status			0.428	[0.495]
Central city status			0.9	[0.301]
Total income			20708.18	[33087.57]
Number of children			2.288	[0.952]
Divorced when CDS	0.085	[0.28]		
Boy			0.509	[0.5]
<u>Sample size</u>				
Obs.	937			

regressed on the same set of covariates as in column (2), no significant pattern is observed except for the lagged income level under marriage. It seems that richer people also tend to have more stable income. The set of coefficient estimates in column (2) will be used to simulate the last information asymmetry measure of absent father in female sample.

## **6.2 Child Support Statement**

To provide empirical evidence for the Child Support Statement that father's lower optimal transfer is associated with higher degree of information asymmetry, I related child support to information asymmetry measures and other factors in hope of seeing a significant negative impact. Models for two dependent variables—received amount and dummy indicating whether any transfer was received—are fitted by Ordinal Least Square (OLS) and Probit techniques.

It's worth noting that the model could've been structurally estimated if the assumptions about utility functions were not made so abstract and unrealistic. But if the purpose is only to prove the existence of strategic behavior and interpret extremely low payment through such existence, not about the utility function parameters, a reduced form OLS would be sufficient to do the job.

### **6.2.1 OLS Estimate for Child Support Amount**

Coefficient estimates of the received amount outcome fitted by OLS are presented in Table 5. The dependent variable is received child support amount, and explanatory variables are information asymmetry as defined by the column title and other independent variables. These variables have been related to child support amount awarded and received empirically. Mother's income is coded in actual amount instead of logarithm, as logarithm neglects all zero income which is not scarce among mothers. Welfare participation status is coded in dummy, indicating whether the mother was covered or not. Age is coded in years. Race and education are coded in categories, with the default category being White and college with 12 grades. Number of children and length of previous marriage measure marital-specific capital from the marriage, and number of years since divorce captures a time varying pattern of divorced father's contribution. Additional control variables include residence within a PMSA, central city of a PMSA, state, and year of the survey.

For each of the five information asymmetry measures in columns, numbers presented in

the first row show the estimated change in transfer amount associated with one unit change in explanatory variables. For instance, examining the first row in the first column, a 1% increase in father's scaled income standard deviation reduces amount paid by \$16 per year. As can be seen in the first row, except the discrete control, the estimated effects of father's income volatility on transfer amount show strong consistency in negative direction and are all significantly different from zero. So there is evidence that fathers with more unstable income tend to systematically underpay support.

But the estimates also show large degree of variation in terms of the magnitude. Although the multiple measures are generally not comparable, since they are constructed in different manners, I can still compare the overall mean squared change and recent mean squared change in second and third column. As expected, the more recent control tends to affect more with an even larger impact in absolute value. Ignoring the somewhat bizarre estimate in column (4), I find each additional percent of income variation tend to reduce the received support amount by \$6-23 per year, depending on the measure of income volatility adopted.

Effects of other socioeconomic characteristics are consistent with findings of previous studies, although precise estimates again vary by income volatility measures adopted. Mothers covered by the welfare program receive significantly lower transfer from the father, while her total income doesn't matter much. Because of the \$50 pass-through legislation, joining the program reduces voluntary payment by \$1000 annually, and White people tend to pay \$600 more annually than Black and other race. As expected, the measures of marital-specific capital both exert significantly positive impacts, with each additional child and marriage year raising total annual payment by \$500 and \$20. Finally, there does not seem to exist a time varying pattern in father's contribution, since the new variable of years since divorce is always insignificant. It's somewhat surprising to see mother's age negatively impacts father's ability to pay, but maybe that's because the older the parents are when the child is still young, the shorter amount of time there is for them to enjoy the benefit from him/her. That's why they wouldn't invest too much on the child.

It's worth noting that although the reported size for female sample is 4,617 in Table 2, none of the five columns end up having those many observations. This is because calculation of income volatility consumes observations. For instance, calculation of standard deviation, mean squared change requires at least two rounds of labor income under marriage, and recent mean

squared change over the last three periods requires four, self-employed dummy requires father's self-employed status, and squared residual requires not only father's labor income but also other demographic characteristics. Ideally, the analysis would be restricted to observations with all five measures available, but according to column (3), that would cut the sample size further by half.

### **6.2.2 Probit Estimate for Child Support Amount**

Turning from amount to dummy, Table 6 examines the results from fitting child support receipt dummy by Probit model. The outcome variable is child support receipt dummy, and the explanatory variables are information asymmetry measures as defined by column title and other independent repressors. The reported coefficients are marginal effect evaluated at sample mean for continuous regressors and discrete change in the probability for dummy variables.

The findings are in general consistent with those of OLS model in Table 5, in that significantly negative effects of income variation are observed for all columns except self-employed dummy. In terms of the magnitude, 1% increase in father's scaled income standard deviation reduces payment likelihood by 1.3%. But still the estimates show little consistency in magnitude, and the more recent control of information asymmetry tends to have larger impact as in column (2) and (3).

Mothers covered by welfare program are 18% less likely to receive any transfer from the father, and her total income may have increased the chance of receipt, although the magnitude is too small to detect. Older mothers are less likely to receive anything from the older fathers. White fathers are 14% more likely to pay than Black, and both measures of marital-specific capital—number of kids and duration of previous marriage, increase the probability significantly. Finally, the time varying pattern of divorced father's payment still does not exist.

### **6.3 Alternative Hypotheses Ruled Out**

Short versioned estimation results from predicting additional controls with income volatility in female, male, and child samples are reported in Table 7. For brevity, only coefficient estimates for income volatility measures and its interaction term with biological parents' marital status,

Table 5: OLS Estimate for Child Support Equation

Child support amount	St.Dev of Ln(laborinc)	Mean Squared Change of Ln(laborinc)	Recent Mean Squared Change of Ln(laborinc)	Self-employed	Squared Residual of Ln(laborinc)
	(1)	(2)	(3)	(4)	(5)
Information asymmetry	-1,606.062*	-634.479***	-746.037**	4.933	-2,261.955***
	[1.93]	[2.82]	[1.97]	[0.03]	[4.01]
Mother's income	0.005	0.005	0.001	0.005	0.004
	[1.05]	[0.98]	[0.21]	[1.31]	[0.86]
Mother's welfare participation status	-1,056.749***	-1,051.969***	-1,244.206***	-967.540***	-936.641***
	[7.64]	[7.60]	[6.09]	[7.85]	[7.70]
Mother's age	-15.906**	-15.088**	-13.698	-14.952**	-16.523**
	[2.14]	[2.03]	[1.35]	[2.28]	[2.29]
Mother's race-Black	-653.608***	-642.278***	-593.942***	-578.122***	-507.214***
	[4.97]	[4.89]	[3.74]	[4.95]	[4.26]
Mother's race-Other	-638.989***	-621.783***	-678.597***	-583.412***	-640.037***
	[2.66]	[2.60]	[2.64]	[2.83]	[2.95]
Mother's education-0-5 grades	-586.839***	-604.007***	-480.430**	-475.813**	-525.118***
	[2.82]	[2.95]	[2.02]	[2.37]	[3.18]
Mother's education-6-8 grades	102.465	95.989	373.221*	14.933	193.483
	[0.63]	[0.60]	[1.71]	[0.10]	[1.19]
Mother's education-9-11 grades	-1.720	-4.910	74.627	-2.623	53.820
	[0.02]	[0.05]	[0.51]	[0.03]	[0.58]
Mother's education-College, no degree	329.271**	318.622**	440.318***	277.292**	302.023**
	[2.45]	[2.38]	[2.60]	[2.37]	[2.54]
Mother's education-College, bachelors degree	742.021**	726.858**	1,068.895***	693.179**	634.593**
	[2.38]	[2.33]	[2.62]	[2.31]	[2.00]
Mother's education-College, advanced degree	447.944	435.122	733.128**	451.562*	507.778*
	[1.56]	[1.51]	[1.98]	[1.73]	[1.66]
Mother's PMSA status status	212.861	214.486	129.974	127.278	98.476
	[1.47]	[1.50]	[0.68]	[0.99]	[0.73]
Mother's central city status	-268.416	-268.210	-527.936	-265.118	-314.854
	[0.88]	[0.88]	[1.27]	[0.95]	[1.07]
Mother's number of kids	507.402***	503.422***	564.034***	487.352***	494.969***
	[7.88]	[7.76]	[6.18]	[8.15]	[8.24]
Duration of mother's previous marriage	22.218***	20.899***	8.073	22.595***	21.540***
	[2.98]	[2.81]	[0.73]	[3.42]	[2.88]
Number of years since mother divorced	-10.605	-11.744	-19.222	-12.032	-3.336
	[1.17]	[1.28]	[1.42]	[1.51]	[0.39]
Constant	1,354.682***	1,321.904**	1,666.249***	985.449*	1,126.175**
	[2.64]	[2.58]	[2.64]	[1.90]	[2.25]
Observations	3829	3829	2701	4355	4217
R-squared	0.22	0.22	0.25	0.21	0.22

Note: State, region, and year effects are controlled. Robust t statistics in brackets.

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

Table 6: Probit Estimate for Child Support Equation

Child support dummy	St.Dev of Ln(laborinc)	Mean Squared Change of Ln(laborinc)	Recent Mean Squared Change of Ln(laborinc)	Self-employed	Squared Residual of Ln(laborinc)
	(1)	(2)	(3)	(4)	(5)
Information asymmetry	-1.322*** [3.59]	-0.670*** [3.74]	-0.853*** [2.69]	0.019 [0.36]	-0.661*** [3.30]
Mother's income	0.000*** [3.47]	0.000*** [3.26]	0.000** [2.17]	0.000*** [3.09]	0.000*** [2.62]
Mother's welfare participation status	-0.183*** [5.18]	-0.176*** [4.96]	-0.225*** [4.21]	-0.190*** [5.68]	-0.181*** [5.29]
Mother's age	-0.016*** [4.41]	-0.016*** [4.45]	-0.015*** [3.58]	-0.014*** [4.26]	-0.014*** [4.10]
Mother's race-Black	-0.139*** [3.84]	-0.133*** [3.74]	-0.094** [2.05]	-0.135*** [3.99]	-0.103*** [3.03]
Mother's race-Other	-0.113** [2.13]	-0.107** [2.04]	-0.107 [1.35]	-0.088* [1.75]	-0.101** [2.07]
Mother's education-0-5 grades	-0.172** [1.99]	-0.169** [2.03]	-0.190* [1.81]	-0.171** [2.11]	-0.166** [2.07]
Mother's education-6-8 grades	-0.101 [1.18]	-0.090 [1.05]	-0.047 [0.35]	-0.102 [1.34]	-0.113 [1.37]
Mother's education-9-11 grades	0.011 [0.24]	0.015 [0.34]	0.059 [1.00]	0.009 [0.22]	0.006 [0.14]
Mother's education-College, no degree	0.047 [1.36]	0.044 [1.30]	0.065 [1.48]	0.053* [1.70]	0.055* [1.80]
Mother's education-College, bachelors degree	0.123** [2.10]	0.111* [1.92]	0.205*** [2.82]	0.113* [1.94]	0.066 [1.12]
Mother's education-College, advanced degree	0.091 [1.51]	0.084 [1.41]	0.101 [1.27]	0.093 [1.64]	0.098 [1.52]
Mother's PMSA status status	0.030 [0.65]	0.030 [0.68]	-0.029 [0.51]	0.027 [0.66]	0.026 [0.63]
Mother's central city status	-0.036 [0.58]	-0.033 [0.55]	-0.095 [1.23]	-0.055 [0.91]	-0.069 [1.14]
Mother's number of kids	0.123*** [8.07]	0.119*** [7.73]	0.125*** [5.74]	0.122*** [8.26]	0.117*** [8.25]
Duration of mother's previous marriage	0.013*** [3.65]	0.012*** [3.46]	0.007* [1.67]	0.011*** [3.70]	0.011*** [3.50]
Number of years since mother divorced	0.006 [1.33]	0.005 [1.31]	0.000 [0.04]	0.003 [0.69]	0.004 [1.11]
Observations	3480	3480	2454	3942	3826

Note: State, region, and year effects are controlled. Robust z statistics in brackets.

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

if any, are presented. Full simulation results can be found from Table A-2 to A-5 in Appendix.

The first two continuous outcomes of divorced father's logarithm labor income and food expense/income ratio are fitted by OLS model in male sample. Other than father's income volatility, regressors also include father's income level, age, race, education, number of kids, and geographical location dummies within marriage. The following two categorical outcomes of contact frequencies are fitted by Ordinal Probit model in child sample. Regressors include father's income volatility, parents' divorce status, their interactions, and mother's characteristics. The discrete outcome for whether mother relocated at bottom is fitted by Probit model in female sample. The reported coefficients represent marginal effect evaluated at sample mean for continuous information asymmetry measures and discrete change in the probability for self-employed dummy.

As can be seen from Table 7, almost no significant relationship between income volatility and additional controls exists, except labor income against self-employed dummy. Focusing on the middle panel, for instance, none of these ten regressions find significantly negative correlation between income volatility and father's activities with child, regardless of when they were divorced or not. Some of them may appear to be marginally significant, but in the opposite direction. Among the 50 auxiliary regressions that have been estimated, only for once is a significantly negative correlation observed, which is between labor income and self-employed dummy. But in view of its poor performance in terms of both sample mean and child support regressions, I tend to suspect self-employed dummy as a good proxy for information asymmetry, and therefore ignore this astray result anyway.

With that being said, I believe income volatility and additional controls are not correlated, which makes it impossible for any alternative impacts on child support to be captured by income volatility measures as in child support regressions. Therefore, even though these alternatives might indeed have some effect on father's child support payment, they will not mess up with income volatility, and any observed income volatility effect on child support should not be attributed to these alternatives either. This concludes alternative hypotheses rule-out analysis, and leaves strategic behavior as the only plausible explanation for inadequate payment. These observations allow me to conclude that the observed significantly negative relationship between income volatility and child support in Table 5 and 6 is indeed caused by father's strategic behavior.

Table 7: Simulation of Additional Controls

Variable	St.Dev of Ln(laborinc)	Mean Squared Change of Ln(laborinc)	Recent Mean Squared Change of Ln(laborinc)	Self-employed	Squared Residual of Ln(laborinc)
	(1)	(2)	(3)	(4)	(5)
<b>OLS Model</b>					
<u>Ln(Labor income)</u>					
Information asymmetry	1.599 (1.51)	0.300 (1.08)	0.397 (1.35)	-0.231** (2.27)	0.827 (1.48)
<u>Food expense/income ratio</u>					
Information asymmetry	0.396 (0.31)	0.194 (0.53)	0.054 (0.13)	-0.127 (0.81)	-0.131 (0.20)
<b>Ordinal Probit Model</b>					
<u>Indoor activities with child</u>					
Information asymmetry	1.869 [1.32]	0.835 [1.61]	0.241 [0.34]	-0.173 [1.29]	0.947 [1.28]
Father divorced	0.041 [0.18]	-0.047 [0.27]	-0.118 [0.64]	-0.095 [0.58]	-0.036 [0.14]
Information asymmetry * Father divorced	-4.019 [0.79]	-1.522 [0.80]	-0.673 [0.40]	0.244 [0.68]	-0.625 [0.21]
<u>Outdoor activities with child</u>					
Information asymmetry	-1.408 [1.25]	0.038 [0.12]	-0.315 [0.81]	0.252* [1.93]	-0.557 [0.97]
Father divorced	-0.299 [1.30]	-0.316* [1.80]	-0.346* [1.69]	-0.343** [2.11]	-0.333 [1.42]
Information asymmetry * Father divorced	-2.083 [0.47]	-1.276 [0.87]	-0.236 [0.20]	-0.256 [0.52]	-0.261 [0.12]
<b>Probit Model</b>					
<u>Whether mother relocated</u>					
Information asymmetry	0.065 [1.22]	0.017 [1.01]	0.012 [0.62]	-0.007 [0.65]	0.037 [1.07]

Notes: Absolute value of t statistics in brackets for Ln(labor income) and Food Income Ratio.  
Robust z statistics in brackets for Indoor, Outdoor Activities with Child, and Whether Mother Relocated.  
\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

## 7 Conclusions

This paper analyzes father's child support transfer and mother's remarriage decision jointly in a dynamic model. The way of their decision making and interaction is built into a Stackelberg game, assuming the father gains information advantage about his own type upon separation. The model concludes that with information asymmetry about father's type, it is not only possible but also profitable for him to manipulate the mother's remarriage decision by paying less. The statement is empirically supported by the PSID data, using father's income volatility as approximate measures of information asymmetry. In terms of the magnitude, the annual reduction is estimated to be \$6-23 in amount or 0.7-1.3% in likelihood associated with 1% increase in the scaled degree of income volatility. These results are shown to be robust, as alternative hypotheses have been ruled out by simulated additional controls.

As a byproduct, the model also points to the endogeneity involved in conventional estimate of child support-remarriage relationship. The closed-form solution of this model reveals that mother's unobserved remarriage propensity enters both her remarriage equation and father's optimal transfer amount. Failure to control for such unobserved propensity would introduce positive bias in conventional estimates, and therefore leads to the inconclusive evidence in literature. With the positive bias eliminated by instrumental variable, transfer is expected to have a negative impact on remarriage. The unbiased estimate of such impact awaits further study on finding appropriate instrument variables that are correlated with child support payment but not remarriage.

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## APPENDIX

### First order condition

Substituting  $a_{f1} = Y_f - c_{f1}$  and formulas for  $U_{f2}^{s*}, U_{f2}^{r*}(\tilde{\alpha}_s), f(\tilde{\alpha}_s)$  into the objective function, father’s first period problem is equivalent to:

$$\begin{aligned} \max_{c_{f1}} V &= Y_f - c_{f1} + \beta_f(c_{f1} - \frac{c_{f1}^2}{2\dot{\alpha}_f}) + & (A-1) \\ &\rho \int_0^{g(c_{f1})} \{Y_f - \dot{\alpha}_f(1 - \frac{1}{\beta}) + \beta[\dot{\alpha}_f(1 - \frac{1}{\beta}) - \frac{\dot{\alpha}_f}{2}(1 - \frac{1}{\beta})^2]\} kd\tilde{\alpha}_s + \\ &\rho \int_{g(c_{f1})}^{\frac{1}{k}} \{Y_f + \beta[\tilde{\alpha}_s(1 - \frac{1}{\beta}) - \frac{\tilde{\alpha}_s^2(1 - \frac{1}{\beta})^2}{2\dot{\alpha}_f}]\} kd\tilde{\alpha}_s \end{aligned}$$

Setting the first order derivative of  $V$  with respect to  $c_{f1}$  to 0, solution of  $c_{f1}$  has to satisfy the following equation:

$$\begin{aligned} 0 &= -1 + \beta(1 - \frac{c_{f1}}{\dot{\alpha}_f}) + & (A-2) \\ &\rho\{Y_f - \dot{\alpha}_f(1 - \frac{1}{\beta}) + \beta[\dot{\alpha}_f(1 - \frac{1}{\beta}) - \frac{\dot{\alpha}_f}{2}(1 - \frac{1}{\beta})^2]\} kg'(c_{f1}) - \\ &\rho\{Y_f + \beta[g(c_{f1})(1 - \frac{1}{\beta}) - \frac{g^2(c_{f1})}{2\dot{\alpha}_f}(1 - \frac{1}{\beta})^2]\} kg'(c_{f1}) \end{aligned}$$

Since the equilibrium condition  $\dot{\alpha}_f = g(c_{f1})$  must hold at the solution, Equation (A-2) can be simplified as

$$0 = -1 + \beta\left(1 - \frac{c_{f1}}{\dot{\alpha}_f}\right) - \rho\dot{\alpha}_f\left(1 - \frac{1}{\beta}\right)kg'(c_{f1}) \quad (\text{A-3})$$

or

$$g'(c_{f1}) = \frac{\beta}{k\rho\dot{\alpha}_f} + \frac{\beta^2}{k\rho\dot{\alpha}_f^2(1-\beta)}c_{f1} \quad (\text{A-4})$$

which is a first order differential equation in  $c_{f1}$ . Solving this equation for  $g(c_{f1})$ , this leads to:

$$g(c_{f1}) = \frac{\beta}{k\rho\dot{\alpha}_f}c_{f1} + \frac{\beta^2}{2k\rho\dot{\alpha}_f^2(1-\beta)}c_{f1}^2 + C \quad (\text{A-5})$$

where  $C$  is any constant. Note that this is not the desired functional form of  $f(\cdot)$  yet, as  $\dot{\alpha}_f$  is still involved. By the equilibrium condition again, the equilibrium value of  $c_{f1}$  is obtained by setting Equation (A-5) to  $\dot{\alpha}_f$ :

$$\dot{\alpha}_f = \frac{\beta}{k\rho\dot{\alpha}_f}c_{f1} + \frac{\beta^2}{2k\rho\dot{\alpha}_f^2(1-\beta)}c_{f1}^2 + C \quad (\text{A-6})$$

Solving this quadratic equation in  $c_{f1}$ , I have

$$c_{f1}^* = \dot{\alpha}_f\left(1 - \frac{1}{\beta}\right)\left(1 \pm \sqrt{1 + \frac{2k\rho(\dot{\alpha}_f - C)}{1-\beta}}\right) \equiv g^{-1}(\dot{\alpha}_f) \quad (\text{A-7})$$

□

## Second order condition

To guarantee the above  $c_{f1}$  solutions are indeed local maximizers, their second order conditions need to be checked also. Taking the derivative of right hand side of Equation (A-2) with

respect to  $c_{f1}$ , the second order derivative is as follows:

$$\begin{aligned} \frac{\partial^2 V}{\partial c_{f1}^2} &= -\frac{\beta}{\dot{\alpha}_f} + \rho \left\{ Y_f - \dot{\alpha}_f \left(1 - \frac{1}{\beta}\right) + \beta \left[ \dot{\alpha}_f \left(1 - \frac{1}{\beta}\right) - \frac{\dot{\alpha}_f}{2} \left(1 - \frac{1}{\beta}\right)^2 \right] \right\} k g''(c_{f1}) - \quad (\text{A-8}) \\ &\quad \rho \left\{ Y_f + \beta \left[ g(c_{f1}) \left(1 - \frac{1}{\beta}\right) - \frac{g^2(c_{f1})}{2\dot{\alpha}_f} \left(1 - \frac{1}{\beta}\right)^2 \right] \right\} k g''(c_{f1}) - \\ &\quad \rho \beta \left[ g'(c_{f1}) \left(1 - \frac{1}{\beta}\right) - \frac{g(c_{f1})g'(c_{f1})}{\dot{\alpha}_f} \left(1 - \frac{1}{\beta}\right)^2 \right] k g'(c_{f1}) \end{aligned}$$

By the equilibrium condition  $\dot{\alpha}_f = g(c_{f1})$ , the above reduces to

$$\frac{\partial^2 V}{\partial c_{f1}^2} = -\frac{\beta}{\dot{\alpha}_f} - k\rho \left(1 - \frac{1}{\beta}\right) (\dot{\alpha}_f g''(c_{f1}) + g'^2(c_{f1})) \quad (\text{A-9})$$

Although Equation (A-5) is not the final functional form from econometricians' view, it does reveal the father's perception at the equilibrium, as  $\dot{\alpha}_f$  is known to him. Therefore, Equation (A-5) could be used here to obtain  $g'(c_{f1})$  and  $g''(c_{f1})$ :

$$g'(c_{f1}) = \frac{\beta}{k\rho\dot{\alpha}_f} + \frac{\beta^2 c_{f1}}{k\rho\dot{\alpha}_f^2(1-\beta)} \quad (\text{A-10})$$

$$g''(c_{f1}) = \frac{\beta^2}{k\rho\dot{\alpha}_f^2(1-\beta)} \quad (\text{A-11})$$

Plugging Equation (A-10) and (A-11) into Equation (A-9), the second order derivative reduces to:

$$\frac{\partial^2 V}{\partial c_{f1}^2} = \frac{\beta(1-\beta)}{k\rho\dot{\alpha}_f^2} \left[ 1 + \frac{\beta c_{f1}^*}{\dot{\alpha}_f(1-\beta)} \right]^2 \quad (\text{A-12})$$

As  $\beta > 1$  by assumption, the sign of SOC direction is always negative for both solutions, and does not vary with  $c_{f1}^*$ . As a result, both  $c_{f1}^*$  roots satisfy the second order condition for local maximum, and it is impossible to exclude either of them in pure mathematical sense.

However, a closer look at Equation (A-10) reveals that the way mother updates her deduced  $\dot{\alpha}_f$  from  $c_{f1}$  is different across the two roots:

$$g'(c_{f1}^*) = \frac{\beta^2}{k\rho\dot{\alpha}_f^2(1-\beta)} \left[ c_{f1}^* - \dot{\alpha}_f \left(1 - \frac{1}{\beta}\right) \right] \begin{cases} > 0 & \text{if } c_{f1}^* = \dot{\alpha}_f \left(1 - \frac{1}{\beta}\right) \left(1 - \sqrt{1 + \frac{2k\rho(\dot{\alpha}_f - C)}{1-\beta}}\right) \\ < 0 & \text{if } c_{f1}^* = \dot{\alpha}_f \left(1 - \frac{1}{\beta}\right) \left(1 + \sqrt{1 + \frac{2k\rho(\dot{\alpha}_f - C)}{1-\beta}}\right) \end{cases} \quad (\text{A-13})$$

In particular, only the low amount indicates a positive comovement between what he paid

and how much he cares about the child. With the high amount, however, things would be the other way around. The mother would form such an expectation of his type that the more he paid, the less he cares about the child. This is an obvious contradiction to the common sense, and does not survive economic judgmental criteria. Therefore, although both high and low amounts achieve a local maximum of the value function, only the low one is accepted as an economically meaningful solution.

□

### Comparative static analysis and interpretation

To further understand how lower transfer is preferable to father with private information, comparative static analysis of father's value function is also provided.

To begin with, it should be made clear that the father is always better off when she remarries, due to “free-rider” benefit. This can be seen from Equation (7), (4), and (9). With a stepfather who cares about the child expenditure at least as he does, the father can always enjoy a boosted utility level with more expenditure on his own adult consumption while not decreasing the child's. Therefore, the more likely she remarries, the better off he is.

An alternative way to see this is by taking the partial derivative of  $V$  with respect to  $g(c_{f1})$ , while keeping all other variables constant:

$$\begin{aligned} \frac{\partial V}{\partial g(c_{f1})} &= \rho\{Y_f - \dot{\alpha}_f(1 - \frac{1}{\beta}) + \beta[\dot{\alpha}_f(1 - \frac{1}{\beta}) - \frac{\dot{\alpha}_f}{2}(1 - \frac{1}{\beta})^2]\}k - \\ &\rho\{Y_f + \beta[g(c_{f1})(1 - \frac{1}{\beta}) - \frac{g^2(c_{f1})}{2\dot{\alpha}_f}(1 - \frac{1}{\beta})^2]\}k \end{aligned} \quad (\text{A-14})$$

Evaluation of the partial derivative at the equilibrium condition  $\dot{\alpha}_f = g(c_{f1})$  leads to

$$\frac{\partial V}{\partial g(c_{f1})} = -k\rho\dot{\alpha}_f(1 - \frac{1}{\beta}) \quad (\text{A-15})$$

which is always negative when  $\beta > 1$ . In economic words, the higher threshold value a stepfather must have, the less likely father gets to enjoy the “free-rider” benefit, and the worse off he is.

Secondly, remember the father can always bring down the stepfather's threshold type and increase mother's remarriage probability by paying less, according to the positive derivative

in Equation (A-13). Altogether, the observed father's under-transfer behavior is a result of his strategic intention to trigger more remarriage by decreasing her screening standard.

□

Table A-1: Simulation for father's Scaled Income Squared Residuals

Variable	Ln(labor income) in divorce (1)	Scaled Squared Residuals (2)
Ln(labor income)	0.631*** [11.28]	-0.080*** [6.70]
age	-0.003 [0.73]	0.000 [0.13]
Race-Black	-0.282*** [3.50]	0.018 [1.21]
Race-Other	-0.031 [0.21]	-0.004 [0.09]
Education-0-5 grades	-0.527* [1.65]	0.072 [0.95]
Education-6-8 grades	-0.159 [1.16]	-0.038 [1.64]
Education-9-11 grades	-0.086 [1.00]	-0.042** [2.58]
Education-College, no degree	0.137* [1.67]	-0.016 [0.96]
Education-College, bachelors degree	0.128 [1.17]	0.001 [0.05]
Education-College, advanced degree	0.330*** [2.77]	0.004 [0.15]
Number of kids	0.033 [1.05]	0.001 [0.14]
PMSA status	0.032 [0.42]	-0.008 [0.54]
Central city status	0.060 [0.56]	0.007 [0.37]
Constant	3.294*** [5.05]	0.659*** [4.95]
Observations	2210	2210
R-squared	0.42	0.13

Note: State, region, and year effects are controlled. Absolute value of t statistics in brackets.

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

Table A-2: Simulation of father's Ln(laborinc) after Divorce

Ln(laborinc) after divorce	St.Dev of Ln(laborinc)	Mean Squared Change of Ln(laborinc)	Current Mean Squared Change of Ln(laborinc)	Self-employed	Squared Residual of Ln(laborinc)
	(1)	(2)	(3)	(4)	(5)
Information asymmetry	1.599 (1.51)	0.300 (1.08)	0.397 (1.35)	-0.231** (2.27)	0.827 (1.48)
Ln(labor income)	0.844*** (3.43)	0.833*** (3.36)	0.885*** (3.40)	0.816*** (3.33)	0.819*** (3.52)
age	0.037 (0.72)	0.043 (0.85)	0.023 (0.39)	0.044 (0.93)	0.029 (0.63)
Race-Black	-0.216*** (2.61)	-0.219*** (2.62)	-0.221** (2.40)	-0.272*** (3.51)	-0.246*** (3.05)
Race-Other	-0.014 (0.09)	-0.023 (0.16)	-0.133 (0.51)	-0.059 (0.41)	-0.019 (0.14)
Education-0-5 grades	8.692** (2.02)	8.626** (1.99)	16.274*** (6.97)	8.307** (1.98)	7.741** (2.03)
Education-6-8 grades	-0.033 (0.02)	0.151 (0.09)	0.950 (0.62)	0.308 (0.19)	0.202 (0.13)
Education-9-11 grades	0.256 (0.21)	0.399 (0.32)	1.063 (0.98)	0.580 (0.51)	0.137 (0.12)
Education-College, no degree	2.235 (1.61)	2.254 (1.63)	2.001 (1.31)	2.188* (1.66)	2.147* (1.68)
Education-College, bachelors degree	2.449 (1.28)	2.567 (1.35)	2.194 (1.01)	2.689 (1.59)	3.691** (2.51)
Education-College, advanced degree	1.117 (0.66)	1.254 (0.75)	1.884 (1.12)	1.030 (0.59)	0.831 (0.51)
PMSA status	0.062 (0.82)	0.062 (0.81)	0.027 (0.30)	0.059 (0.77)	0.027 (0.33)
Central city status	0.008 (0.07)	0.010 (0.10)	-0.050 (0.44)	0.009 (0.09)	0.043 (0.41)
Number of kids	0.051 (1.59)	0.052* (1.65)	0.092*** (2.84)	0.047 (1.52)	0.032 (0.99)
Constant	0.609 (0.36)	0.615 (0.37)	-0.230 (0.12)	0.893 (0.55)	0.981 (0.60)
Observations	2063	2063	1571	2181	2210
R-squared	0.45	0.45	0.49	0.44	0.43

Note: Income and age, education level interaction effects, and state, region, and year effects are controlled.  
 Absolute value of t statistics in brackets. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

Table A-3: Simulation of father's Food Expenditure Income Ratio after Divorce

Food expenditure/income	St.Dev of Ln(laborinc)	Mean Squared Change of Ln(laborinc)	Current Mean Squared Change of Ln(laborinc)	Self-employed	Squared Residual of Ln(laborinc)
	(1)	(2)	(3)	(4)	(5)
Information asymmetry	0.396 (0.31)	0.194 (0.53)	0.054 (0.13)	-0.127 (0.81)	-0.131 (0.20)
Ln(labor income)	0.085 (0.18)	0.106 (0.22)	0.193 (0.37)	0.068 (0.18)	0.075 (0.19)
age	0.044 (0.39)	0.048 (0.40)	0.099 (0.62)	0.049 (0.46)	0.050 (0.48)
Race-Black	0.089 (1.18)	0.090 (1.18)	0.119 (1.16)	0.078 (1.08)	0.099 (1.52)
Race-Other	-0.168 (1.05)	-0.168 (1.05)	-0.325 (0.97)	-0.206 (1.29)	-0.211 (1.32)
Education-0-5 grades	3.344 (0.40)	3.351 (0.40)	0.600 (0.06)	3.213 (0.38)	4.310 (0.52)
Education-6-8 grades	3.872** (2.42)	3.905** (2.38)	3.968* (1.81)	3.732** (2.54)	3.785*** (2.66)
Education-9-11 grades	2.428** (2.08)	2.455** (2.06)	2.033* (1.66)	2.062* (1.95)	2.425** (2.26)
Education-College, no degree	1.195 (0.92)	1.212 (0.93)	1.794 (0.75)	1.089 (0.89)	1.159 (0.98)
Education-College, bachelors degree	0.692 (0.39)	0.776 (0.44)	0.791 (0.35)	0.720 (0.50)	0.023 (0.02)
Education-College, advanced degree	-0.736 (0.54)	-0.778 (0.60)	-0.870 (0.57)	-0.449 (0.39)	-0.308 (0.27)
PMSA status	-0.120 (1.30)	-0.124 (1.38)	-0.087 (1.07)	-0.087 (0.93)	-0.078 (0.87)
Central city status	0.044 (0.22)	0.045 (0.22)	0.126 (0.47)	0.047 (0.24)	0.042 (0.21)
Number of kids	-0.021 (0.38)	-0.022 (0.39)	-0.032 (0.42)	-0.010 (0.20)	-0.003 (0.06)
Constant	-0.467 (0.12)	-0.626 (0.16)	-1.552 (0.29)	-0.611 (0.18)	-0.757 (0.22)
Observations	2063	2063	1571	2181	2210
R-squared	0.07	0.07	0.09	0.07	0.07

Note: Income and age, education level interaction effects, and state, region, and year effects are controlled.  
 Absolute value of t statistics in brackets. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

Table A-4: Simulation of Father's Indoor Activities with Child

Indoor activities	St.Dev of Ln(laborinc)	Mean Squared Change of Ln(laborinc)	Current Mean Squared Change of Ln(laborinc)	Self-employed	Squared Residual of Ln(laborinc)
	(1)	(2)	(3)	(4)	(5)
Information asymmetry	1.869 [1.32]	0.835 [1.61]	0.241 [0.34]	-0.173 [1.29]	0.947 [1.28]
Father divorced	0.041 [0.18]	-0.047 [0.27]	-0.118 [0.64]	-0.095 [0.58]	-0.036 [0.14]
Information asymmetry * Father divorced	-4.019 [0.79]	-1.522 [0.80]	-0.673 [0.40]	0.244 [0.68]	-0.625 [0.21]
Boy	0.164** [2.26]	0.166** [2.28]	0.152** [2.03]	0.151** [2.08]	0.159** [2.18]
Mother's income	-0.000 [0.05]	-0.000 [0.14]	-0.000 [0.13]	-0.000 [0.09]	-0.000 [0.08]
Mother's age	-0.053*** [7.29]	-0.052*** [7.23]	-0.047*** [6.23]	-0.052*** [7.26]	-0.052*** [7.22]
Mother's race-Black	-0.616*** [5.46]	-0.619*** [5.49]	-0.641*** [5.57]	-0.614*** [5.46]	-0.588*** [5.12]
Mother's race-Other	-0.382** [2.33]	-0.398** [2.42]	-0.448*** [2.59]	-0.414** [2.54]	-0.398** [2.43]
Mother's education-0-5 grades	-0.120 [0.27]	-0.226 [0.54]	-0.109 [0.23]	-0.065 [0.13]	-0.090 [0.21]
Mother's education-6-8 grades	0.302 [1.03]	0.308 [1.05]	0.248 [0.80]	0.290 [0.98]	0.323 [1.10]
Mother's education-9-11 grades	-0.326** [2.02]	-0.326** [2.03]	-0.288 [1.64]	-0.328** [2.04]	-0.329** [2.04]
Mother's education-College, no degree	0.273*** [2.61]	0.274*** [2.62]	0.300*** [2.78]	0.277*** [2.66]	0.282*** [2.72]
Mother's education-College, bachelors degree	0.335*** [3.08]	0.347*** [3.20]	0.385*** [3.41]	0.357*** [3.31]	0.338*** [3.08]
Mother's education-College, advanced degree	0.713*** [4.76]	0.716*** [4.77]	0.732*** [4.77]	0.747*** [5.08]	0.757*** [5.01]
Mother's PMSA status	-0.006 [0.06]	-0.009 [0.08]	-0.012 [0.11]	-0.016 [0.14]	-0.023 [0.21]
Mother's central city status	-0.022 [0.17]	-0.025 [0.19]	-0.019 [0.14]	-0.014 [0.11]	-0.008 [0.06]
Mother's number of kids	-0.072* [1.79]	-0.074* [1.86]	-0.076* [1.86]	-0.062 [1.53]	-0.061 [1.54]
Observations	926	926	883	933	920

Note: State, region, and year effects are controlled. Robust z statistics in brackets.

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

Table A-5: Simulation of Father's Outdoor Activities with Child

Outdoor activities	St.Dev of Ln(laborinc)	Mean Squared Change of Ln(laborinc)	Current Mean Squared Change of Ln(laborinc)	Self-employed	Squared Residual of Ln(laborinc)
	(1)	(2)	(3)	(4)	(5)
Information asymmetry	-1.408 [1.25]	0.038 [0.12]	-0.315 [0.81]	0.252* [1.93]	-0.557 [0.97]
Father divorced	-0.299 [1.30]	-0.316* [1.80]	-0.346* [1.69]	-0.343** [2.11]	-0.333 [1.42]
Information asymmetry * Father divorced	-2.083 [0.47]	-1.276 [0.87]	-0.236 [0.20]	-0.256 [0.52]	-0.261 [0.12]
Boy	0.307*** [4.26]	0.307*** [4.25]	0.313*** [4.20]	0.302*** [4.19]	0.300*** [4.16]
Mother's income	0.000 [0.77]	0.000 [0.69]	0.000 [0.53]	0.000 [0.74]	0.000 [0.70]
Mother's age	-0.055*** [7.78]	-0.055*** [7.92]	-0.052*** [7.19]	-0.055*** [7.94]	-0.055*** [7.85]
Mother's race-Black	-0.246** [2.22]	-0.242** [2.19]	-0.254** [2.23]	-0.229** [2.06]	-0.236** [2.10]
Mother's race-Other	-0.233 [1.34]	-0.212 [1.21]	-0.153 [0.83]	-0.218 [1.26]	-0.220 [1.25]
Mother's education-0-5 grades	0.016 [0.02]	-0.025 [0.04]	0.009 [0.01]	-0.062 [0.09]	-0.156 [0.25]
Mother's education-6-8 grades	-0.051 [0.19]	-0.055 [0.20]	0.092 [0.33]	-0.045 [0.16]	-0.060 [0.22]
Mother's education-9-11 grades	-0.337** [1.97]	-0.335** [1.97]	-0.279 [1.47]	-0.345** [2.04]	-0.330* [1.90]
Mother's education-College, no degree	-0.066 [0.63]	-0.070 [0.68]	-0.071 [0.67]	-0.072 [0.70]	-0.066 [0.64]
Mother's education-College, bachelors degree	-0.064 [0.58]	-0.073 [0.68]	-0.026 [0.23]	-0.095 [0.87]	-0.063 [0.57]
Mother's education-College, advanced degree	0.133 [0.93]	0.129 [0.91]	0.177 [1.20]	0.102 [0.74]	0.129 [0.91]
Mother's PMSA status	-0.061 [0.60]	-0.061 [0.61]	-0.053 [0.52]	-0.055 [0.55]	-0.066 [0.66]
Mother's central city status	0.163 [1.44]	0.160 [1.42]	0.245** [2.12]	0.159 [1.39]	0.168 [1.46]
Mother's number of kids	0.072* [1.68]	0.068 [1.58]	0.076* [1.71]	0.072* [1.68]	0.066 [1.52]
Observations	926	926	883	933	920

Note: State, region, and year effects are controlled. Robust z statistics in brackets.

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

Table A-6: Simulation of Whether Mother Relocated

Outdoor activities	St.Dev of Ln(laborinc)	Mean Squared Change of Ln(laborinc)	Current Mean Squared Change of Ln(laborinc)	Self-employed	Squared Residual of Ln(laborinc)
	(1)	(2)	(3)	(4)	(5)
Information asymmetry	-1.408 [1.25]	0.038 [0.12]	-0.315 [0.81]	0.252* [1.93]	-0.557 [0.97]
Father divorced	-0.299 [1.30]	-0.316* [1.80]	-0.346* [1.69]	-0.343** [2.11]	-0.333 [1.42]
Information asymmetry * Father divorced	-2.083 [0.47]	-1.276 [0.87]	-0.236 [0.20]	-0.256 [0.52]	-0.261 [0.12]
Boy	0.307*** [4.26]	0.307*** [4.25]	0.313*** [4.20]	0.302*** [4.19]	0.300*** [4.16]
Mother's income	0.000 [0.77]	0.000 [0.69]	0.000 [0.53]	0.000 [0.74]	0.000 [0.70]
Mother's age	-0.055*** [7.78]	-0.055*** [7.92]	-0.052*** [7.19]	-0.055*** [7.94]	-0.055*** [7.85]
Mother's race-Black	-0.246** [2.22]	-0.242** [2.19]	-0.254** [2.23]	-0.229** [2.06]	-0.236** [2.10]
Mother's race-Other	-0.233 [1.34]	-0.212 [1.21]	-0.153 [0.83]	-0.218 [1.26]	-0.220 [1.25]
Mother's education-0-5 grades	0.016 [0.02]	-0.025 [0.04]	0.009 [0.01]	-0.062 [0.09]	-0.156 [0.25]
Mother's education-6-8 grades	-0.051 [0.19]	-0.055 [0.20]	0.092 [0.33]	-0.045 [0.16]	-0.060 [0.22]
Mother's education-9-11 grades	-0.337** [1.97]	-0.335** [1.97]	-0.279 [1.47]	-0.345** [2.04]	-0.330* [1.90]
Mother's education-College, no degree	-0.066 [0.63]	-0.070 [0.68]	-0.071 [0.67]	-0.072 [0.70]	-0.066 [0.64]
Mother's education-College, bachelors degree	-0.064 [0.58]	-0.073 [0.68]	-0.026 [0.23]	-0.095 [0.87]	-0.063 [0.57]
Mother's education-College, advanced degree	0.133 [0.93]	0.129 [0.91]	0.177 [1.20]	0.102 [0.74]	0.129 [0.91]
Mother's number of kids	0.072* [1.68]	0.068 [1.58]	0.076* [1.71]	0.072* [1.68]	0.066 [1.52]
Mother's PMSA status	-0.061 [0.60]	-0.061 [0.61]	-0.053 [0.52]	-0.055 [0.55]	-0.066 [0.66]
Mother's central city status	0.163 [1.44]	0.160 [1.42]	0.245** [2.12]	0.159 [1.39]	0.168 [1.46]
Observations	926	926	883	933	920

Note: State, region, and year effects are controlled. Robust z statistics in brackets.

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.