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The More Kids, The Less Mom's Divvy: Impact of Childbirth on Intrahousehold Resource Allocation *

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Abstract

We investigate how childbirth affects intrahousehold resource allocation for married Japanese couples. We develop reduced-form and structural-form specifications from a unified theoretical framework. Under a weak set of assumptions, we can focus on private goods to track the changes in intrahousehold resource allocation. Our estimation results show that the allocation of resources within household tend to move to the disadvantage of women after a childbirth. One additional child is associated with at least 2.6 percentage points decrease in women's private expenditure share. Our estimation results reject the income-pooling hypothesis, and show that women are more risk averse than men.

JEL classification code: D11, D12, D13, J12.

Keywords: Childbirth, Bargaining, Intrahousehold allocation, Relative risk aversion, Japan.

1 Introduction

Childbirth is one of the most important life events for many couples. The newborn bring about new responsibilities, one of which is economic responsibility. The couple as parents has to face additional expenses related to the baby—cribs, diapers, baby clothes and toys, to name a few. The couple will also face other expenses, such as education and medical expenses, as the child grows older.

Then, how does the couple cope with those additional expenses for the children? Childbirth *per se* typically does not increase the couple's disposable income enough to cover all such expenses, even though it may bring about some benefits—such as income tax credit for children, childbirth benefit and dependent allowance. Hence, increased spending on children must be accommodated by reducing expenditures or savings.

Then, does the mother, the father, or both reduce their expenditures on private goods—goods enjoyed by a single individual? Or do they reduce the expenditure on (intrahousehold) public goods—goods enjoyed by the household as a whole? These questions are key to the understanding of whose shoulder the new responsibilities for the newborn fall on. However, as far as we are aware, no one has attempted to directly answer these questions. Indeed, there is a dearth of empirical studies on how specific life events, such as childbirth, alter intrahousehold resource allocation.

This may be surprising given that there is a large body of literature on intrahousehold resource allocation. As we shall see in Section 2, economists and sociologists have long investigated how resources are allocated within a household. However, analysis of the impact of specific life events on intrahousehold allocation has been difficult because of the lack of data and the methodological difficulties that we shall elaborate later. We shall overcome these problems by using a unique panel dataset that includes a direct measurement of intrahousehold resource allocation.

In order to identify the determinants of intrahousehold resource allocation, we develop reduced-form and structural-form specifications from a unified theoretical framework. Under both specifications, we observe that the wife's share in the private expenditure tends to be lower with more children in the household. This is true, even after controlling for the changes in wife's income share, which tends to fall after a childbirth. Our results show that one additional child is associated with at least 2.6 percentage points decrease in women's share in private expenditure. In addition to the impact of childbirth, the structural-form specification also allows us to identify the gender difference in relative risk aversion. Our estimation results indicate that women are more risk averse than men.

This paper is organized as follows: Section 2 reviews both sociological and economic studies on intrahousehold resource allocation, and discusses their relevance to this study. Section 3 lays out the analytical framework for this study. Section 4 develops the estimation equations. Section 5 presents the data and summary statistics. Section 6 presents the estimation results. Section 7 provides discussion and concluding remarks.

2 Review of Related Literature

Sociologists have long been interested in the intrahousehold resource allocation. One of the earliest sociological studies on this subject, Young (1952) has emphasized the importance of intrahousehold allocation in analyzing poverty, because there may be some members suffering from acute poverty in a relatively wealthy family. To date, a number of studies have been carried out on the subject of intrahousehold resource allocation. However, many of these studies have focused on the management of household finance to investigate the power within the household, and they do not answer how childbirth alters intrahousehold allocation (*e.g.* Burgoyne (1994); Morris (1993); Pahl (1983, 1995); Vogler and Pahl (1994)). Further these studies are often based on anecdotes or a small number of observations with a poor sampling scheme.

A recent study by Pahl (2005) shares the motivation with this study. He discussed the implications of the individualization of couple finances. He argues that, when women are expected to pay the cost of children under the independent management of household finances, the decrease of women's income as a result of childbirth results in increased gender inequality in spending. This would be an interesting hypothesis to test, but his study lacks empirical investigation.

Further, his study misses three potentially important points. First, gender inequality in spending may arise regardless of the way the money is managed. Second, this inequality may be spurious, if women are simply deferring their consumption. Third, the inequality in spending may underestimate the true inequality, if women have to sacrifice both spending and leisure time much more than men do.

Economists have traditionally taken households as a single unit of decision-making, and little attention was paid to intrahousehold allocation. Unitary household models—in which the members of the household pool all the resources and reallocate them to jointly maximize a household welfare function—have been conveniently and conventionally employed. A series of seminal works by Becker (1973, 1974, 1981) have provided the justification for this approach. The unitary model can be justified if each household member has an identical preference. Alternatively, it can be justified when the household has an altruistic dictator, a result known as the rotten kid theorem. While the unitary model is convenient, the set of assumptions to justify it appears too strong, and it masks the heterogeneity that exists within the household.

Since 1980s, collective models of households—which addresses the heterogeneity within the household— have appeared in the economics literature. We shall now briefly review this literature and discuss its relevance. More complete surveys of intrahousehold allocation and collective models can be found in Bergstrom (1996), Lundberg and Pollak (1996) and Behrman (1997).

Earlier theoretical studies that explicitly treated intrahousehold allocation are based on the cooperative Nash bargaining. Manser and Brown (1980) investigate the allocative and distributive behavior of Nash-bargained households as well as the household formation itself. McElory and Horney (1981) scrutinize the properties of the demand function of a Nash-bargained household and compare it with the neoclassical demand system. Manser and Brown (1980) and McElory and Horney (1981) take the single state (*i.e.* divorce) as the threat point. Lundberg and Pollak (1993), on the other hand, proposes to take the "noncooperative" marriage as the threat point. Other studies that incorporate the elements of noncooperative marriage into the bargaining framework include Lundberg and Pollak (1994), Konrad and Lommerud (2000) and Chen and Woolley (2001). McElory (1990) provides comparative statics of the changes in demands with respect to the changes in extrahousehold environmental parameters.

A second strand of theoretical studies on the behavior of non-unitary households is the Pareto-efficiency approach pioneered by Chiappori (1988, 1992). Unlike the Nash-bargaining approach, Chiappori (1988, 1992) does not impose any particular bargaining structure, and only requires Pareto efficiency instead. However, most of the studies based on the Pareto-efficiency approach did not treat public goods explicitly. A notable exception is a recent work by Blundell et al. (2005).

Unlike the unitary model, both the Nash-bargaining approach and the Pareto-efficiency approach allow us to explicitly deal with the intrahousehold heterogeneity. Both approaches include a parameter that is directly related to the intrahousehold allocation, which we shall call the *alloca-*

tion parameter. The bargaining power is the allocation parameter for the Nash-bargaining model,[1] and the sharing rule—the weights attached to each individual's utility function—is the allocation parameter for the Pareto-efficiency approach. The Nash-bargaining approach can be considered as a special case of the Pareto-efficiency approach as we discuss in the next section.

In general, the Pareto-efficiency approach has an advantage over the Nash-bargaining approach when we are interested in testing the unitary household model, because it does not rely on a particular bargaining structure that is difficult to justify. Hence, we also take the Pareto-efficiency approach, and impose no particular bargaining structure *a priori*.

On the empirical front, a number of studies have been carried out to test the unitary model. Using expenditure data in Canada, Browning et al. (1994) test the unitary model based on the Pareto-efficiency approach. They find that the share of wife's expenditure on cloth is larger when the wife's share of income is higher, when the age of wife is higher relative to that of the husband, and when the total household expenditure is higher. Browning and Chiappori (1998) develop an empirical test of the unitary household model based on the restriction on the demand system. They reject the unitary model again with a Canadian data set using a more complete set of expenditure categories.

Browning et al. (2006) construct the adult-equivalence scale based on the Pareto-efficiency approach. They develop a new estimation strategy to identify the parameters for consumption technology, the quadratic almost ideal demand system as well as the sharing rule. They argue that the sharing rule can be interpreted as the bargaining power within the household, though they do not provide detailed discussion on the determinants of the sharing rule.

A more straightforward and perhaps more popular approach to testing the unitary model is the testing of the income-pooling hypothesis, a consequence that follows from the unitary model. Thomas (1990) tests the income-pooling by estimating the impact of maternal and paternal incomes on the children's health outcome, and rejects the income-pooling hypothesis.

Lundberg et al. (1997) use the institutional change in the UK child benefit scheme to test the income-pooling hypothesis. They find that there was a substantial increase in spending on women's and children's clothing relative to men's clothing after the institutional changes that shifted resources from husbands to wives. They take this as the evidence to reject the income-pooling

[1] Alternatively, one can formulate the problem as a change in the threat point. In practice, it is difficult, if not impossible, to identify the threat point and the bargaining power jointly. Hereafter, we only consider the bargaining power.

hypothesis. Their argument, however, was questioned by Hotchkiss (2005), because Lundberg et al. (1997) did not consider the natural control group.

Phipps and Burton (1998) take a somewhat different approach. They estimate Engel curves as a function of the generalized quadratic form of husband's and wife's incomes. Their econometric specification provides restrictions on the parameters under the income-pooling hypothesis for each expenditure category. They found that the income-pooling hypothesis is rejected for some, but not all the expenditure categories. Hayashi (1995) also uses an Engel curve equation to test the intergenerational altruism in Japan, exploiting the generational differences in food taste for identification.

Quisumbing and Maluccio (2003) systematically test in four countries the unitary model. They test the equality of the impacts of the assets held by the husband and the wife at the time of marriage on the Engel curve. The null hypothesis was rejected in three out of four countries. They also look at the educational outcome for children using an inferential approach similar to Thomas (1990).

Our empirical investigation is different from the existing empirical studies on intrahousehold resource allocation in two important aspects. First, most empirical studies we reviewed above assume that the allocation parameter is identical across households up to a limited set of observables. This assumption may be indispensable for cross-sectional studies, but appears too strong. We relax this assumption by exploiting the panel structure of the data to control for the unobservable differences among households.

Second, existing empirical studies focused primarily on testing (and rejecting) the unitary model. While these studies shed light on the heterogeneity of preferences within the household, they typically fail to address the changes of the allocation parameter over time. In fact, it is often implicitly assumed that the allocation parameter is constant over time within the same household. As a result, they do not tell us whether and how certain factors, such as childbirth, may affect the allocation parameter. We instead look at how the allocation parameter changes in response to the changes in the household characteristics.

3 Analytical Framework

This section lays out the analytical framework for our empirical analysis. We first develop a variant of the collective model of household that allows us to explicitly deal with the allocation of private goods within the household. Based on this model, we develop estimation equations both in a reduced form and a structural form in the next section.

We assume that the unit of decision-making is a couple, where a *couple* consists of a wife w and a husband h. In principle, we can apply our analytical framework to all the couples that are living together. However, we only consider married couples, because our data do not allow us to identify the intrahousehold allocation of resources for cohabiting couples. In our model, a *household* is a unit that includes a couple, and possibly some children and other household members. We assume children and other household members do not directly affect intrahousehold resource allocation, but indirectly to the extent that the couple cares about them.

We consider n goods in the economy. For each household, each of these n goods is classified either as a private good or a public good. Private goods are enjoyed by only one member of the couple, whereas the public goods are enjoyed by both members of the couple. Note that there is no obvious distinction between private and public goods in general. While clothes and leisure are usually considered as private goods, and housing and utilities as public goods, the distinction depends on the couple. Expenses for certain goods, say, food, may or may not be private. Food is clearly excludable and divisible, and, hence, appears to be a private good. However, one could also argue that food is a public good if the couple enjoys the food more by consuming jointly. Thus, the classification of public and private goods is dependent upon the household. Given this, we develop an estimation strategy with no requirement of *a priori* classification of private and public goods, details of which will be discussed in the subsequent sections.

Now, let $\mathcal{H}$ be the set of all households in the economy. We let $\mathbb{R}_+^{i(H)}$ and $\mathbb{R}_+^{c(H)}$ be the consumption sets of private and public goods for a household $H \in \mathcal{H}$, where $i : \mathcal{H} \to \mathbb{N}$ and $c : \mathcal{H} \to \mathbb{N}$ give the number of private and public goods for household H. Since the total number of goods in the economy is fixed, the consumption set for all the households is $\mathbb{R}^n = \mathbb{R}^{i(H)} \times \mathbb{R}^{c(H)}$ for any $H \in \mathcal{H}$. Further, we let $Y : \mathcal{H} \to \mathbb{R}_+$ be the mapping from the household index to the household income.

For $H \in \mathcal{H}$, we let $\mathbb{I}^i \equiv \{1, \ldots, i(H)\}$ the index set of private goods. The index set of public goods is $\mathbb{I}^c \equiv \{i(H)+1,\ldots,n\}$. For each $m \in \{w,h\}$, we define $\mathbb{I}^m \equiv \{m\} \times \mathbb{I}^i$ to explicitly distinguish the consumption of private goods by different individuals. Further, we let $p \in \Delta(\mathbb{R}^n_{++})$ be the row price vector of the n goods, where $\Delta(A)$ is a unit simplex for a set A. We denote by p^i and p^c the price vectors of private goods and public goods with $p = (p^i, p^c) = (p_1, \ldots, p_{i(H)}, p_{i(H)+1}, \ldots, p_n)$ for $H \in \mathcal{H}$. Hereafter, we shall consider a particular household, and so we shall drop the argument H until the next section.

Each member $m \in \{w,h\}$ of the couple has a cardinal utility function $U^m : \mathbb{R}^i_+ \times \mathbb{R}^c_+ \to \mathbb{R}_+$. We also assume that the utility function is a strictly increasing, strictly concave, and twice continuously differentiable function on $\mathbb{R}^n_+$. Under these assumptions, the utility possibility frontier (UPF) is strictly concave (Mas-Colell et al., 1995, p. 576). For $m \in \{w,h\}$, we consider the following assumptions:

A1: $\mathbb{I}^m$ is *weakly separable* from $\mathbb{I}^c$ in U^m. That is, for any $j,k \in \mathbb{I}^m$ and any $l \in \mathbb{I}^c$,

$$\frac{\partial}{\partial x_l^c}\left(\frac{\partial U^m/\partial x_j^m}{\partial U^m/\partial x_k^m}\right) = 0,$$

where x_j^m and x_k^m are the jth and kth components of the vector of m's private goods consumption $x^m \in \mathbb{R}^i$, and x_l^c is the lth component of the vector of public goods consumption $x^c \in \mathbb{R}^c$. We use similar notations below.

A2: The couple is *collectively rational.* That is, any allocation $(\tilde{x}^w, \tilde{x}^h, \tilde{x}^c)$ chosen by the couple is Pareto-efficient so that, given the budget constraint the couple faces, U^w cannot be increased without decreasing U^h and *vice versa.*

Assumption **A1** states that the marginal rate of substitution between any two private goods does not depend on the level of the public goods consumption. The weak separability can be understood in the context of the *two-stage budgeting.* That is, the total expenditure is allocated to each group of goods (*i.e.* private goods and public goods) in the first stage, and then the expenditure for each group is allocated to each item within the group in the second stage. It is well known that the second stage of two-stage budgeting is a necessary and sufficient condition for the weak separability. Hence, if the set of private goods and the set of public goods are weakly separable from each other, the expenditure allocation for public goods should bear no direct relationship with that for private goods.

We require Assumption **A2** for econometric identification. Under **A2**, when the UPF is held fixed, any intrahousehold allocation can be uniquely described by the slope of the line tangent to the UPF for that allocation. Formally, for any Pareto-efficient allocation $(\tilde{x}^w, \tilde{x}^h, \tilde{x}^c)$, there exists a unique *allocation parameter* $\lambda \in [0,1]$ such that $(\tilde{x}^w, \tilde{x}^h, \tilde{x}^c)$ is supported as follows:

$$
\begin{aligned}
(\tilde{x}^w, \tilde{x}^h, \tilde{x}^c) = \underset{(x^w, x^h, x^c)}{\operatorname{argmax}} \ & \lambda U^w(x^w, x^c) + (1-\lambda) U^h(x^h, x^c) \\
\text{s.t.} \quad & p^i(x^w + x^h) + p^c x^c \leq Y.
\end{aligned} \tag{1}
$$

The allocation parameter λ tells us how the resources are allocated within the household. In what follows, we shall exclude the degenerate cases where $\lambda \in \{0,1\}$ because they are in effect a single-decision maker case.

We shall call the maximization problem Eq(1) the *household problem* $(U^w, U^h; Y, \lambda)$. We shall denote the maximand in Eq(1) by $W_\lambda(x^w, x^h, x^c)$. Since the individual utility functions are continuous and strictly increasing, W_λ is also continuous and strictly increasing. Further, W_λ satisfies the following properties:[2]

Proposition 1 *Suppose that individual utility functions satisfy* **A1** *and* **A2**. *Then, for the household problem $(U^w, U^h; Y, \lambda)$, any Pareto efficient allocation $(\tilde{x}^w, \tilde{x}^h, \tilde{x}^c)$ can be supported as a solution to the following problem:*

$$
\begin{aligned}
(\tilde{x}^w, \tilde{x}^h, \tilde{x}^c) = \underset{(x^w, x^h, x^c)}{\operatorname{argmax}} \ & \lambda \bar{U}^w(u^w(x^w), x^c) + (1-\lambda) \bar{U}^h(u^h(x^h), x^c) \\
\text{s.t.} \quad & p^i(x^w + x^h) + p^c x^c \leq Y,
\end{aligned} \tag{2}
$$

where, for $m \in \{w,h\}$, the private goods sub-utility u^m is a continuous, strictly increasing and strictly concave function, and $\bar{U}^m$ is a continuous, strictly increasing, and strictly quasi-concave function.

Further, $\mathbb{I}^m$ is weakly separable from $\mathbb{I}^c$ in W_λ for each $m \in \{w,h\}$.

With a little abuse of notation, we can define the marginal utility with respect to private goods evaluated at a Pareto efficient allocation by $\phi^m \equiv \partial \bar{U}^m / \partial u^m \big|_{(x^m, x^c) = (\tilde{x}^m, \tilde{x}^c)}$ for $m \in \{w,h\}$. Notice

[2] The proofs for all the lemmas, propositions and theorems are relegated to the Appendix.

that $\tilde{x}^w$, $\tilde{x}^h$ and $\tilde{x}^c$ are a function of Y, p and λ. Thus, ϕ^m is also a function of Y, p and λ. We require the following assumption about the ratio $\psi = \phi^w(\phi^h)^{-1}$ of the marginal utilities:

A3: The elasticity $\rho \equiv \lambda/\psi \cdot \partial\psi/\partial\lambda$ satisfies $\rho > -(1-\lambda)^{-1}$ for any $\lambda \in (0,1)$, $Y \in \mathbb{R}_+$ and $p \in \Delta(\mathbb{R}^n_{++})$.

Intuitively, one can expect ρ to be negative. As λ increases, one would expect that the private goods sub-utility for the wife increases, whereas that for the husband decreases. Then, ψ would go down as the marginal utilities ϕ^m would move in the opposite direction to u^m. Assumption **A3** requires that this decrease in ψ is relatively small in the absolute terms. As we shall argue below, this condition ensures that no "surprise" occurs.

We can now show that the intrahousehold allocation can be fully characterized by the pattern of private goods consumption. To this end, we define the private sub-problem of the household problem $(U^w, U^h; Y, \lambda)$:

Definition 1 The problem $(u^w, u^h; y, \mu)$ is called *the private sub-problem* of the household problem $(U^w, U^h; Y, \lambda)$ if the following conditions are satisfied: For any Pareto efficient allocation $(\tilde{x}^w, \tilde{x}^h, \tilde{x}^c)$, there exists a private goods expenditure $y \leq Y$ and the private allocation parameter $\mu \in (0,1)$ such that $(\tilde{x}^w, \tilde{x}^h)$ is supported by the following problem:

$$(\tilde{x}^w, \tilde{x}^h) \equiv \underset{(x^w, x^h)}{\text{argmax}} \ \mu u^w(x^w) + (1-\mu)u^h(x^h) \quad \text{s.t.} \quad p^i(x^w + x^h) \leq y.$$

Using this definition, we can show that there is such a reduced form for any household problem $(U^w, U^h; Y, \lambda)$.

Theorem 1 *Suppose that* **A1** *is satisfied for both w and h, and* **A2** *is also satisfied in the household problem $(U^w, U^h; Y, \lambda)$. Then, a private sub-problem $(u^w, u^h; y, \mu)$ exists. Further, $\partial\mu/\partial\lambda > 0$ holds if and only if* **A3** *holds.*

Thus, when **A3** holds, μ and λ moves in the same direction. That is, when the allocation parameter in the original problem goes up (by a certain exogenous change), the allocation parameter in the private sub-problem also increases. On the other hand, if **A3** is violated, μ and λ move in the opposite directions. A surprise of this sort can happen when the marginal utility with respect to private goods for the wife relative to that for the husband diminishes very quickly. Noting that this surprise can only occur when $\rho < -1$ because $-1 > -(1-\lambda)^{-1}$, **A3** appears to be a reasonable assumption, even though we are unable to test it.

Theorem 1 provides a justification for focusing on private goods in our empirical investigation. The private goods allocation in any Pareto efficient allocation in the household problem $(U^w, U^h; Y, \lambda)$ is supported as a Pareto efficient one in the private sub-problem $(u^w, u^h; y, \mu)$. Note that μ is a function of p, Y and λ, as is clear from the construction of μ—which is provided in the proof of Theorem 1 in the Appendix. Hence, after controlling for the changes in p and Y, we only need to look at the changes in the private allocation parameter μ in order to track the direction of changes in the intrahousehold resource allocation as represented by the allocation parameter λ.

4 Estimation Strategy

4.1 Reduced-Form Specification

As shown in Theorem 1, the intrahousehold resource allocation supported in the household problem $(U^w, U^h; Y, \lambda)$ can be reduced to the allocation of private goods supported in the private sub-problem $(u^w, u^h; y, \mu)$ under the assumptions **A1** and **A2**. This in turn implies that the allocation of private goods is determined by the prices p^i of the private goods, and the expenditure on private goods $y(= Y - p^c x^c)$. Therefore, assuming **A3** holds, we can focus on the private allocation parameter μ to analyze the changes in the allocation of resources within the household.

We use the wife's share $s \equiv (p^i x^w) y^{-1} \equiv y^w y^{-1}$ in the expenditure $y(= y^w + y^h)$ on private goods as a proxy for μ, where y^m denotes the private goods expenditure for m. To track the changes in μ, we consider the following reduced-form specification that looks like an Engel-curve equation:

$$\begin{aligned} \tilde{s}_t &= \beta_0 + \beta_1 \ln y_{H\tau} + \sum_{j \in \mathbb{I}} \beta_{2,j} \ln p_{j,H\tau} + f(\mu) + \tilde{\epsilon}_{H\tau} \\ &= \beta_0 + \beta_1 \ln y_{H\tau} + \sum_{j \in \mathbb{I}} \beta_{2,j} \ln p_{j,H\tau} + \sum_{q=1}^{Q} \beta_3^q z_{q,H\tau} + \epsilon_{H\tau}, \end{aligned} \tag{3}$$

where $y_{H\tau}$, $p_{j,H\tau}$, and $z_{q,H\tau}$ are respectively the expenditure on private goods, the price of jth good, and qth factor that may affect μ—such as the number of children— at time τ for household H . $f : (0,1) \to \mathbb{R}$ is a monotonic function, $\tilde{s}$ the "latent" share, and $\epsilon_{H\tau}$ the error term. Note that s is doubly censored at zero and one so that $s = \min(1, \max(0, \tilde{s}))$. Thus, we will subsequently check the prevalence and the impact of censoring of s. The reduced-form specification in Eq(3) is simple and straightforward, and the estimated coefficients have a straightforward interpretation.

There are three points to make here. First, because s is homogeneous of degree zero in y and p^i, we must have:

$$\beta_1 + \sum_{j \in \mathbb{I}^i} \beta_{2,j} = 0, \tag{4}$$

which can be used to test the validity of the reduced-form specification. Second, because μ depends on income Y, we include the logarithmic income in the set of regressors z.

Third, there is potentially an endogeneity problem in estimating Eq(3). Suppose that women have a stronger preference for children than men. Then, a large number of children may be partly as a result of women's (unobservable) strong bargaining power in the household, which also tends to result in a high share of women in private expenditure. If this is the case, we need valid instruments for the number of children. Otherwise, the estimate of the negative (positive) effect of the children will be underestimated (overestimated).

4.2 Structural-Form Specification

The reduced-form specification is not without problems. First, the introduction of the "latent" share is artificial and has no obvious economic interpretation. Further, we cannot get consistent estimate when the Tobit model has fixed effects. Second, the private allocation parameter μ changes when u^m is affine-transformed, which is theoretically unattractive. Hence, we transform the problem so that the measurement unit or the origin of u^m does not matter.

The structural-form specification has two additional advantages. First, as we elaborate below, the estimation equation has a close relationship with the PIGL preference and the risk attitudes of the couple. Second, besides the condition of homogeneity of degree zero, the structural-form specification comes with additional restrictions on the coefficients, which we can use to test the validity of the specification.

Let us start with the first order conditions of the private sub-problem. Since the allocation in the private sub-problem is Pareto-efficient, we have $\mu \partial u^w / \partial x_l^w = (1 - \mu) \partial u^h / \partial x_l^h$. Now, let $v^m : \mathbb{R}_{++} \times \mathbb{R}_+^i \to \mathbb{R}$ be the indirect utility function corresponding to u^m. We use the subscripts to denote the partial derivatives of v^m. For example, the marginal utility of m's private goods expenditure is $v_y^m(y^m, p^i) \equiv \partial v^m(y^m, p^i)/\partial y^m$. Then, noting that the marginal utilities for direct and indirect utility functions satisfy $\partial u^m/\partial x_j^m = p_j^i v_y^m(y^m, p^i)$, we have:

$$\begin{aligned}\mu v_y^w(y^w, p^i) = (1-\mu)v_y^h(y^h, p^i) \iff & \mu v_y^w(sy, p^i) = (1-\mu)v_y^h((1-s)y, p^i) \\ \iff & \ln\frac{\mu}{1-\mu} = \ln v_y^h((1-s)y, p^i) - \ln v_y^w(sy, p^i).\end{aligned}$$

By totally differentiating the above equation with dropping the arguments, we have:

$$\mathrm{d}\left[\ln\frac{\mu}{1-\mu}\right] = -\left[\frac{v_{yy}^h}{v_y^h} + \frac{v_{yy}^w}{v_y^w}\right] y\mathrm{d}s + \left[\frac{v_{yy}^h(1-s)}{v_y^h} - \frac{v_{yy}^w s}{v_y^w}\right]\mathrm{d}y + \sum_{j\in\mathbb{I}^i}\left[\frac{v_{p_j y}^h}{v_y^h} - \frac{v_{p_j y}^w}{v_y^w}\right]\mathrm{d}p_j. \tag{5}$$

We obviously have $v_y^m > 0$ as u^m is strictly increasing in all arguments. In addition, the second order condition in the private sub-problem $(u^w, u^h; y, \mu)$ implies $v_{yy}^m < 0$. Thus, the coefficient on $\mathrm{d}s$ is positive. For the interpretation of other terms in Eq(5), we use the following lemma:

Lemma 1 *Let $x_j^m(y^m, p^i)$ be m's Marshallian demand function for private good $j \in \mathbb{I}^i$. Then, we have:*

$$\frac{v_{p_j^i y}^m}{v_y^m} = -\frac{\partial x_j^m}{\partial y^m} - \frac{v_{yy}^m}{v_y^m} x_j^m(y^m, p^i) = (R^m - \xi_j^m)\frac{x_j^m}{y^m}, \tag{6}$$

where $R^m \equiv -v_{yy}^m y^m/(v_y^m)^{-1} (> 0)$ is a measure of relative risk-aversion when the price p^i is held constant, and $\xi_j^m \equiv y/x_j^m \cdot \partial x_j^m/\partial y$ the income elasticity of demand for private good j.

Note that R^m may depend on prices because the indirect utility functions also depend on prices. However, we assume away the price dependence of R^m in our empirical investigation, as with other studies on risk. Using Lemma 1, we now obtain from Eq(5) an expression that is invariant with respect to affine transformations of v^m:

Proposition 2 *Let us denote the expenditure share of private good j in m's private expenditure share by $\omega_j^m = p_j x_j^m (y^m)^{-1}$. Then, letting $\mu^* \equiv -\ln(\mu^{-1}-1)$ and $s^* \equiv -\ln(s^{-1}-1)$, we have the following expression:*

$$\begin{aligned}\mathrm{d}s^* \quad = \quad & \frac{1}{(sR^h + (1-s)R^w)}\mathrm{d}\mu^* + \frac{(R^h - R^w)}{(sR^h + (1-s)R^w)}\mathrm{d}(\ln y) \\ & + \sum_{j\in\mathbb{I}^i}\frac{(\xi_j^h - R^h)\omega_j^h - (\xi_j^w - R^w)\omega_j^w}{(sR^h + (1-s)R^w)}\mathrm{d}(\ln p_j).\end{aligned} \tag{7}$$

Further, assuming that $|r| \ll 1$, and taking the Taylor approximation of Eq(7), we have the following *estimable form:*

$$\begin{aligned} \mathrm{d}s^* &= \tilde{R}^{-1}(1+rt)\mathrm{d}\mu^* + r\mathrm{d}(\ln y) + \sum_{j\in\mathbb{I}^i}\Big[(\tilde{R}^{-1}\tilde{\xi}_j - 1)\delta_{\omega_j} + \tilde{R}^{-1}(r\tilde{\xi}_j - \delta_{\xi_j})\delta_{\omega_j}t \\ &\quad -\tilde{R}^{-1}r\delta_{\xi_j}\delta_{\omega_j}t^2 + (\tilde{R}^{-1}\delta_{\xi_j} - r)\tilde{\omega}_j + r\delta_{\xi_j}\tilde{R}^{-1}t\tilde{\omega}_j\Big]\,\mathrm{d}(\ln p_j) + O(r^2), \end{aligned} \tag{8}$$

where $\tilde{R} \equiv 2^{-1}(R^h + R^w)$, $r \equiv \tilde{R}^{-1}(R^h - R^w)$, $\tilde{\omega}_j \equiv s\omega_j^w + (1-s)\omega_j^h$, $t \equiv 2^{-1} - s$, $\delta_{\omega_j} \equiv \omega_j^h - \omega_j^w$, $\delta_{\xi_j} \equiv \xi_j^h - \xi_j^w$, *and* $\tilde{\xi}_j \equiv 2^{-1}(\xi_j^h + \xi_j^w)$.

A few remarks on Eq(7) are in order. First, note that $\partial s^*/\partial\mu^* > 0$. Hence, after controlling for $\ln y$ and $\ln p^i$, the changes in s^* reflect the changes in μ^* and thus the changes in μ. The sensitivity of s^* to μ^*, therefore, depends on the average of the relative risk aversion for the couple weighted by the private expenditure share of the other member of the couple.

In general, when both members of the couple are more risk averse, s^* is less sensitive to the changes in μ^*. Risk averse individuals have high marginal utility of private goods when their consumption of private goods is low. As a result, when the couple is highly risk averse, a transfer from the relatively better-off to the relatively worse-off dramatically increases the utility of the latter. This, in turn, means that the UPF for the private sub-problem is very concave. Thus, the change in the slope of the line tangent to the private UPF translates into only a small change in s^*.

Second, in addition to the changes in μ^*, s^* is also affected by the changes in y and p^i. The response of s^* to the total private goods expenditure y is ambiguous. It depends on the difference in the relative risk aversion between the husband and the wife. Notice here that the marginal utility of private goods expenditure weighted by the private allocation parameter must be equated so that $\mu^w v_y^w = \mu^h v_y^h$. When the wife is more risk averse than the husband, and μ and s are fixed, v_y^w tends to decrease faster than v_y^h as y goes up. Thus, in order to restore $\mu^w v_y^w = \mu^h v_y^h$, s must go down so that v_y^w increases and v_y^h decreases. The effect of price p^i on s is also ambiguous. When the wife is more risk averse than the husband, the rise in the prices of goods for which her income elasticity is low and her share in her private spending is large tends to increase s.

Third, the share affects $\partial s^*/\partial\mu^*$ when the wife and the husband have different coefficients of relative risk aversion as implied by Proposition 3 below. Hence, the relationship between the left-hand-side variable and the right-hand-side variables is likely to depend on $\tilde{s}$ in Eq(3). This means that one can take the reduced-form estimation results only as describing the average relationship. Proposition 3 also shows that the constancy of $\partial s^*/\partial\mu^*$ is related to the price independent generalize linear (PIGL) preference (See, Muellbauer (1975)) for both the husband and the wife.

Proposition 3 *The following three conditions are equivalent:*

1. *The coefficient* $\left(R^h s + R^w(1-s)\right)^{-1}$ *on* $\mathrm{d}\mu^*$ *in Proposition 2 does not depend on the share* s*, private expenditure* y*, or prices* p^i*.*

2. *There is a constant* R *such that* $R^h = R^w = R$*.*

3. $v^m(y^m, p)$ *has a PIGL form, and the couple has a common coefficient of relative risk aversion with respect to* y^m*. That is, for each of* $m \in \{w, h\}$*, we can write* v^m *as* $v^m(y^m, p) = a^m(p)c(y^m; R) + b^m(p)$*, where* R *is a constant,* $c(y^m; R)$ *is a CRRA utility function:* $c(y^m; R) = ((y^m)^{1-R} - 1)(1-R)^{-1}$ *if* $R \neq 1$*, and* $c(y^m; R) = \ln y^m$ *if* $R = 1$*.*

In order to derive an estimation equation, we now replace the small variation by the within-sample deviation in Eq(8). For example, letting H and τ be the subscripts for household and time, and $\bar{s}^*_H \equiv \frac{1}{T}\sum_{\tau=1}^{T} s_{H\tau}$, we replace $\mathrm{d}s^*$ by $\Delta s^*_{H\tau} \equiv s^*_{H\tau} - \bar{s}^*_H$. Similarly, we let $\overline{\ln y_H}$ and $\overline{\ln p^i_{H,j}}$ be the mean for $\ln y_{H\tau}$ and $\ln p^i_{H\tau,j}$ over the observation periods, and replace $\mathrm{d}(\ln y)$ and $\mathrm{d}(\ln p^i_j)$ by $\Delta \ln y_{H\tau} \equiv \ln y_{H\tau} - \overline{\ln y_H}$ and $\Delta \ln p^i_{j,H\tau} \equiv \ln p^i_{H\tau,j} - \overline{\ln p^i_{H,j}}$. Further, we assume that, after controlling for price changes, $\mu^*_{H\tau}$ can be explained by the changes in a set of explanatory variables $\{z^1_{H\tau}, \cdots, z^Q_{H\tau}\}$, so that $\mu^*_{H\tau} = \bar{\mu}_H + \gamma_0 + \sum_{q=1}^{Q}\gamma_1^q \Delta z^q_{h\tau} + \sum_{j\in\mathbb{I}}\gamma_2^j \Delta \ln p_j + \eta_{H\tau}$, where $\eta_{H\tau}$ is an error term. Letting $\bar{t}_H = 2^{-1} - (1+\exp(-\bar{s}^*_H))^{-1}$, we have the following estimation equation:

$$\begin{aligned}\Delta s^*_{H\tau} \;=\;& \beta_0 + \sum_{q=1}^{Q}\beta_1^q \Delta z^q_{H\tau} + \beta_2 \bar{t}_H + \sum_{q=1}^{Q}\beta_3^q \bar{t}_H \Delta z^q_{H\tau} + \beta_4 \Delta \ln y_{H\tau} + \sum_{j\in\mathbb{I}}[\beta_5^j \Delta \ln p_j + \\ & \beta_6^j \bar{t}_H \Delta \ln p_j] + \sum_{j\in\mathbb{I}^i}[\beta_7^j \bar{t}^2_H \Delta \ln p_j + \beta_8^j \tilde{\omega}_{H\tau,j}\Delta \ln p_j + \beta_9^j \tilde{\omega}_{H\tau,j}\bar{t}_H \Delta \ln p_j] + \epsilon_{H\tau} \qquad (9)\end{aligned}$$

Comparing Eq(8) and Eq(9) (See Appendix for the details of the derivation), we have the following restrictions on the coefficients:

$$\frac{\beta_3^q}{\beta_1^q} = \beta_4 = \frac{\beta_9^j}{\beta_8^j + \beta_4}(= r) \qquad (10)$$

Further, since s is homogeneous of degree zero in y and p^i, we must have

$$\beta_4 + \sum_{j \in \mathbb{I}^i} \beta_5^j = \sum_{j \in \mathbb{I}^i} \beta_6^j = \sum_{j \in \mathbb{I}^i} \beta_7^j = \sum_{j \in \mathbb{I}^i} \beta_8^j = \sum_{j \in \mathbb{I}^i} \beta_9^j = 0. \tag{11}$$

As with Eq(4) in the reduced-form specification, Eq(10) and Eq(11) can be used for specification tests. By simply testing $r = 0$, we can also test whether both the wife and the husband have a PIGL indirect utility function with a common coefficient of relative risk aversion.

5 Data and Descriptive Statistics

The primary data source we use for our empirical investigation is the Japanese Panel Survey of Consumers (JPSC) collected by the Institute for Research on Household Economics. We use the nine rounds between 1994 and 2002. The JPSC sample uses stratified two-stage sampling; The entire country of Japan is divided into eight blocks, each of which is further divided into large cities, other cities, and towns to form a total of twenty-three strata, except for Shikoku block in which there is no large city. A total of 125 enumeration areas were distributed to the twenty-three strata in proportion to their estimated population. The data we used contain two cohorts; Cohort A consists of women aged between 24 and 34 at the time of the first survey in 1993, and Cohort B consists of women aged between 24 and 27 as of 1997. The questionnaire for each round has core questions, including the demographics and the education of each family member, employment, income, expenditure, saving, and time use.[3]

We took a sub-sample of double-income couples living together at the time of observation, which accounts for about a third of the whole sample of married couples in JPSC. We excluded the records with missing values in the variables of our interest. Since the reduced-form estimation requires us to calculate within-sample deviations, we need to have a sufficient number of observations for each woman. Hence, we decided to use the records for women with at least three observations. As a result, we had 2,079 observations and 412 women. About 20 percent of these women gave birth to at least one child within the observation periods. Table 1 provides summary statistics of the data we used.

[3]Further information on the JPSC data can be obtained from `http://www.kakeiken.or.jp/en/index.html`.

Table 1: Descriptive statistics of the JPSC data used in this study. Expenditure, saving and income are expressed in JPY 10,000.

Number of Children	0	1	2	3+	Total
(A) Demographics					
Wife's Age	31.43	33.90	35.53	36.25	34.70
Hb's Age	34.55	36.46	38.21	39.44	37.50
# wife's parents living w/ couple	0.04	0.15	0.23	0.24	0.19
# hb's parents living w/ couple	0.32	0.51	0.65	0.65	0.57
(B) Expenditure (by beneficiary)					
Total Expenditure	22.66	22.10	25.43	25.88	24.42
Exp. for wife	2.75	2.03	1.96	1.87	2.08
Exp. for hb	4.54	3.75	4.08	3.94	4.06
Exp. for family as a whole	14.19	12.21	13.39	13.62	13.32
Exp. for children	0.00	2.78	4.30	4.87	3.43
Exp. for other members	1.18	1.34	1.71	1.58	1.53
(C) Saving					
Total saving	9.93	8.16	8.98	8.93	8.96
Saving for wife	1.79	1.27	1.35	1.28	1.39
Saving for hb	1.79	1.66	1.78	1.57	1.72
Saving for family as a whole	6.05	3.99	3.77	3.40	4.10
Saving for children	0.02	1.03	1.72	2.24	1.41
Saving for other members	0.26	0.21	0.35	0.45	0.33
(D) Income					
Wife's disposable income	14.63	12.39	12.41	13.17	12.88
Hb's disposable income	26.31	27.06	28.42	29.16	27.95
(E) Time Use					
Wife's hrs for leisure	3.64	2.66	2.53	2.33	2.70
Wife's hrs for work	5.49	4.75	5.05	4.94	5.04
Wife's hrs for domestic work	3.09	5.23	5.32	5.80	5.04
Hb's hrs for leisure	4.14	3.37	3.55	3.33	3.57
Hb's hrs for work	7.70	7.66	7.85	7.82	7.78
Hb's hrs for domestic work	0.39	1.24	0.97	1.23	0.98
(F) Wife's share in income and expenditure (%)					
Private expenditure (narrow)	37.18	35.14	29.42	30.57	31.95
Private expenditure (extended)	39.58	34.56	31.17	31.51	33.21
Disposable income (narrow)	35.17	29.99	29.45	29.43	30.45
Disposable income (extended)	44.61	43.12	42.69	43.42	43.20
Number of Observations	324	408	993	354	2079

The expenditure section of the JPSC questionnaires has two components. In the first component, the questionnaire directly asks the "beneficiary" of the expenditure. That is, the respondents are asked to break down the total expenditure into the amount for the wife, for the husband, for the family as a whole, for the children, and for all the other household members. This component typically does not exist in similar expenditure surveys, and is a unique feature of the JPSC data. It allows us to measure directly the private expenditure y^m without arbitrarily taking certain goods as private goods.

We treat the expenditure for the wife and the husband private expenditure. The response to this question is subjective, because it is the respondent (*i.e.* the wife) who determines the beneficiary of the expenditure. However, the self-reporting nature of the data poses little problem here. Since the panel structure of the data allows us to control for the heterogeneity of respondents in the perception of who the beneficiaries are, we can capture the changes in the allocation parameter due to childbirth after controlling for the (unobservable) self-reporting effect for each respondent.

In the second component of expenditure section, the questionnaire asks how much money was spent for the month of September of the survey year on each of the following eleven expenditure categories: (A) Food, (B) Housing, (C) Utility, (D) Furniture and Household Utensils, (E) Clothes and Footwear, (F) Medical Care, (G) Transportation, (H) Communication, (I) Education, (J) Reading and Recreation, and (K) Other Miscellaneous.[4] The expenditure data by category are available only from 1998. The two expenditure components are independently asked, so that we do not know the breakdown of each expenditure category by beneficiaries. For example, we know the aggregate amount of expenditure on clothes, but we do not know how much of it was spent for the wife.

Note that the second component is the standard format for expenditure surveys. This format is inconvenient for analyzing intrahousehold allocation, because we cannot calculate y^m (and hence s) from the data. It is always possible, of course, to subjectively assign the beneficiary of each expenditure category. For example, as Lundberg et al. (1997) do, it appears reasonable to treat the expenditure on women's clothes as private expenditure for the wife. However, this approach can be misleading or completely invalid if the changes in the wife's private expenditure on women's clothes are negatively correlated with the changes in her private expenditure on other goods. This is because the former does not reflect her private expenditure share. In contrast, subjective assignments of

[4] Other Miscellaneous includes remittances to children and parents as well as social expenses.

beneficiaries are unnecessary with the first expenditure component of the JPSC data.

As Section (B) of Table 1 shows, couples with no kids have on average the highest private expenditure for both the husband and the wife. For both of them, the average private expenditure drops after the first child, and the drop is higher for the wife than the husband. While wives' average private expenditure tends to decline with the second and third children, the husbands' expenditure do not change much. This appears to imply that increased expenditures due to children are accommodated in part by wives' reduced private expenditure.

This, of course, is far from conclusive. For example, one could argue that wives may be simply deferring consumption. This is plausible because mothers cannot be (fully) substituted by baby-sitters or domestic helpers, so that the wives' opportunity cost of spending money may be much higher with children than otherwise. To see whether this is the case, we can look at the pattern of household savings. JPSC questionnaire asks about the breakdown of the savings by the beneficiaries in the same way as the expenditure. Hence, we can take private savings as a proxy for future consumption.[5] Section (C) of Table 1 shows that wives' private saving is substantially smaller after the first child. However, there is no such clear pattern for the husbands. Thus, we have no evidence to support deferred consumption.

One could also argue that the apparently disproportionate burden of children on wives may simply be because of the changes in earnings. It is common for working women to switch to less demanding jobs, or reduce their working hours after a childbirth. This, in turn, changes the relative earnings within the couple. To see if this is indeed the case, we looked at the average disposable salary income (after paying for the tax and social security contributions) for the husband and the wife. As Section (D) of Table 1 shows, the disposable income for the husband tend to go up with more children. However, the wife's disposable income is, on average, the highest when she has no children.

In the JPSC data, the reported private expenditure does not include the value of the consumption of leisure time, and the reported disposable income does not include the value of domestic labor. However, inclusion of these are important, because how the burden of children is shared depends in part on how the couple's time is used. For example, it is possible that lower "monetary" private expenditure for the wife may be compensated by a longer leisure time. Section (E)

[5] Obviously, there is no guarantee that the wife's private saving indeed goes to her private expenditure in the future. However, there is a small chance that the husband can spend her private savings without her consent, because joint accounts are not available in Japan so that private savings are indeed held privately.

of Table 1 reports the average number of hours in a day spent on leisure, work and domestic work. While the hours spent on domestic work increases for both the husband and the wife with the arrival of the first child, this increase is much larger for the wife. At the same time, the leisure time for each of them decreases, and the decrease is larger for the wife, suggesting that women are not compensated by longer leisure time.

To incorporate the values of leisure time and domestic work in the analysis, we extended the definition of expenditure and income in the following manner: We first calculated the wage rate by dividing the disposable income by the number of hours worked per months. Then, we multiplied the wage rate by the number of hours spent for leisure per month to evaluate the monetary value of leisure time. Similarly, the value of domestic work, which includes household chore and child rearing, is estimated at the number of hours spent on domestic work multiplied by the wage rate. We shall hereafter call the definitions of expenditure and income in the raw data set the *narrow* definitions. The *extended* definitions of expenditure and income include private savings, the values of leisure time and domestic work.

As Section (F) of Table 1 shows, the wife's share in both income and expenditure become, on average, closer to one half under the extended definitions. However, the gap between the income and expenditure widens under the extended definitions, as expected from the preceding discussions. Do the extended definitions help improve our analysis of the allocation parameter? The answer appears to be positive. Under the narrow definitions, the correlation between the wife's share in disposable income and her share in private expenditure is 26.1%. On the other hand, the corresponding figure is 30.2% under the extended definitions. As these figures suggests, the model fit is indeed better under the extended definitions. Hence, our preferred measures of income and expenditure are the ones based on the extended definitions.

The discussion so far highlighted the fact that married women with a larger number children tend to have lower private expenditure share $s_{H\tau}$. It is not yet clear, however, whether the lower share $s_{H\tau}$ is purely as a result of lower share in her disposable income, or as a result of "extra" reduction purely due to the larger number of children. Thus, we answer in the subsequent sections, "Do women give up her share in the private expenditure to cope with additional expenditures for the children on top of what can be explained by the lower contribution to the household income?"

Let us briefly discuss a few other issues associated with the estimation of Eq(9). First, note that

β_7^j, β_8^j and β_9^j terms involve only the prices of private goods. However, what goods are considered as private goods depends on the household. For example, in a household where the couple always eats together, food may well be considered public. On the other hand, if both the husband and the wife work till late and eat separately, food is a private good.

It is, therefore, difficult to determine *a priori* what goods should be private or public for each household. Thus, we initially treat all the eleven categories of goods as if they were a private good. Under the separability assumption, the prices of public goods included in $p_{H\tau}$ would only act as random noise and the consistency of the estimate remains unaffected, provided that it is uncorrelated with the error term. Thus, the inclusion of all the categories does no obvious harm to the estimation.

We face a similar problem for $\tilde{\omega}_{H\tau,j}$, which is a vector of the average categorical shares of private goods expenditure. One way to deal with this issue is, again, to include all of the eleven categories. However, this approach is not fully satisfactory. If we include the shares for public goods, we cannot expect Eq(10) and Eq(11) to hold. This is because the expenditure shares for public goods may capture a part of variations in μ not explained by z.

Hence, we also consider an alternative approach in which we drop from Eq(9) all the terms involving $\tilde{\omega}_{H\tau,j}$. This is in effect equal to treating $\tilde{\omega}$ as an unobserved random variable with additive error structure, so that the consistency of the estimates for β_0, β_1^q, β_2, β_3, β_4, β_5^j and β_6^j remains unaffected. This approach has additional advantages. First, the categorical share data, which are available only from 1998, become unnecessary. Second, we do not need to subjectively decide which goods are private when estimating Eq(9).

The way we handle private goods and public goods has implications for the specification tests in Eq(10) and Eq(11). That is, we can expect these equations to hold only for private goods, and not for public goods. Given that which categories are private depends on the household, the test is approximate at best. We can interpret the results for the specification tests only with some (subjective) judgements as to which goods are private and which goods are public for most households. This point also applies to the specification test Eq(4).

Having said this, summary statistics and introspection provide some guidance as to which goods are public and which goods are private. Table 2 presents the expenditure share in percentage points by the eleven categories. The shares for furniture, utility and medical care do not fluctuate much.

These categories, in particular the first two, are likely to be public for most households, because every household member benefits from expenditure in these categories. They also satisfy weak separability because these are unaffected by the composition of the shares for other categories. The aggregate share of these three categories (Public I) is also stable.

Table 2: Share of expenditure by categories and the number of children. Shares are expressed in percentage.

Number of Children		0	1	2	3+	Total
A	Food	28.04	30.82	31.67	32.17	31.08
B	Housing	14.70	6.03	5.02	4.21	6.46
C	Furniture	1.88	2.06	2.54	1.89	2.24
D	Utility	10.01	9.43	8.99	9.66	9.34
E	Clothes and Footwear	5.58	5.10	4.78	4.77	4.95
F	Medical Care	2.43	2.87	2.79	2.99	2.79
G	Transportation	9.79	8.25	7.90	7.51	8.16
H	Communication	6.20	4.97	4.74	4.79	5.00
I	Education	0.30	6.97	10.87	11.58	8.76
J	Reading and Recreation	10.38	9.58	8.86	10.10	9.44
K	Other Miscellaneous	10.68	13.92	11.84	10.33	11.77
Number of Observations		183	230	611	235	1259
Public I (C+D+F)		14.32	14.35	14.32	14.55	14.37
Public II (B+C+D+F+I)		29.32	27.36	30.22	30.34	29.59
Public III (B+C+D+F+G+I+K)		49.79	49.53	49.95	48.17	49.52

Table 2 also shows that the shares for such as food and education tend to go up with the number of children. On the other hand, the shares for clothes and footwear, and housing tend to go down. Education and housing are public in nature, and they appear to be substitutable because the sum of these categories are reasonably stable. Public II includes education and housing categories in addition to the Public I goods.

Transportation and other miscellaneous include some public component, because both categories include services that benefit everyone in the household. Public III includes these two categories in addition to the Public II goods. To come up with working definitions of private goods (for most households), we take the complement of the set of public goods in the universe of all goods . For example, Private I consists of A, B, E, G, H, I, J, and K.

Note that the expenditure share of public goods does not fluctuate much with the number of children, regardless of the definition of public goods. Hence, the observed shares are consistent with the Cobb-Douglas preference with respect to aggregate private and public goods, provided there exist relevant aggregator functions. Since Cobb-Douglas preference implies weak separability of private goods from public goods, our three definitions of public goods appear reasonable.

We can use these definitions to check whether the specification tests are passed. Because the testing procedure requires a choice of the definition of private goods, the specification tests cannot give us definitive conclusions. Yet, they help us determine whether our equations are reasonable.

We merged three additional data sets into the JPSC data. First, since the JPSC data do not contain price information, we merged the Consumer Price Index (CPI) collected by the Statistics Bureau, the Ministry of Internal Affairs and Communications. CPI is available for each of the eleven expenditure categories in JPSC for the capital city of each of the 47 prefectures. We constructed the CPI for each expenditure category and for each combination of the prefecture and municipality size by assuming that the price ratios between the three sizes of municipality (*i.e.* large cities, other cities, and towns) are the same across the country in each expenditure category. Hence, we constructed a price index for each category, for each year, for each prefecture and for each size of the municipality.

Second, we compiled population estimates and population censuses published by the Statistics Bureau to obtain the population by prefecture, gender and year for each of the 5-year age groups.[6] We calculated the female-male ratio of the age group around the women's age. We included this variable in the regressors as a proxy for the woman's outside option in the marriage market, which may change the intrahousehold resource allocation.

Finally, we collected prefectural-level data for each year between 1994 and 2002 from various issues of the Japanese Statistical Yearbook. The compiled dataset includes the numbers of medical facilities, parks, schools, kindergartens as well as the incidence of pollution. These variables are related to the welfare of children, and thus likely to affect the number of children. However, these variables are unlikely to directly affect the bargaining power of the women. Hence, we can use these variables as the instrumental variables for the number of children.

[6]Population data we used can be downloaded from the Portal Site of Official Statistics of Japan (`http://www.e-stat.go.jp/SG1/estat/eStatTopPortalE.do`).

6 Estimation Results

In order to understand and address various estimation issues we face, we first ran reduced-form regressions using various estimation methods. The regression results for the smallest model under the extended definitions of income and expenditure are presented in Table 3. The results under the narrow definitions are reported in Table 5 in the Appendix. The model fit is generally lower when the narrow definitions are used. For example, under the extended definitions, the coefficients of determination R^2 for OLS and FE are 0.135 and 0.094 respectively. They are 0.086 and 0.015 under the narrow definitions. Yet, the main results hold under the narrow definitions.

Our primary interest is in the coefficient on the number of children. For example, the (pooled) OLS results suggest that one additional child is associated with 2.6 percentage points less of the wife's share in private expenditure under the extended definitions (and 2.2 percentage points under the narrow definitions). We have tested Eq(4) by the Wald test with the three alternative definitions of private goods. The p-values for the tests are reported at the bottom of Table 3. In all the definitions and by all the estimation methods, Eq(4) was not rejected. Hence, we have no evidence to suggest that our definitions of private goods or the reduced-form equation Eq(3) is inappropriate.

The impact of censoring appears minimal under the extended definitions, because only 18 observations are censored at zero and none at one. Comparison between the pooled OLS and the pooled Tobit confirms this. Under the narrow definitions, the prevalence of censoring is higher with 287 observations censored at zero and 45 at one. However, the censoring problem still does not appear to affect substantially the estimated impact of the number of children .

As we have discussed in the previous section, there may be an endogeneity problem. The OLS estimator is biased if the number of children is an endogenous variable. For example, the number of children may be endogenous if it is associated with the unobservable bargaining power. In 2SLS(A), we ran a two-stage least squares regression, in which the number of children was instrumented by a number of variables taken from the Japanese Statistical Yearbook. These instruments are weak as they do not vary within the same combination of year and prefecture. Further, the Wooldridge χ^2-statistic for the overidentifying restriction (Wooldridge, 1995) is $\chi^2_7 = 16.23$ with the corresponding p-value of 0.023. This indicates that the expected value of the error term conditional on the instruments may be non-zero. We also carried out a robust Hausman test of endogeneity (Cameron and Trivedi, 2005, p.273), and could not reject the exogeneity of the number of children.

Table 3: Regression results for Eq(3) under the extended definitions of income and expenditure. Standard errors are reported in the brackets.

	Pooled OLS	Pooled Tobit	2SLS(A)	2SLS(B)	FE	RE-Tobit	FE-2SLS(A)	FE-2SLS(B)
β_0 Constant	-0.249 (1.417)	-0.283 (1.404)	-12.513 (9.470)	-6.471 (11.055)	0.521 (2.057)	-0.186 (1.511)	0.738 (2.279)	-0.959 (5.653)
$\beta_1 \ln y$	0.001 (0.008)	0.003 (0.006)	-0.007 (0.010)	-0.008 (0.013)	0.004 (0.010)	0.005 (0.006)	0.006 (0.011)	-0.013 (0.019)
β_2 A (Food)	0.562** (0.190)	0.565** (0.194)	1.330 (0.877)	0.662 (0.873)	-0.084 (0.256)	0.258 (0.216)	-0.089 (0.266)	-0.508 (0.686)
B (Hse)	0.068 (0.063)	0.071 (0.060)	0.103 (0.071)	0.118 (0.281)	0.347** (0.123)	0.171* (0.073)	0.344** (0.100)	0.523 (0.285)
C (Util)	-0.086 (0.108)	-0.092 (0.110)	0.096 (0.217)	0.053 (0.202)	-0.157 (0.164)	-0.093 (0.123)	-0.148 (0.173)	0.499 (0.558)
D (Furn)	0.194** (0.062)	0.193** (0.063)	0.162 (0.304)	-0.017 (0.119)	-0.098 (0.126)	0.081 (0.079)	-0.085 (0.140)	-0.801** (0.299)
E (Clth)	-0.010 (0.089)	-0.012 (0.086)	-0.110 (0.662)	0.084 (1.130)	-0.173 (0.139)	-0.070 (0.098)	-0.173 (0.124)	-0.263 (0.348)
F (Med)	0.043 (0.116)	0.043 (0.112)	-0.488 (1.514)	-0.274 (4.365)	0.054 (0.154)	-0.003 (0.125)	0.061 (0.165)	-0.220 (0.531)
G (Trans)	0.455* (0.224)	0.446* (0.222)	1.403 (2.668)	0.798 (5.480)	0.639* (0.279)	0.498* (0.220)	0.606 (0.316)	0.227 (0.723)
H (Comm)	-0.406** (0.119)	-0.401** (0.122)	-0.389 (6.343)	-0.077 (0.691)	-0.192 (0.147)	-0.266* (0.125)	-0.177 (0.168)	0.623 (0.721)
I (Educ)	-0.409** (0.140)	-0.402** (0.139)	-0.230 (8.149)	-0.378 (2.078)	-0.550* (0.254)	-0.364* (0.157)	-0.551** (0.205)	-0.868 (0.543)
J (Rec)	-0.450** (0.144)	-0.452** (0.141)	0.009 (2.168)	0.077 (11.866)	0.031 (0.243)	-0.273 (0.168)	0.004 (0.269)	0.599 (0.639)
K (Oth)	0.167 (0.160)	0.177 (0.163)	0.795 (0.564)	0.369 (4.829)	0.141 (0.277)	0.167 (0.189)	0.113 (0.291)	0.429 (0.602)
β_3 # children	-0.026** (0.003)	-0.026** (0.003)	-0.056** (0.018)	-0.031** (0.010)	-0.026* (0.011)	-0.027** (0.005)	-0.009 (0.097)	-0.032 (0.075)
Fem. ratio	-0.137 (0.231)	-0.136 (0.223)	0.782 (0.611)	0.260 (0.600)	-0.015 (0.735)	0.032 (0.317)	-0.003 (0.730)	0.297 (1.707)
$\ln Y$	-0.002 (0.013)	-0.003 (0.012)	0.026 (0.025)	0.012 (0.022)	-0.023 (0.018)	-0.017 (0.013)	-0.028 (0.036)	-0.028 (0.061)
Inc. share	0.366** (0.030)	0.365** (0.027)	0.342** (0.047)	0.375** (0.052)	0.423** (0.045)	0.389** (0.030)	0.427** (0.040)	0.454** (0.100)
Obs.	2079	2079	2079	673	2079	2079	2079	673
R^2	0.135	—	0.071	0.136	0.094	—	0.093	0.115
Eq(4), Pr. I	0.957	0.988	0.853	0.913	0.754	0.743	0.900	0.652
Eq(4), Pr. II	0.349	0.337	0.694	0.881	0.475	0.398	0.657	0.448
Eq(4), Pr. III	0.264	0.270	0.932	0.977	0.091	0.164	0.081	0.384

Note: Robust standard errors are reported for Pooled OLS, 2SLS(A), 2SLS(B), and FE.

* : Significant at a 5% level.

**: Significant at a 1% level.

Since the quality of the instrumental variables is not satisfactory, we have also included the number of children that the wife wants to have. This question was asked only in 1994, 1997 and 2000 in our data set. Hence, inclusion of this variable entails a significant loss of the sample size. However, this variable is likely to be strongly correlated with the number of children, and is unlikely to be correlated with the error term because this variable reflects the preference and not the bargaining power within the household.

The estimation results with this additional instrumental variable are reported in 2SLS(B) in Table 3. In this case, the Wooldridge χ^2-statistic was $\chi^2_8 = 6.75$ with the corresponding p-value of 0.564, and the standard error for the number of children went down. Hence, 2SLS(B) provides more preferable results than 2SLS(A). As with the previous case, the robust Hausaman test could not reject the exogeneity of the number of children.

Notice that the coefficient on the number of children for OLS is larger than those for 2SLS(A) and 2SLS(B). This is consistent with the existence of unobservable bargaining power we considered earlier. However, the magnitude of endogeneity problem, even if it exists at all, appears to be small as the test results for the robust Hausman tests indicate. In particular, the difference between OLS and 2SLS(B) in the coefficient on the number of children is quite small.

We have so far pooled the sample, and ignored the individual-specific effects. Let us now look at the fixed-effects (within) model reported in the FE column. This model is particularly attractive, because we can control for all the unobservable characteristics of the couple that do not vary over time, which may include the respondents' self-reporting effect, the age difference, the couple's wealth at the time of marriage, and so forth.

As with the OLS estimate, one additional child is associated with 2.6 percentage points decrease in women's private expenditure share in the FE model. Since we cannot obtain a consistent estimate of a fixed-effects Tobit model, we have instead estimated a random-effect Tobit model, which is reported in the RE-Tobit column. As with the estimation of the pooled sample, the effect of censoring on the estimated coefficient on the number of children appears limited.

Finally, we have estimated the fixed-effects versions of the two-stage least square models we considered earlier. The standard error for the number of children is particularly large because the prefecture-year combination can capture only very poorly the variations of the number of children (after controlling for the average number of children within the observation periods). FE-2SLS(B) does better than FE-2SLS(A) with a higher point estimate in absolute value and lower standard error. The standard error is too large for the point estimate for the number of children to be statistically significant in FE-2SLS(B), but the regression results indicate that the magnitude of endogeneity problem appears to be small.

It is worth pointing out that our results clearly reject the income-pooling hypothesis; The estimated coefficient on the income share is between 0.342 and 0.454, which is both economically and statistically significant. One percentage point increase in the wife's disposable income share is associated with approximately 0.4 percentage point increase in her private expenditure share. The level of income, on the other hand, does not systematically affect the allocation parameter. The coefficient on logarithmic income was statistically insignificant, and the point estimate was very small.

We found that the female ratio was not a significant determinant of the allocation parameter. In separate regressions (not reported), we have included in the regressors the average age of children, the presence of either side of parents, the location of residence and whether money was managed primarily by the husband, the wife, or jointly. None of these variables was a significant determinant of the allocation parameter. The fact that financial management was not a significant determinant calls into question the appropriateness of sociological studies focused on the management of household finance.

Let us now turn to the estimation results for the structural-form specification Eq(9). We first consider a regression model in which all the categorical shares $\tilde{\omega}$ are deemed private. We report both the (pooled) OLS estimates and FE estimates.[7] The estimated coefficients for β_0, β_1, β_2, β_3, and β_4 are reported in Table 4. The estimates for other coefficients are reported in Table 7 and Table 8 in the Appendix. Note that the term $\beta_2 \bar{t}_H$ is dropped from Eq(9) in the FE models, because $\bar{t}_H$ is a constant for each H.

The interpretation of the estimated coefficients for the structural-form specification requires caution. First, the left-hand-side variable is the change in the logit transformation of the wife's private expenditure share from a reference point. Hence, the coefficients reported in Table 4 is not directly comparable to those in Table 3 and Table 5. Second, changes in the z variables affect intrahousehold resource allocation through two channels—through the $\beta_1^q \Delta z_{H\tau}^q$ term and

[7] We also ran 2SLS regressions. However, the exogeneity of the regressors was not rejected as with the reduced-form estimation. Hence, we take the number of children as exogenous.

Table 4: Main regression results for Eq(9). Robust standard errors are reported in the brackets. Estimation results for other coefficients are reported in Table 7 and Table 8.

		OLS, all $\tilde{w}$		FE, all $\tilde{w}$		OLS, Pri. III $\tilde{w}$		FE, Pri III $\tilde{w}$		OLS, no $\tilde{w}$		FE, no $\tilde{w}$	
β_0	Constant	0.006	(0.034)	-0.004	(0.073)	0.007	(0.034)	0.024	(0.070)	-0.001	(0.018)	0.001	(0.000)
β_1	# children	-0.349**	(0.130)	-0.384*	(0.179)	-0.238	(0.190)	-0.309	(0.170)	-0.185	(0.106)	-0.186*	(0.081)
	Fem. ratio	0.032	(6.998)	7.454	(8.970)	4.495	(6.377)	5.997	(9.584)	-6.826	(5.478)	-6.864	(5.577)
	$\ln Y$	0.209	(0.171)	0.220	(0.217)	0.240	(0.170)	0.336	(0.222)	0.066	(0.127)	0.065	(0.153)
	Inc. ratio	2.433**	(0.407)	2.451**	(0.547)	2.318**	(0.409)	2.196**	(0.597)	2.352**	(0.321)	2.346**	(0.401)
β_2	t	-0.165	(0.193)	—		-0.173	(0.197)	—		0.008	(0.100)	—	
β_3	$t\times$(# children)	0.776	(0.775)	0.856	(1.093)	0.363	(0.991)	0.661	(1.030)	0.408	(0.610)	0.404	(0.567)
	$t\times$(Fem. ratio)	-1.954	(41.626)	-37.538	(53.549)	-25.491	(39.383)	-24.685	(57.907)	45.198	(30.151)	45.415	(30.757)
	$t \times \ln y$	-1.601	(0.991)	-1.629	(1.388)	-1.914	(1.001)	-2.262	(1.426)	-1.008	(0.779)	-0.984	(0.992)
	$t\times$(Inc. ratio)	-2.413	(2.126)	-2.687	(3.027)	-1.788	(2.170)	-1.629	(3.248)	-1.317	(1.697)	-1.234	(2.164)
β_4	$\ln Y$	-0.097*	(0.047)	-0.144*	(0.058)	-0.069	(0.053)	-0.094	(0.071)	-0.045	(0.040)	-0.046	(0.049)
Obs		1250		1250		1250		1250		2061		2061	
R^2		0.184		0.229		0.145		0.163		0.124		0.124	
Eq(10) / Eq(11), Pr. I		0.001 / 0.112		0.000 / 0.013		—		—		0.147 / 0.838		0.238 / 0.867	
Eq(10) / Eq(11), Pr. II		0.001 / 0.114		0.000 / 0.015		—		—		0.147 / 0.969		0.238 / 0.981	
Eq(10) / Eq(11), Pr. III		0.648 / 0.212		0.552 / 0.007		0.583 / 0.524		0567/0.117		0.147 / 0.277		0.238 / 0.388	
Impact, one more child		-0.048	(0.024)	-0.052	(0.026)	-0.037	(0.014)	-0.043	(0.021)	-0.026	(0.013)	-0.026	(0.013)
Impact, +1 % inc. ratio (%)		0.429	(0.129)	0.425	(0.132)	0.424	(0.118)	0.403	(0.111)	0.444	(0.116)	0.445	(0.115)

* : Significant at a 5% level.

**: Significant at a 1% level.

through the $\beta_3^q \bar{t}_H \Delta z_{H\tau}^q$ term. Therefore, depending on the level of $\bar{t}$, the impact of children on the intrahousehold allocation can be positive or negative. Let us take the results for OLS with all $\tilde{\omega}$ as an example. In this case, when $\bar{t} > 0.450 \approx 0.349/0.776$, or $\bar{s} < 0.050$, the marginal impact of a child is positive. In other words, the model predicts that an additional child can improve the wife's private expenditure share, when her private expenditure share at the reference point is less than five percent.

At the bottom of Table 4, we report the p-values for the Wald tests for Eq(10) and Eq(11). Eq(10) was strongly rejected for models with all $\tilde{\omega}$, when the definition of private goods is Private I or Private II. Thus, our structural-form estimation appears to be valid only when the definition of private goods is Private III. Even then, Eq(11) can be rejected at a 1% significance level for the FE model.

As we have argued earlier, the inclusion of $\tilde{\omega}$ for public goods may cause problems. Hence, it seems appropriate to exclude public goods from the estimation. We constructed a model in which the definition of private goods is Private III. That is, we let $\mathbb{I}^i \equiv \{A, E, H, J\}$. In this model, we cannot statistically reject Eq(10) or Eq(11) for both OLS and FE models as reported in the middle of Table 4. This implies that our specification is reasonable.

We also estimated a model with all the terms involving $\tilde{\omega}$ dropped, the results for which are reported on the right of Table 4. As with the previous model, we cannot statistically reject Eq(10) or Eq(11) for both OLS and FE models, regardless of the definition of private goods we employ. Hence, our preferred models for the structural-form specification are those with Private III $\tilde{\omega}$ and those with no $\tilde{\omega}$.

In order to make the results for the structural form comparable to those for the reduced form, we have computed the impact of an additional child. To do so, we added one to $\Delta z_{H\tau}^1$, and, for each H and τ, we predicted $\Delta \tilde{s}_{H\tau}^*$ using the estimated coefficients and regression residual. Then, the predicted change in the private expenditure share due to an additional child can be expressed as $(1 + \exp(-\bar{s}_H^* + \Delta \tilde{s}_{H\tau}^*))^{-1} - s_{H\tau}$. We report the sample average and the sample standard deviation of the predicted impact of the additional child at the bottom of Table 4.

The average impact of a child for no $\tilde{\omega}$ models is about -2.6 percentage points, which is almost exactly the same as the reduced-form estimates. On the other hand, in the models with Private III $\tilde{\omega}$, the estimated average impact of the additional child is about 50 percent higher in absolute value.

A plausible reason for this is that the private expenditure share $\tilde{\omega}$ may be capturing the effect of (otherwise unobservable) bargaining power in the household, so that the resulting effect is similar to that of instrumental variables regressions in the reduced form. In all the models, the predicted impact of children is negative for all or nearly all the observations. Even though the estimated coefficients $\hat{\beta}_1$ and $\hat{\beta}_3$ are not significant for most models, the average impact of an additional child is negative and significant.

We have also calculated the impact of the change in the wife's disposable income share. One percentage point increase in her disposable income share is associated with slightly more than 0.4 percentage points increase in her private expenditure share, regardless of the models we considered. This number is comparable to the reduced-form estimate. Unlike the impact of an additional child, the resulting impact was unambiguously positive. Income-pooling is again rejected by this finding.

The structural-form specification provides additional insights, which the reduced-form specification does not provide. First, we can test the PIGL preference by testing $r = 0$. This is straightforward, if one notes that the point estimate of r is $\hat{\beta}_4$. Hence, for the models with Private III $\tilde{\omega}$ and those with no $\tilde{\omega}$, we cannot reject the PIGL preference. This result is somewhat surprising, but it may be simply because of the lack of the explanatory power of the model. In the models with all $\tilde{\omega}$, PIGL preference can be rejected at a 5% significance level, but these models may be mis-specified.

Second, we can check the validity of our specification using the point estimate of r. Note that Eq(9) was derived as a first-order approximation to Eq(7). Thus, for this approximation to be reasonably good, the point estimate of r must be sufficiently smaller than one in absolute value. Given that the largest absolute value for the point estimate of r in our preferred models is only 0.094, our specification is indeed appropriate.

Finally, we find that the point estimate of r is negative, though it is not significant in our preferred models. According to our point estimates, married women is more risk averse than married men by 4.6 to 9.9 percent in the coefficient of relative risk aversion. The finding that women are more risk averse is consistent with previous studies on the gender difference in risk attitudes in financial decision-making, which generally find that women are more risk averse than men (Jianakoplos and Bernasek, 1999; Dwyer et al., 2002; Croson and Gneezy, 2008), even though the difference may depend on the situation (Schubert et al., 1999).

Our structural-form has two advantages over these previous studies. First, while research based on financial decision-making is important on its own, it does not necessarily tell us the gender difference in risk tolerance. This is because men and women may have different options to cope with the risk, which do not necessarily appear in the model. For example, it may be the case that men take risk-loving behavior more than women simply because men have better access to the credit market than women. Our structural-form specification is estimated from the consumption expenditure. Hence, it can better capture the gender differences in the coping strategies. Second, our model allows us to measure the ratio of the coefficients of relative risk aversion between men and women. As far as the authors are aware, there have been no study that allow us to identify the gender difference in a quantitatively meaningful manner.

7 Discussion and Conclusions

There is a large body of literature on intrahousehold allocation both in economics and sociology. Sociological literature has focused primarily on the financial management in the household. Economics literature, on the other hand, has focused on relaxing or testing the unitary model. Neither literature has provided satisfactory insights into the impacts of specific life events on intrahousehold allocation. This paper developed an analytical framework to analyze the impact of childbirth. Our analytical framework can also be used for other types of life events.

As the summary statistics show, both the husband and the wife make sacrifice for their children. With the arrival of the first child, each of them, on average, spends more time for domestic work, less time for leisure, and less money for private purposes. However, the burden of children is disproportionately on the wife's shoulder. With additional children, the gap appears to get larger. A question arises whether this observation is true even after controlling for the changes in wife's income share and other factors. To answer this question, we have used regression analysis.

We set up our analytical framework from individual preferences with weak separability. We then derived weak separability at the household level. We showed that, under a fairly weak assumption (**A3**), we can focus on the set of private goods to analyze the changes in intrahousehold allocation of resources. Using this theoretical framework, we developed both reduced-form and structural-form specifications. The structural-form specification was derived as a first-order approximation to Eq(7), which expresses the relationship between the changes in the wife's private expenditure share and the changes in the prices and total private expenditure. We developed an estimation equation Eq(9) by replacing the small variation by the within-sample deviation. For both forms of specifications, we carried out some specification tests. With a reasonable definition of public goods, our preferred models passed the specification tests.

In both specifications, each additional child was associated with at least 2.6 percentage points decrease in the wife's private expenditure share, after controlling for various factors including her share in the total disposable income. The actual effect of the child may be larger than 2.6 percentage points, if larger number of children reflects unobservable bargaining power of the wife that also tends to increase her private expenditure share. While this endogeneity problem may exist as the regression results for 2SLS models indicate, the magnitude of the problem appears to be mild at best.

So far, we have only considered double-income couples. One natural question is what happens if we consider all the couples. The estimation is substantially more difficult for at least two reasons. First, we do not have the wage rate for those not receiving salary, and thus it is difficult to value their domestic labor and leisure time in monetary terms. Second, the labor force participation may be correlated with the unobservable bargaining power, which at the same time affects the intrahousehold resource allocation. As a result, there may be an endogeneity problem, though the direction of bias does not appear obvious.

Despite these issues, we ran a reduced-form estimation under the narrow definition of income and expenditure for the entire sample, which is reported in Table 6 in the Appendix. One additional child was associated with 3.7 percentage points decrease in the woman's share of private expenditure in the FE model, and the magnitudes of the impacts under alternative specifications were similar. Hence, subject to the above-mentioned caveats, our results indicate that the impact of children on women's private expenditure share is also negative for the whole sample.

Our notable limitation of this paper is that it does not tell why childbirth works to the disadvantage of the women. One plausible explanation is the marriage market explanation. Women tend to lose their market value in the marriage market much faster than men with additional children, so that women's outside options get worse relative to men's outside options.

There are at least two other explanations, both of which cannot be captured by our analytical framework. First, women tend to be emotionally more strongly attached to children than men do

(See, for example, Mahony (1996) and Zeanah (1989)). Hence, this may affect the intrahousehold allocation through the additional dimension of bargaining brought about by the children. For example, women may compromise their private expenditure share in order to raise their children in a way they like.

Second and related explanation is preference change. Our theoretical framework assumes that the individual preferences are constant, even though the allocation parameter λ may change. Hence, if the individual utility function changes as a result of childbirth, our results no longer hold. If the private sub-utility remains unaffected, our analysis is still valid within the domain of the private sub-problem. Even in this case, the link between λ and μ, or its interpretation is unclear. While our paper cannot answer which explanation is most suitable, exploring the root cause of the negative impact of childbirth would certainly be an interesting research topic to pursue.

Despite the limitation, this study offers a useful departure point for the analysis of specific life events, to which the deserved attention has not been paid. It also highlights the usefulness of the "beneficiary format" in the expenditure survey. In general, panel data sets are more desirable than cross-section datasets because the former allows us to control for unobservable random effects at the individual level. However, in our (limited) experience, the pooled OLS model and the fixed-effects model provide similar results, indicating that cross-sectional analysis based only on one round of survey can provide meaningful estimates.

Besides showing the impact of childbirth on intrahousehold resource allocation, our study offers additional contributions. First, we showed that one percentage point increase in the wife's disposable income share is associated with around 0.4 percentage points increase in her share of private expenditure. Our study clearly rejects the income-pooling hypothesis as with many of the previous studies. Second, our structural-form estimation allows us to test the PIGL preference, which was not rejected in our preferred models. Third, our study also developed a way to measure the gender difference in the coefficient of relative risk aversion. Our results indicate that women are more risk-averse by 4.6 to 9.9 percent in terms of the rate of relative risk aversion. Our approach provides a completely new way to analyze the gender difference in risk attitudes.

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Appendix

A.1. Proofs

Proof of Proposition 1: Note first that U^m is continuous, strictly increasing and strictly quasi-concave, and $\mathbb{I}^m$ is weakly separable from $\mathbb{I}^c$ in U^m by **A1**. By the fundamental theorem of separability (See, for example, Theorem 3.3b in Blackorby et al. (1978)), there exist continuous, strictly increasing, and strictly quasi-concave functions u^m and $\bar{U}^m$ such that

$$U^m(x^m, x^c) = \bar{U}^m(u^m(x^m), x^c).$$

Therefore, applying this to each of $m \in \{w, h\}$, we have

$$W_\lambda(x^w, x^h, x^c) = \lambda \bar{U}^w(u^w(x^w), x^c) + (1-\lambda)\bar{U}^h(u^h(x^h), x^c).$$

Hence, any Pareto efficient allocation can be supported as a solution to Eq(2). By Theorem 3.5 in Blackorby et al. (1978)), we can choose u^m such that u^m is strictly concave.

Further, for jth and kth components in any $x^m \in \mathbb{R}^i_+$ and lth component in any $x^c \in \mathbb{R}^c_+$, the household utility function W_λ satisfies

$$\frac{\partial}{\partial x^c_l}\left(\frac{\partial W_\lambda/\partial x^m_j}{\partial W_\lambda/\partial x^m_k}\right) = \frac{\partial}{\partial x^c_l}\left(\frac{\partial U^m/\partial x^m_j}{\partial U^m/\partial x^m_k}\right) = \frac{\partial}{\partial x^c_l}\left(\frac{\partial u^m/\partial x^m_j}{\partial u^m/\partial x^m_k}\right) = 0.$$

This proves that $\mathbb{I}^m$ is weakly separable from $\mathbb{I}^c$ in W_λ. □

Proof of Theorem 1: Consider a Pareto efficient allocation $(\tilde{x}^w, \tilde{x}^h, \tilde{x}^c)$. This allocation must satisfy the first order conditions of the maximization problem in Eq(2). Hence, with a little abuse of notation, we have the following for $m \in \{w, h\}$ and any $l_1, l_2, l_3, l_4 \in \mathbb{I}^i$:

$$\frac{\partial \bar{U}^m}{\partial u^m}\frac{\partial u^m}{\partial x^m_{l_1}} \Bigg/ \frac{\partial \bar{U}^m}{\partial u^m}\frac{\partial u^m}{\partial x^m_{l_2}} = \frac{\dfrac{\partial u^m}{\partial x^m_{l_1}}}{\dfrac{\partial u^m}{\partial x^m_{l_2}}} = \frac{p^i_{l_1}}{p^i_{l_2}}; \tag{12}$$

$$\frac{\lambda \dfrac{\partial \bar{U}^w}{\partial u^w}\dfrac{\partial u^w}{\partial x^w_{l_3}}}{(1-\lambda)\dfrac{\partial \bar{U}^h}{\partial u^h}\dfrac{\partial u^h}{\partial x^h_{l_4}}} = \frac{p^i_{l_3}}{p^i_{l_4}}. \tag{13}$$

This is due to the weak separable household utility function W_λ under the assumption **A1** as shown in Proposition 1.

Now, let $\mu^w \equiv \lambda\phi^w$ and $\mu^h \equiv (1-\lambda)\phi^h$, and set $\mu = \frac{\mu^w}{\mu^w+\mu^h}$ and $y = p^i(\tilde{x}^w + \tilde{x}^h)$. Now let us consider the private sub-problem $(u^w, u^h; y, \mu)$ of the household problem $(U^w, U^h; Y, \lambda)$. It is straightforward to verify that the first order conditions for the private sub-problem coincides with Eq (12) and Eq(13). Since u^m is strictly concave, the first order conditions correspond to a unique allocation in $(u^w, u^h; y, \mu)$.

Let us now prove $\frac{\partial\mu}{\partial\lambda} > 0 \Leftrightarrow$ A3.

$$\begin{aligned}
\frac{\partial\mu}{\partial\lambda} &= \frac{\mu^w_\lambda\mu^h - \mu^h_\lambda\mu^w}{(\mu^w+\mu^h)^2} \\
&= \frac{\phi^w\phi^h + \lambda(1-\lambda)(\phi^w_\lambda\phi^h - \phi^w\phi^h_\lambda)}{(\mu^w+\mu^h)^2} \\
&= \frac{\phi^w\phi^h}{(\mu^w+\mu^h)^2}\cdot\left(1+\lambda(1-\lambda)\left(\frac{\phi^w_\lambda}{\phi^w} - \frac{\phi^h_\lambda}{\phi^h}\right)\right) \\
&= \frac{\phi^w\phi^h}{(\mu^w+\mu^h)^2}\cdot\left(1+\lambda(1-\lambda)\psi^{-1}\frac{\partial\psi}{\partial\lambda}\right) \\
&= \frac{\phi^w\phi^h}{(\mu^w+\mu^h)^2}\cdot(1+(1-\lambda)\rho) \qquad (14)
\end{aligned}$$

Since the first term in Eq(14) is positive and $1-\lambda > 0$, we have:

$$\frac{\partial\mu}{\partial\lambda} > 0 \Leftrightarrow \rho > -(1-\lambda)^{-1}$$

This completes the proof of Theorem 1. □

Proof of Lemma 1: By Roy's identity, we have $\partial v^m/\partial y = -x^m_j(y, p^i)\cdot\partial v^m/\partial p^i_j$. Differentiating this with respect to y^m and dividing both sides of the equality by v^m_y, we have the lemma. □

Proof of Proposition 2: First note the following:

$$\begin{aligned}
\left(\frac{v^h_{yy}}{v^h_y} + \frac{v^w_{yy}}{v^w_y}\right) y\,\mathrm{d}s &= \left(\frac{v^h_{yy}}{v^h_y} + \frac{v^w_{yy}}{v^w_y}\right) s(1-s)y\,\mathrm{d}\left(\ln\frac{s}{1-s}\right) \\
&= \left(\frac{y^h v^h_{yy}}{v^h_y}s + \frac{y^w v^w_{yy}}{v^w_y}(1-s)\right)\mathrm{d}\left(\ln\frac{s}{1-s}\right) \\
&= (sR^h + (1-s)R^w)\,\mathrm{d}s^*
\end{aligned}$$

Using in Eq(5) this as well as $\mathrm{d}y = y\,\mathrm{d}\ln y$, $\mathrm{d}p^i_j = p^i_j\,\mathrm{d}\ln p^i_j$, and Eq(6), we have Eq(7). To derive

Eq(8), first notice that the following equation follows from Eq(7):

$$\begin{aligned} \mathrm{d}s^* &= \frac{1}{\tilde{R}(1-rt)}\mathrm{d}\mu^* + \frac{r}{1-rt}\mathrm{d}(\ln y) \\ &\quad + \sum_{j\in\mathbb{I}^i}\left[\frac{\tilde{\xi}_j\delta_{\omega_j} + \delta_{\xi_j}\tilde{\omega}_j - \delta_{\xi_j}\delta_{\omega_j}t}{\tilde{R}(1-rt)} - \delta_{\omega_j} - \frac{r\tilde{\omega}_j}{1-rt}\right]\mathrm{d}(\ln p_j). \end{aligned}$$

Taking the first-order Taylor approximation, we have Eq(8). □

Proof of Proposition 3: 2. ⇒ 1. is obvious. To prove 3. ⇒ 2., we simply need to plug $v_y^m = a^m(p)c'(y^m)$ and $v_{yy}^m = a^m(p)c''(y^m)$ in the definition of R^m.

To prove 1. ⇒ 2., notice that we can write the reciprocal of the coefficient as $R^w + s(R^h - R^w)$. This expression is independent of s only if $R^w = R^h$, in which case we have $R^w + s(R^h - R^w) = R^w = R^h$. For this to be independent of y and p^i, we must have a constant R such that $R^w = R^h = R$.

To prove 2. ⇒ 3., let us first keep the prices fixed. Transforming the definition of R, for each of $m \in \{w, h\}$, we have

$$\frac{\mathrm{d}v_y^m}{v_y^m} = -R\frac{\mathrm{d}y^m}{y^m}.$$

Noting that both y^m and v_y^m are positive, we obtain $\ln v_y^m = -R\ln y^m + c^m(p)$ by integrating both the sides over y, where $c^m(p)$ is constant with respect to income. Then, by setting $a^m(p) = \exp(c^m(p))$, exponentiating both sides of the equality, and further integrating over y^m, we have $v^m(y^m, p) = a^m(p)c(y^m; R) + b^m(p)$. □

Derivation of Eq(10): After replacing in Eq(8) the small variations by the within-sample deviations and t by $\bar{t}_H$, we can arrive at Eq(9) by making following substitutions:

$$\begin{aligned} \beta_0 &= \tilde{R}^{-1}\gamma_0 + O(r^2), \quad \beta_1^q = \tilde{R}^{-1}\gamma_1^q, \quad \beta_2 = \tilde{R}^{-1}r\gamma_0, \quad \beta_3^q = \tilde{R}^{-1}r\gamma_1^q, \quad \beta_4 = r, \\ \beta_5^j &= \tilde{R}^{-1}\gamma_2^j \cdot \mathrm{Ind}(j \in \mathbb{I}^i) + (\tilde{R}^{-1}\tilde{\xi}_j - 1)\delta_{\omega_j}, \\ \beta_6^j &= \tilde{R}^{-1}r\gamma_2^j \cdot \mathrm{Ind}(j \in \mathbb{I}^i) + \tilde{R}^{-1}(r\tilde{\xi}_j - \delta_{\xi_j})\delta_{\omega_j}, \\ \beta_7^j &= -\tilde{R}^{-1}r\delta_{\xi_j}\delta_{\omega_j}, \quad \beta_8^j = \tilde{R}^{-1}\delta_{\xi_j} - r, \quad \beta_9^j = \tilde{R}^{-1}\delta_{\xi_j}r, \quad \epsilon_{H\tau} = \tilde{R}^{-1}(1+rt)\eta_{H\tau}. \end{aligned}$$

Eq(10) follows from these equations. □

A.2. Additional Tables

Table 5: Regression results for Eq(3) under the narrow definitions of income and expenditure. Standard errors are reported in the brackets.

	Pooled OLS		Pooled Tobit		2SLS(A)		2SLS(B)		FE		RE-Tobit		FE-2SLS(A)		FE-2SLS(B)	
β_0 Constant	-2.394	(2.206)	-2.523	(2.455)	-44.448**	(15.065)	-42.218*	(20.017)	-2.607	(3.531)	-2.260	(2.707)	-2.556	(3.656)	3.557	(9.303)
$\beta_1 \ln y$	-0.008	(0.012)	0.004	(0.009)	-0.013	(0.013)	0.016	(0.023)	-0.002	(0.017)	0.009	(0.009)	-0.002	(0.009)	0.007	(0.024)
β_2 A (Food)	-0.260	(0.294)	-0.275	(0.339)	2.365	(1.358)	1.920	(1.562)	0.163	(0.394)	-0.004	(0.385)	0.162	(0.418)	-0.841	(1.158)
B (Hse)	0.092	(0.106)	0.100	(0.105)	0.122	(0.119)	0.256	(0.479)	0.332*	(0.153)	0.172	(0.129)	0.332*	(0.159)	0.560	(0.474)
C (Util)	-0.163	(0.164)	-0.258	(0.192)	0.646	(0.352)	-0.873*	(0.344)	-0.198	(0.282)	-0.243	(0.220)	-0.196	(0.279)	-1.645	(0.936)
D (Furn)	0.101	(0.097)	0.172	(0.109)	0.066	(0.465)	0.211	(0.222)	0.078	(0.188)	0.167	(0.137)	0.081	(0.220)	-0.417	(0.503)
E (Clth)	0.208	(0.134)	0.199	(0.150)	-0.096	(0.988)	-0.365	(1.891)	-0.631**	(0.202)	-0.144	(0.177)	-0.631**	(0.196)	-1.099	(0.579)
F (Med)	0.145	(0.186)	0.209	(0.196)	-1.744	(2.491)	-2.445	(6.902)	0.212	(0.285)	0.187	(0.223)	0.213	(0.259)	0.033	(0.891)
G (Trans)	0.016	(0.349)	0.142	(0.389)	3.076	(4.318)	3.806	(8.746)	0.603	(0.401)	0.413	(0.400)	0.593	(0.563)	1.891	(1.196)
H (Comm)	0.192	(0.174)	0.181	(0.212)	0.397	(9.944)	2.766*	(1.105)	-0.201	(0.228)	-0.035	(0.225)	-0.198	(0.255)	1.534	(1.213)
I (Educ)	-0.039	(0.205)	-0.078	(0.244)	0.772	(12.842)	1.516	(3.554)	-0.263	(0.323)	-0.242	(0.280)	-0.264	(0.327)	-0.329	(0.888)
J (Rec)	-0.213	(0.216)	-0.354	(0.246)	1.169	(3.979)	0.080	(19.623)	0.537	(0.359)	-0.052	(0.297)	0.532	(0.400)	0.154	(1.064)
K (Oth)	0.443	(0.261)	0.506	(0.284)	2.604*	(1.004)	2.049	(7.824)	-0.047	(0.433)	0.289	(0.336)	-0.053	(0.459)	-0.121	(1.021)
β_3 # children	-0.022**	(0.005)	-0.024**	(0.006)	-0.040	(0.029)	-0.029	(0.017)	-0.023	(0.017)	-0.026**	(0.008)	-0.019	(0.164)	-0.043	(0.099)
Fem. ratio	0.139	(0.347)	0.099	(0.390)	2.426*	(0.937)	1.776	(1.013)	0.595	(0.995)	0.145	(0.541)	0.597	(1.152)	-3.728	(2.880)
$\ln Y$	0.042*	(0.021)	0.045	(0.023)	0.055	(0.029)	0.008	(0.043)	-0.009	(0.032)	0.022	(0.027)	-0.009	(0.035)	-0.035	(0.102)
Inc. share	0.390**	(0.037)	0.423**	(0.044)	0.412**	(0.063)	0.503**	(0.083)	0.021	(0.074)	0.299**	(0.056)	0.023	(0.101)	0.035	(0.218)
Obs.	2079		2079		2079		673		2079		2079		2079		673	
R^2	0.086		———		-0.099^		0.038		0.015		———		0.015		0.056	
Eq(4), Pr. I	0.450		0.494		0.682		0.638		0.557		0.551		0.667		0.514	
Eq(4), Pr. II	0.502		0.496		0.453		0.635		0.612		0.479		0.704		0.522	
Eq(4), Pr. III	0.453		0.285		0.823		0.902		0.764		0.444		0.775		0.293	

Note: Robust standard errors are reported for Pooled OLS, 2SLS(A), 2SLS(B), and FE.

* : Significant at a 5% level.

**: Significant at a 1% level.

^ : The error sum of squares exceeded the total sum of squares.

Table 6: Regression results for Eq(3) under the narrow definitions of income and expenditure for the whole sample including non-double-income couples. Standard errors are reported in the brackets.

	Pooled OLS		Pooled Tobit		2SLS(A)		2SLS(B)		FE		RE-Tobit		FE-2SLS(A)		FE-2SLS(B)	
β_0 Constant	-0.362	(1.250)	-0.594	(1.605)	-12.184	(7.407)	-6.471	(11.055)	-20.236*	(10.149)	-0.187	(1.793)	0.118	(1.754)	-1.010	(2.409)
$\beta_1 \ln y$	-0.045**	(0.007)	-0.031**	(0.006)	-0.034**	(0.009)	-0.008	(0.013)	-0.033**	(0.012)	-0.028**	(0.010)	-0.019**	(0.006)	-0.030**	(0.007)
β_2 A (Food)	-0.276	(0.175)	-0.236	(0.228)	0.504	(0.610)	0.662	(0.873)	0.734	(0.817)	0.401	(0.247)	0.051	(0.264)	0.387	(0.251)
B (Hse)	0.016	(0.055)	0.005	(0.071)	0.008	(0.118)	0.118	(0.281)	0.164	(0.387)	0.019	(0.090)	-0.013	(0.086)	0.027	(0.088)
C (Util)	-0.150	(0.096)	-0.205	(0.128)	0.250	(0.264)	0.053	(0.202)	-0.560**	(0.192)	-0.031	(0.157)	-0.129	(0.146)	-0.066	(0.162)
D (Furn)	0.100	(0.055)	0.138	(0.073)	0.050	(0.074)	-0.017	(0.119)	0.105	(0.336)	-0.038	(0.105)	0.096	(0.091)	-0.101	(0.165)
E (Clth)	0.132	(0.075)	0.144	(0.099)	0.059	(0.657)	0.084	(1.130)	-0.031	(1.345)	-0.150	(0.116)	-0.058	(0.117)	-0.154	(0.114)
F (Med)	0.089	(0.105)	0.126	(0.131)	-0.494	(1.131)	-0.274	(4.365)	-1.142	(4.855)	-0.001	(0.146)	0.098	(0.147)	-0.010	(0.143)
G (Trans)	0.166	(0.190)	0.226	(0.250)	0.718	(1.744)	0.798	(5.480)	1.810	(5.674)	0.691**	(0.223)	0.490	(0.255)	0.859*	(0.419)
H (Comm)	0.239*	(0.108)	0.250	(0.147)	0.375	(4.654)	-0.077	(0.691)	1.652	(2.157)	-0.181	(0.139)	0.003	(0.155)	-0.266	(0.226)
I (Educ)	0.063	(0.123)	0.059	(0.167)	0.278	(5.670)	-0.378	(2.078)	0.796	(1.141)	-0.439*	(0.215)	-0.230	(0.193)	-0.315	(0.325)
J (Rec)	-0.395**	(0.125)	-0.573**	(0.166)	0.039	(3.214)	0.077	(11.866)	-0.109	(12.079)	-0.005	(0.218)	-0.377	(0.200)	0.068	(0.254)
K (Oth)	0.099	(0.148)	0.173	(0.190)	0.800	(1.950)	0.369	(4.829)	0.834	(1.262)	-0.140	(0.218)	0.076	(0.220)	-0.092	(0.232)
β_3 # children	-0.033**	(0.003)	-0.040**	(0.004)	0.045	(0.036)	-0.031**	(0.010)	-0.037**	(0.009)	-0.033**	(0.008)	-0.039**	(0.005)	-0.105	(0.153)
Fem. ratio	0.029	(0.192)	0.039	(0.256)	0.228	(0.537)	0.260	(0.600)	0.761	(0.532)	-0.514	(0.559)	-0.345	(0.358)	-0.425	(0.567)
$\ln Y$	0.090**	(0.007)	0.111**	(0.009)	0.085**	(0.009)	0.012	(0.022)	0.104**	(0.013)	0.064**	(0.010)	0.094**	(0.010)	0.058**	(0.016)
Inc. share	0.260**	(0.013)	0.310**	(0.016)	0.280**	(0.017)	0.375**	(0.052)	0.273**	(0.024)	0.193**	(0.023)	0.279**	(0.019)	0.159*	(0.073)
Obs.	6962		6962		6962		2327		6962		6962		6962		2327	
R^2	0.099		0.095		-0.009^		0.094		0.032		——		0.016		0.047	
Eq(4), Pr. I	0.997		0.966		0.805		0.523		0.702		0.863		0.540		0.958	
Eq(4), Pr. II	0.797		0.904		0.654		0.526		0.178		0.704		0.178		0.746	
Eq(4), Pr. III	0.031		0.041		0.932		0.928		0.574		0.090		0.933		0.558	

Note: Robust standard errors are reported for Pooled OLS, 2SLS(A), 2SLS(B), and FE.

* : Significant at a 5% level.

**: Significant at a 1% level.

^ : The error sum of squares exceeded the total sum of squares.

Table 7: Additional regression results for Eq(9) (Continued from Table 4 and continue to Table 8.)

	OLS, all $\tilde{w}$		FE, all $\tilde{w}$		OLS, Pri. III $\tilde{w}$		FE, Pri III $\tilde{w}$		OLS, no $\tilde{w}$		FE, no $\tilde{w}$	
β_5 A (Food)	2.932	(4.362)	2.884	(5.410)	2.212	(4.799)	2.420	(6.544)	0.771	(2.057)	0.761	(2.256)
B (Hse)	1.025	(1.254)	-0.151	(1.973)	1.025	(1.002)	0.093	(1.364)	0.999	(0.799)	1.006	(0.913)
C (Util)	1.633	(2.832)	2.345	(3.500)	-0.223	(1.778)	0.314	(2.213)	-1.308	(1.400)	-1.314	(1.438)
D (Furn)	0.185	(1.299)	0.656	(1.633)	0.465	(1.264)	0.751	(1.752)	-0.572	(1.073)	-0.580	(1.234)
E (Clth)	-2.638	(1.744)	-4.401	(2.350)	-3.239	(1.763)	-4.737	(2.580)	-2.416*	(0.944)	-2.424*	(1.062)
F (Med)	-3.319	(2.169)	-7.223*	(3.331)	-1.445	(1.922)	-5.068	(3.646)	0.855	(1.253)	0.860	(1.315)
G (Trans)	1.334	(5.164)	-6.316	(8.826)	10.366*	(4.487)	2.570	(9.256)	1.409	(1.814)	1.418	(1.933)
H (Comm)	-0.692	(1.873)	-3.172	(2.282)	-0.056	(1.719)	-2.700	(2.385)	2.501*	(1.222)	2.493	(1.417)
I (Educ)	-0.469	(3.062)	0.164	(4.478)	-2.516	(2.731)	-1.998	(4.188)	0.190	(1.855)	0.164	(2.080)
J (Rec)	-1.014	(3.371)	2.220	(4.855)	-1.553	(2.977)	3.245	(4.495)	-2.087	(2.081)	-2.058	(2.278)
K (Oth)	-4.086	(3.548)	-11.059	(5.628)	-0.954	(2.892)	-4.448	(4.262)	1.355	(1.849)	1.380	(2.192)
β_6 A (Food)	28.514	(35.642)	13.180	(50.826)	33.869	(35.363)	51.502	(54.777)	6.387	(20.920)	6.738	(23.067)
B (Hse)	4.219	(13.588)	-1.483	(20.938)	3.926	(6.199)	11.283	(9.071)	8.051	(9.792)	7.827	(10.790)
C (Util)	-16.737	(21.081)	-11.492	(23.901)	0.175	(9.202)	0.431	(12.240)	-6.611	(14.318)	-6.727	(14.721)
D (Furn)	-1.628	(13.445)	-5.663	(17.686)	-6.085	(7.144)	-11.676	(10.108)	6.914	(11.764)	6.955	(13.974)
E (Clth)	-1.306	(14.031)	13.747	(20.416)	3.606	(13.576)	12.465	(20.394)	0.839	(8.833)	0.966	(9.688)
F (Med)	23.434	(22.943)	2.378	(28.959)	5.713	(10.539)	25.510	(20.307)	-0.874	(13.842)	-0.854	(14.483)
G (Trans)	99.969*	(49.104)	-0.262	(102.567)	-37.895	(25.366)	-43.599	(56.940)	43.237*	(17.673)	42.852*	(19.255)
H (Comm)	-20.086	(20.890)	-4.339	(25.778)	-11.155	(14.190)	3.045	(26.360)	-36.541**	(13.981)	-36.365*	(16.655)
I (Educ)	-56.010	(34.763)	-102.791	(54.974)	5.709	(16.106)	7.363	(24.761)	-31.668	(21.274)	-31.138	(23.213)
J (Rec)	-32.664	(32.507)	-60.031	(43.411)	-15.688	(27.699)	-48.043	(43.260)	2.363	(22.124)	1.825	(24.405)
K (Oth)	12.332	(30.318)	79.463	(53.627)	5.879	(14.603)	32.729	(24.756)	-18.525	(16.499)	-19.090	(17.192)
β_7 A (Food)	-87.233	(84.697)	14.236	(123.097)	-90.377	(72.651)	-111.581	(119.280)	-51.838	(66.927)	-53.563	(71.531)
B (Hse)	-10.655	(43.451)	40.464	(71.297)	——	——	——	——	-13.313	(32.692)	-12.332	(35.648)
C (Util)	24.453	(54.720)	-20.690	(66.693)	——	——	——	——	42.732	(44.830)	43.383	(48.052)
D (Furn)	-9.788	(40.914)	-19.416	(52.964)	——	——	——	——	-27.606	(35.756)	-27.635	(42.007)
E (Clth)	50.044	(38.781)	13.138	(58.694)	36.952	(37.787)	16.337	(57.178)	36.878	(29.020)	36.514	(33.627)
F (Med)	-28.390	(68.644)	152.994	(104.595)	——	——	——	——	-8.624	(41.193)	-8.630	(42.784)

* : Significant at a 5% level.
**: Significant at a 1% level.

Table 8: Additional regression results for Eq(9) (Continued from Table 4 and Table 7).

	OLS, all $\tilde{w}$		FE, all $\tilde{w}$		OLS, Pri. III $\tilde{w}$		FE, Pri III $\tilde{w}$		OLS, no $\tilde{w}$		FE, no $\tilde{w}$	
β_7 G (Trans)	-420.832**	(158.932)	-61.965	(386.409)	—		—		-135.815*	(60.253)	-134.152*	(67.391)
H (Comm)	54.600	(59.562)	27.751	(76.832)	3.101	(35.612)	-10.564	(75.217)	60.021	(42.537)	59.208	(52.051)
I (Educ)	236.997*	(110.769)	446.978*	(173.067)	—		—		57.685	(68.763)	55.397	(75.870)
J (Rec)	142.008	(86.027)	225.041	(115.282)	88.105	(72.823)	159.594	(115.193)	44.176	(62.410)	45.877	(71.188)
K (Oth)	79.424	(87.941)	-14.595	(158.055)	—		—		41.446	(52.473)	43.417	(53.699)
β_8 A (Food)	8.201	(10.256)	14.319	(12.245)	6.145	(11.919)	9.088	(13.775)	—		—	
B (Hse)	-1.025	(9.078)	0.925	(13.098)	—		—		—		—	
C (Util)	-21.744	(24.422)	-16.871	(31.095)	—		—		—		—	
D (Furn)	-9.004	(10.510)	-15.949	(14.018)	—		—		—		—	
E (Clth)	-5.975	(20.431)	12.665	(24.887)	-2.902	(20.990)	13.461	(27.651)	—		—	
F (Med)	39.039**	(13.951)	46.607**	(14.229)	—		—		—		—	
G (Trans)	88.899*	(34.540)	143.442**	(33.049)	—		—		—		—	
H (Comm)	4.187	(8.563)	8.965	(11.848)	0.250	(6.533)	5.708	(9.661)	—		—	
I (Educ)	-4.492	(7.708)	-8.216	(10.415)	—		—		—		—	
J (Rec)	-5.295	(8.880)	-0.917	(13.474)	-5.177	(8.031)	-6.568	(11.414)	—		—	
K (Oth)	16.420	(12.358)	24.867	(24.241)	—		—		—		—	
β_9 A (Food)	-103.697	(64.707)	-125.839	(80.252)	-86.218	(72.871)	-109.612	(87.017)	—		—	
B (Hse)	68.498	(59.707)	72.955	(92.151)	—		—		—		—	
C (Util)	120.637	(122.221)	158.148	(142.906)	—		—		—		—	
D (Furn)	54.045	(44.934)	94.704	(62.564)	—		—		—		—	
E (Clth)	70.638	(105.842)	25.933	(121.678)	49.183	(106.676)	20.743	(140.771)	—		—	
F (Med)	-246.711**	(90.758)	-196.664	(122.823)	—		—		—		—	
G (Trans)	-429.122**	(154.515)	-561.850**	(167.465)	—		—		—		—	
H (Comm)	43.447	(51.462)	23.844	(68.542)	44.289	(41.779)	28.017	(63.559)	—		—	
I (Educ)	21.995	(45.509)	56.378	(63.785)	—		—		—		—	
J (Rec)	89.844	(50.581)	73.765	(73.178)	85.230	(48.075)	94.680	(66.839)	—		—	
K (Oth)	-165.175*	(70.418)	-226.727	(126.164)	—		—		—		—	

* : Significant at a 5% level.
**: Significant at a 1% level.