Do Household Members Share Income Risk Through Labor Supply? -Evidence from Collective Model

Sisi Zhang[*]

VERY PRELIMINARY AND INCOMPLETE

May 23, 2007

Abstract

In this paper I study how household members insure each other against idiosyncratic shocks via joint labor supply decisions. I introduce income shocks into the collective model, with a specified sharing rule to reflect both bargaining process and risk sharing behavior. Different from other collective labor supply models, I allow permanent wages and transitory wage shocks to affect sharing rule in a different direction. A drop in one's permanent wage deceases his bargaining power, which reduces his share of pooled resources, while a drop in his transitory wage will increase his share of household income as a result of risk sharing agreement. The model generates a "risk sharing effect" in addition to the income and substitution effects in the standard labor supply model. I also examine how risk sharing behavior affect household members' participation decisions. The model will be estimated using Survey of Income Program Participation (SIPP).

JEL Codes: D12, D13, D81, J22.

Keywords: Risk Sharing, Collective Model, Household Labor Supply.

1   Introduction

Many studies have documented that income volatility has increased significantly in the last couple decades (Gottschalk and Moffitt, 1994, Moffitt and Gottschalk,

[*]Department of Economics, Boston College, 140 Commonwealth Ave, Chestnut Hill, MA, 02467. Email: zhangse@bc.edu. I would like to thank Peter Gottschalk and Shannon Seitz for invaluable advice, thank Donald Cox, Jeremy Lise, Aloysius Siow, Kit Baum for helpful comments.

2002). Such increases in transitory income fluctuation have been of concern to policy makers since increased income volatility is associated with increases in risk and reduction in welfare. However people who live in the same household could provide insurance against each other's adverse shocks by making intra-household transfers. In this paper, I aim to answer the following question: to what extent household members share their income risk by adjusting labor supply and making intra-household transfers? The answer to this question matters for the following reasons: it provides a better understanding to household joint decisions in reaction to increasing income volatility. The interaction of such intra-household risk sharing with social insurance systems affect smoothing abilities, and it is important for the efficient design and evaluation of social insurance policies. The presence of mechanisms that allow households to smooth idiosyncratic shocks also has a bearing on aggregation results such as income distribution.

There have been many studies testing efficient risk sharing within groups (Cochrane (1991), Altonji et al. (1992), Townsend (1994), etc.). These studies are based on complete markets hypothesis: if there exists full risk sharing, individuals' consumption should be independent of idiosyncratic shocks. They treat leisure as exogenous, therefore can not draw any implications on labor supply. However, it is natural to assume that individuals not only share risk by savings or consumption smoothing, but also share risks by adjusting each other's labor supply. In this way income is endogenous and reflects joint labor supply decisions. In the face of shocks, each agent will reallocate their demand for leisure, in a more complex way than the one-dimensional model where utility only depends consumption.

An ideal framework for the study of intra-household risk sharing is the collective model first developed in Chiappori (1988). This collective model considers household members pool their resources and jointly making decisions. Instead of referring to some specific bargaining mechanism, it only makes a very weak and general assumption: households always reach Pareto-efficient agreements. According to the Second Welfare Theorem, the decision can be decentralized into a two-stage process under the assumption of efficiency. In a typical two-earner household (usually refers to as husband and wife), they first form an agreement on how to allocate the pooled resources. In the second stage, each person maximizes one's own utility subject to the allocated pooled resources. This collective model has been generalized to study various household behaviors such as demand for com-

2

modities, joint labor supply decisions or household production (Chiappori 1997). Several studies by Mazzocco develop intertemporal collective models which allows for uncertainty in consumption, wages and non-labor income (Mazzocco (2004), Mazzocco (2005), Mazzocco (2006a)). In these models household members can save jointly by using a risk-free asset and the efficient risk sharing is characterized by Euler equations for public and private consumptions. However, they can not use the leisure Euler equations since it requires agent supplies a positive amount of labor in each period and each state of nature, which is an excessively strong assumption. There are several empirical studies that also explain how household members adjust labor supply in response to stochastic shocks. For instance, the "added worker effect" literature studies whether there is a temporary increase in the labor supply of married women whose husbands have become unemployed (Lundberg (1985), Stephens (2002), etc.). These studies focus on how wife's labor supply respond to husband's employment shocks. While collective models enable me to examine labor supply response from both sides, which involves joint decision from bargaining and risk sharing.

I make the following contribution to the existing literature on risk sharing and collective labor supply: First, I introduce income shocks measured by transitory fluctuation in wages into collective model. In this stochastic model Pareto efficiency implies the decision can be decentralized into a two-stage process: the husband and wife first agree upon certain sharing rule which divides their pooled income, conditional on realized shocks. Once shocks are realized and transfers have taken place, each one separately chooses labor supply and private consumption, subject to the corresponding budget constraint. Individual preferences and the sharing rule can be identified up to an additive constant. Second, I specify the way household members divide pooled resources to reflect both bargaining process and risk sharing behavior. Most household decision models predict that intra-household allocation depends on household members' bargaining power. In my model household members not only bargain over the resources but also share the risk together. Household decision process depends on the relative permanent wage, as a measure of bargaining power, and relative transitory wage, as a measure of income risk. A standard labor supply model predicts that when husband receives a negative wage shock, income effect induces him to work more (if leisure is a normal good), while substitution effect induces him to work less. However,

my model predicts an additional "risk sharing effect": the wife will transfer more to the husband in response to his negative wage shock, which generates an additional income effect to husband's labor supply. Third, I allow permanent wage and transitory wage shocks to affect household behavior in different direction. A drop in husband's permanent wage decreases his bargaining power, which reduces his share of pooled resources. While a drop in his transitory wage will increase his share of income since the wife agrees to share the risk and make more transfer to compensate for his adverse shock. Finally, I estimate this risk sharing model with participation decision. Since shocks not only affect labor supply but also affect participation decisions, it is important to incorporate corner solutions to both household members.

The data I use is Survey of Income and Program Participation (SIPP), a national representative longitudinal data set. This data set has substantial advantage over the Panel Study of Income Dynamics (PSID), the primary data source for studies on efficient risk sharing in U.S. (Cochrane, 1991, Altonji et al., 1992). First, SIPP provides monthly information on wages, hours worked, while PSID interviews on annual basis, [1] hence can not provide precise information on short term wage or labor supply changes. Second, the model in this paper assumes there is no marriage related decision in the household during the entire sample period. This model is more realistic when data covers shorter period while might be too restrictive if I use PSID for more than thirty years. I use SIPP 1996 panel which covers monthly information from December 1995 to February 2000.

In the remaining of this paper, I first review related literature in Section 2. I then develop the collective labor supply and risk sharing model in Section 3, follows by data description in Section 4. I will proceed with estimation in Section 5.

2   Literature Review

If markets are complete, then individuals' consumption would not respond to idiosyncratic income shocks. Several studies test this full risk sharing assumption within certain groups such as households or extended families using data from

---

[1]After year 1996, PSID only interviews every other year. Thus I even do not observe labor supply response in each year after 1996

U.S. as well as developing countries. Cochrane (1991) presents cross-sectional regressions of consumption growth on a variety of idiosyncratic variables using food consumption from PSID. Full insurance is rejected for shocks such as long illness and involuntary job joss, but not for spells of unemployment, loss of work due to strike, and an involuntary move. Altonji et al. (1992) focus on risk sharing within American families but find no evidence of risk sharing.

In developing countries especially in rural area, where income volatilities are higher, insurance and credit markets are imperfect for the poor, there are more evidence in favor of risk sharing. Townsend (1994) found that household consumption in village India are not much influenced by contemporaneous own income, sickness, unemployment, or other idiosyncratic shocks, controlling for village level risk. Fafchamps and Lund (2001) examine data in rural Philippines, they find that shocks have a strong effect on gifts and informal loans, but little effect on sales of livestock and grain. Mutual insurance does not appear to take place at the village level; rather, households receive help primarily through networks of friends and relatives. Dercon and Krishnan (2000) testing risk sharing within households using unpredicted illness shocks as a measure of individual idiosyncratic shocks. They find that in most households full risk sharing of illness shocks takes place. These reduced form empirical studies treat leisure as exogenous, therefore can not draw any implications on labor supply.

The above empirical testing of risk sharing literature mostly focuses on consumption smoothing. While there is another stream of literature that studies how people share income risk via labor supply behavior. This is usually referred as "added worker effect" literature (Lundberg (1985), Maloney (1987), Stephens (2002)), which studies a temporary increase in the labor supply of married women whose husbands have become unemployed. These studies only examines one sided effect, namely, women's labor supply response to husbands' unemployment, under the assumption that husbands are the primary earners in the households and they do not respond to wive's unemployment. In the recent U.S. labor market there is a sharp increase in female labor force participation and the distinction between primary earners and secondary earners become obscure. Therefore, it is important to consider the labor supply response from both sides.

In order to examine how household members joint making decisions, an ideal framework is the collective model. To maximize household welfare as a whole,

household members have to decide who gets what share of the total. Chiappori (1988), Browning et al. (1996), and Chiappori et al. (2002) developed the theoretical framework in which household members jointly taking Pareto-efficient decisions. They show that if preferences are egoistic and budget constraints are linear, under the very weak assumption of efficiency, allocations can be decentralized into a two-stage budgeting process, according to the Second Welfare Theorem. In a two-member household, the husband and wife first decide how to allocate the pooled resources according to certain sharing rule. Then each member separately chooses labor supply and private consumption. This setting is shown to generate testable restrictions on labor supplies. Moreover, the observation of labor supply behavior is sufficient to recover the individual preferences and the sharing rule (up to a constant). This model provides an useful tool in analyzing intra-household behavior.

Most studies based on collective model are static and uses cross-section data. However, such collective framework can be easily extended to the stochastic world, where household member not only share income but also share risks. Mazzocco (2004), Mazzocco (2005), Mazzocco (2006a), Mazzocco (2006b) and Mazzocco and Saini (2006) develop a series of intertemporal collective models based on Chiappori (1988)'s static model. These intertemporal models allows for uncertainty in private and public consumption, wages as well as non-labor income. Household members can save jointly by using a risk-free asset. In Mazzocco (2005) the efficient risk sharing is characterized by Euler equations for public and private consumptions. Leisure Euler equations could be added but they are satisfied only if corresponding agent supplies a positive amount of labor in each period and each state of nature, which is an excessively strong assumption. In Mazzocco (2006a), Mazzocco (2006b) and Mazzocco and Saini (2006), they relax the ex-ante Pareto efficiency assumption, so that individual members need not to commit to future allocations at the time of household formation. Their empirical testing shows household members cannot commit to future plans, and households renegotiate their decisions over time. This is a potential interesting question which relates to marriage decisions. Marriage decision is beyond the scope of this paper and thus my sample only includes those who remain married for the entire sample period and contrast their behavior with another sample which contains single agents only.

Existing collective models specify the sharing rule as a function of (realized)

wages, non-labor income or some distribution factors that affect their bargaining power in the household (for instance, local sex ratio that represents marriage opportunities, or relative potential earnings or age gap that represents their bargaining power). Motivated by Gottschalk and Moffitt (1994), I want to emphasize that permanent wages and transitory wage shocks have different impact on the sharing rule. The permanent wages (mean wages over time for certain individual), as a counterpart of potential wages, characterize spouse's bargaining power. The increase of one's permanent wage increases his or her relative bargaining power hence increases his or her share of pooled income. On the other hand, the transitory wage shocks, which is the deviation from the mean wages, could affect sharing rule in a different way. If wife receives a negative wage shock, the husband transfers more to the wife to compensate for her earnings loss. Hence this part captures the risk sharing effect of the sharing rule.

Most collective labor supply models assume both household members supply positive hours, since participation decision largely complicates the model. As static models only requires cross-sectional data, this is not a quite restrictive assumption although it does cause selection bias. However, when examining household behavior over time using panel data, everyone participate in each period would be a very restrictive requirement. Blundell et al. (2007) derive the restrictions for collective model when male can only choose to work full time or stay home, while female can choose continuous labor supply. They estimate this model and test the restrictions using the U.K. data. Donni (2003) discusses a more general case in which both male and female labor supply functions are continuous and either of them can choose nonparticipation. The identification strategy is that when someone does not participate in the labor market, the sharing rule and preferences can still be identified from the spouse's labor supply. In my model it is important to find out when someone gets unemployed, what is spouse's labor supply response. And it is also important to see whether a negative shock not only affects spouse's labor supply but also spouse's participation decision. Hence I also derive and estimate the sharing rule and labor supply functions for the nonparticipation case.

3 Empirical Evidence on Household Risk Sharing

In this section, I present some empirical evidence on intra-household risk sharing. If household members insure each other against income shocks by adjusting labor supply, for instance, one member works more when the other member gets adverse income shocks, then household income would not fluctuate as much as individual earnings. Figure 1 compares transitory variances of log household income with log male wage earnings for married households from Panel Study of Income Dynamics (PSID)[2] 1974-2000. [3] Over the past thirty years transitory fluctuation of household income is always higher than than fluctuation of male wage earnings (except for one year), which is consistent with my story that household members adjust labor supply to insure each other against adverse shocks. And this pattern can not be explained by other household smoothing mechanism such as intertemporal savings behavior.

Furthermore, if there exists risk sharing between household members, then single agents who live by himself would behave differently from those who live with spouse. Table 1 compares transitory fluctuations in income, wage rate and hours between married and single agents using SIPP 1996 panel. [4] Transitory variances of log household income for single males and females are 0.495 and 0.464 respectively, which are much higher than married households (0.214). Transitory variances of log household earnings for single agents are also higher than married couples. I also compares their fluctuation in wage rate, hours and individual earnings. Individuals who are married face higher wage volatility than singles, but earnings fluctuation for married individuals are lower, which also suggests they absorb each other's adverse shocks. Meanwhile, married individuals has about 10 percent higher variances in hours than singles. [5] This suggests that they not only

---

[2]Although the primary data source in this paper is SIPP 1996 panel, it only covers 4 years data, from which I can hardly observe time trend for transitory variances.

[3]I calculate transitory variances following Moffitt and Gottschalk (2002). Let $y_{it} = \mu_i + \nu_{it}$ where ν_{it} is transitory component for income or earnings. Since $Var(y_{it}) = \sigma_\mu^2 + \sigma_\nu^2$ and $Cov(y_{it}, y_{it'}) = \sigma_\mu^2$, one can easily get transitory variance from $var(y_{it}) - cov(y_{it}, y_{it'})$. Here I set t' as lag five years.

[4]Following Gottschalk and Moffitt (1994), I measure transitory fluctuation by calculating variances for each household over time, then take the average across all households. I use same data and sample cuts as in estimation. The description of data can be found in Section 5.

[5]Notice that I take logs for variance calculation, thus the statistics does not include those

adjust labor supply in response to their own income shocks, but also adjust labor supply in response to spouse's adverse shocks.

4   Theoretical Framework

In this section I present a model of intra-household risk sharing. The model is based on Chiappori's (1988, 2007) collective model of household decision making. I start with specification of the sharing rule and a description of the decision process for married couples when both husband and wife are working, then I derive the model restrictions that allow for the identification of the sharing rule, and discuss issues on nonparticipation. Last I describe the problem faced by single agents.

4.1   Model Set Up

I consider a two-member household with husband and wife. Let h^i and C^i denote member i's labor supply (with $i = f, m$ and $0 \leq h^i \leq 1$) and consumption of a private Hicksian commodity C (with $C^f + C^m = C$) respectively. Labor supply choice is continuous and the price of the consumption good is set to one. Assume the preferences to be egoistic type, member i's utility can be represented as $U^i(1 - h^i, C^i)$, where U^i is continuously differentiable, strictly monotone and strongly quasi-concave. I also assume there is no public consumption or domestic production. Let w_m, w_f and y denote husband and wife's wage rates and household's non-labor income respectively. Non-labor income includes asset income, public and private transfers. Assume there are random shocks to wages and non-labor income. [6] Further more, denote $\overline{w}_i$ as the permanent wage which can be measured by the average wage for individual i over the sample period T. Let ϵ_{wi} denote the transitory wage shock, which is the deviation from the mean wage. By definition ϵ_{wi} is mean zero. I assume individual labor supply and household total consumption are observable, but private consumptions and intra-household transfers are not, which is consistent with available information from the data. In the

---

who do not work.

    [6]I assume that household members always pool their non-labor income, in the sense that y is not divided further into y_f and y_m. This implies that they always fully share the shocks to non-labor income. This is a reasonable assumption since many public or private transfers target to the household instead of individuals, and asset income such as rent is usually the income to the whole household.

model the intra-household transfers and individual preferences can be identified up to an additive constant.

4.2 Specification of the Sharing Rule and Decision process

Assume household decision process is efficient, household chooses h^f, h^m, C^f, C^m to solve the following Pareto problem:

$$
\max \mu U^f(1 - h^f, C^f) + (1 - \mu)U^m(1 - h^m, C^m)
$$
$$
s.t. C^f + C^m \leq w^f h^f + w^m h^m + y
$$

(1)

where scalar μ is Pareto weight $\in [0, 1]$. In this context, μ represents female bargaining power within the household which may well depend on both agents' wages and non-labor income or some distribution factors that affect their bargaining position but not preferences (Chiappori, Fortin and Lacroix 2002). Chiappori (1988) has shown the well-known results that according to the Second Welfare Theorem, the household decision process can be decentralized into a two-stage problem given intra-household transfers. In my model when wages and non-labor income are stochastic, in the first stage they agree on certain sharing rule to decide how to make intra-household transfers, contingent on the realized shocks. In the second stage when shocks are realized and the transfers have taken place, each one separately chooses labor supply and private consumption, subject to the corresponding budget constraint.

In most collective models the sharing rule reflects household member's income sharing mechanism. It is usually a function of male and female's wage and non labor income (Chiappori 1988). An increase of one's wage will increase his bargaining power, hence increases his share of pooled resources. The sharing rule could also depend on some distribution factors that affects bargaining process without affecting preferences. Chiappori et al. (2002) take divorce legislation as a distribution factor which affect their threaten point in marriage. Lise and Seitz (2004) use the ratio of husband and wife's potential earnings as distribution factor. Since the main purpose of this paper is to study intra-household risk sharing, I specify the sharing rule in a way that it reflects both bargaining and risk sharing behavior. In this setting, the decision process depends on husband and wife's relative permanent wages, as a measure of bargaining power, and their difference in transitory wage

fluctuation, as a measure of income shocks. I allow permanent wage and transitory wage to have different impact on household decision process. The intuition is that a drop in husband's permanent wage decreases his bargaining power, which reduces his share of pooled resources. While a drop in his transitory wage will increase his share of income since the wife agrees to share the risk hence make more transfer to compensate for his earnings loss due to adverse shocks. The sharing rule ϕ is defined as the amount of non-labor income y allocated to the wife, and is specified as follows:

$$\phi = \phi(y, \overline{w}_f - \overline{w}_m, \epsilon_{wf} - \epsilon_{wm}, z) \tag{2}$$

$\overline{w}^f - \overline{w}^m$ is the difference between wife and husband's permanent wages, as a measure of their relative potential wages which affect their bargaining power. If the difference is positive, wife has larger bargaining power than the husband hence claim larger proportion of pooled resources. $\epsilon_{wf} - \epsilon_{wm}$ is their difference in transitory wages, and vector z includes demographic characteristics such as husband and wife's education, age and race. After the shocks are realized, their pooled resources have been allocated according to this sharing rule. Then each one maximized utility subject to the constraint of his own earnings plus allocated non-labor income:

$$
\begin{aligned}
&maxU^f(1 - h^f, C^f, z, v_f) \\
s.t.&C^f = w^f h^f + \phi(y, \overline{w}_f - \overline{w}_m, \epsilon_{wf} - \epsilon_{wm}, z) \\
&maxU^m(1 - h^m, C^m, z, v_m) \\
s.t.&C^m = w^m h^m + y - \phi(y, \overline{w}_f - \overline{w}_m, \epsilon_{wf} - \epsilon_{wm}, z)
\end{aligned}
\tag{3}
$$

These egoistic preferences depend on one's own leisure and private consumption, some demographic characteristics z and unobserved preference shocks v_j. The sharing rule ϕ can be larger than total non-labor income, which implies all the non-labor income and part of male's earnings transfer to the wife. ϕ could also be negative, in the sense that wife transfers all non labor income and some of her earnings to the husband. For the time being I assume no corner interior solutions, the first order conditions from utility maximization implies labor supply

11

is a function of one's own wage and the sharing rule.

$$h^f = h^f(w^f, \phi(y, \overline{w}_f - \overline{w}_m, \epsilon_{wf} - \epsilon_{wm}, z)) \tag{4}$$

$$h^m = h^m(w^m, y - \phi(y, \overline{w}_f - \overline{w}_m, \epsilon_{wf} - \epsilon_{wm}, z)) \tag{5}$$

A standard labor supply model predicts that when husband receives a negative wage shock, he gets a positive income effect to his labor supply if leisure is a normal good, and he gets a negative substitution effect. In this model wage shocks have an additional "risk sharing effect": the wife will transfer more to the husband in response to his negative wage shock, which generates a negative income effect to husband's labor supply.

To estimate labor supply equations, specific functional form must be assumed. Similar as in Chiappori et al. (2002) and Blundell et al. (2007), I specify a simple labor supply function which is linear in all arguments:

$$h_{it}^f = f_0 + f_1 w_{it}^f + f_2 y_{it} + f_3(\overline{w}_i^f - \overline{w}_i^m) + f_4(\epsilon_{it}^{wf} - \epsilon_{it}^{wm}) + f_5'z + v_{it}^f$$
$$h_{it}^m = m_0 + m_1 w_{it}^m + m_2 y_{it} + m_3(\overline{w}_i^f - \overline{w}_i^m) + m_4(\epsilon_{it}^{wf} - \epsilon_{it}^{wm}) + m_5'z + v_{it}^m \tag{6}$$

where unobserved heterogeneity v_{it}^m and v_{it}^f comes from preference shocks which moves labor supply around, and they are jointly normally distributed.

However, since wage w_{it}^j is a sum of permanent wage $\overline{w}_i^j$ and transitory wage shock ϵ_{it}^{wj}, there exists perfect collinearity between $(\overline{w}_i^f - \overline{w}_i^m)$, $(\epsilon_{it}^f - \epsilon_{it}^m)$ and w_{it}^j. Hence I rewrite w_{it}^j as $\overline{w}_i^j + \epsilon_{it}^{wj}$, and rearrange terms in the labor supply functions:

$$h_{it}^f = a_0 + a_1 y_{it} + a_2 \overline{w}_i^f + a_3 \overline{w}_i^m + a_4 \epsilon_{it}^{wf} + a_5 \epsilon_{it}^{wm} + a_6'z + v_{it}^f$$
$$h_{it}^m = b_0 + b_1 y_{it} + b_2 \overline{w}_i^f + b_3 \overline{w}_i^m + b_4 \epsilon_{it}^{wf} + b_5 \epsilon_{it}^{wm} + b_6'z + v_{it}^f \tag{7}$$

The relation between reduced form parameters ($a's$ and $b's$) and structural form parameters ($f's$ and $m's$) is shown in the Appendix A. In order to make reduced form consistent with structural form, I need restriction $a_2 + a_3 = a_4 + a_5$ and $b_2 + b_3 = b_4 + b_5$. The structural parameters can be identified.

4.3 Identification of the Sharing Rule

The decision making process can be decentralized into the above two stage problem under the assumption of Pareto efficiency. Chiappori (1988) derive restrictions implied by Pareto efficiency and discuss the identification of the sharing rule and preferences. Chiappori et al. (2002) further discuss identification when the sharing rule also depends on some distribution factors. These distribution factors are defined as variables that affect household members' bargaining position but do not affect their preferences. In my model, there are two components act as distribution factors: husband and wife's difference in permanent wages $(\overline{w}_i^f - \overline{w}_i^m)$ and difference in wage shocks $(\epsilon_{it}^f - \epsilon_{it}^m)$. The basic intuition for identification of the sharing rule is follows: two distribution factors enter labor supply functions only through the same function ϕ, and changes in non-labor income also affect labor supply only through function ϕ. The estimated effect of all variables on wife's labor supply allow me to estimate the marginal rate of substitution between distribution factors and non-labor income in the sharing rule. The same argument applies to male labor supply. These conditions allow me to directly identify the partial derivatives of the sharing rule. The cross-derivative constraints on the sharing rule impose testable restrictions. The restrictions on parameters in my labor supply equations are given by:

$$\frac{f_3}{m_3} = \frac{f_4}{m_4} \Leftrightarrow -\frac{a_3}{b_2} = -\frac{a_5}{b_4} \tag{8}$$

The intuition of this restriction is: it is the same sharing rule that enters both male and female labor supply functions, hence the ratio of marginal effect should be equivalent. Given this restriction, partial derivatives of the sharing rule can be uncovered as follows:

$$
\begin{aligned}
\gamma_y &= \frac{m_3 f_2}{m_3 f_2 - f_3 m_2} = \frac{b_2 a_1}{b_2 a_1 + a_3 b_1} \\
\gamma_{\overline{w}} &= \frac{m_3 f_3}{m_3 f_2 - f_3 m_2} = \frac{-b_2 a_3}{b_2 a_1 + a_3 b_1} \\
\gamma_{\epsilon w} &= \frac{m_4 f_4}{m_4 f_2 - f_4 m_2} = \frac{-b_4 a_5}{-b_4 a_1 + a_5 b_1}
\end{aligned}
\tag{9}
$$

thus the sharing rule can be recovered except for an additive constant:

$$\phi_1 = \gamma_{0+} \gamma_{1y} y_{it} + \gamma_{1\overline{w}}(\overline{w}_{it}^f - \overline{w}_{it}^m) + \gamma_{1\epsilon w}(\epsilon_{it}^{wf} - \epsilon_{it}^{wm}) \tag{10}$$

4.4 Participation Decision

Up to now the model is set up in a way that both husband and wife work positive hours each period, so that we can use first order conditions to recover the sharing rule and preferences. However, risk sharing behavior not only affect how much they work but also affect their participation decisions. For instance, in a household that husband earns a lot and wife stays at home, when husband gets a large adverse shock, wife's reservation wage drops and she is more likely to work. Therefore it is important to incorporate participation decisions and it is largely complicates the model. In this section I discuss the identification issues on the remaining three scenarios: when husband works but wife does not (define as N_f); when wife works but husband does not (N_m); and when neither of them participate in the labor market (N_{mf}). The basic identification strategy for the nonparticipation case is that when one partner does not participate in the labor market, I can still identify the sharing rule and preferences from spouse's labor supply. The partial derivatives of the sharing rule on the participation frontier P, where both of them participate, provide boundary conditions for the partial derivatives for the nonparticipation set N_f and N_m. Blundell et al. (2007) estimate the model when men's only choice is whether to work full-time or not to work, and women have continuous choice of labor supply. Donni (2003) develops the model when both husband and wife both have participation and continuous labor supply decision. My following analysis is based Donni (2003) and I focus on how risk sharing behavior could possibly affect participation and labor supply decision.

In the labor supply framework for single agent, the participation decision is characterized by reservation wage. At this wage, the agent is indifferent between working and not working. In the context of two agents' joint decision, when a member is indifferent between working and not working, Pareto efficiency of household decision requires that his or her partner must be indifferent as well. Suppose not, if husband is indifferent between work or not, but his participation yields a positive gain for the wife, then he will choose to participate, otherwise the decision is inefficient. [7]

Equation (7) provides labor supply functions defined on spouses' participation set P. For simplicity, I denote a' and b' as row vector of parameters and x as a

---

[7]This lemma is formally stated in Blundell et al. (2007).

column vector of variables in equation (7):

$$h^f = a'x + v^f \tag{11}$$

$$h^m = b'x + v^m \tag{12}$$

when husband does not work, the sharing rule changes, hence wife's labor supply also switches regime, the parameters change:

$$h^f = A'x + u^f \tag{13}$$

and similarly, when wife does not work, husband's labor supply switches regime to:

$$h^m = B'x + u^m \tag{14}$$

however, the parameters must satisfy certain restrictions for the labor supply to be continuous along the participation frontier. Donni (2003) proved they need to satisfy the following relation:

$$A'x = a'x + s_1(b'x) \tag{15}$$

$$B'x = b'x + s_2(a'x) \tag{16}$$

where s_1 and s_2 are free parameters but can be estimated from the observed labor supplies. Along the participation frontier, by definition, the last term in equation (15) and (16) vanishes, and consequently, $A'x = a'x$, $B'x = b'x$, which means the labor supplies are continuous.

From labor supply functions associated with the case when husband participate but wife does not, I can identify the sharing rule ϕ_2. The opposite case can also be identified and ϕ_3 is derived. Since the sharing rule is continuous along the participation frontier. ϕ_2 and ϕ_3 must be equal to ϕ_1 along the participation frontier. This means the parameters in the sharing rules must satisfy the following condition:

$$\begin{aligned} \gamma_2'x &= \gamma_1'x + r_1(b'x) \\ \gamma_3'x &= \gamma_1'x + r_2(a'x) \end{aligned} \tag{17}$$

where r_1 and r_2 are free parameters. Using restrictions from (11), (15), (16) and

15

(17), r can be written as a function of s. Hence the sharing rules with one of the partners does not work can be identified.

5   Data

The data I use for this paper is Survey of Income and Program Participation (SIPP), a national representative longitudinal data set. This data set has substantial advantage over the Panel Study of Income Dynamics (PSID), the primary data source for studies on efficient risk sharing in U.S.. First, SIPP provides monthly information on wage rate, hours worked, while PSID interviewed on annual basis hence can not provide information on wage or labor supply changes for period that less than a year. Second, this model assumes there is no marriage related decision in the household during the entire sample period. This is more realistic and less restrictive when data covers less years. Third, SIPP provides key variables to identify individuals change wages within same employer and when moving to a new employer, hence I may distinguish risk sharing via changing in labor supply or switching jobs.

I use SIPP 1996 panel which covers monthly information from December 1995 to February 2000. My sample includes individuals who were 20 to 64 and who did not have children less than 18 years old. I further divide sample into two files, one includes "single" individuals who remain single, divorced, separated or widowed and live by himself/herself. I estimate the standard labor supply model on this sample since each agent live by himself and there is no risk sharing behavior within household. The other file includes married couples who do not live with any relatives. In both files agents with changes in marital status are excluded from the sample. All wage and income variables are deflated with CPI-U-RS and set base period to January 2000. [8]

Table 2-4 show summary statistics for married couples, single males and single females respectively. The sample is mainly consists of whites. For married couples, husbands works more than wives both in terms of weeks worked or hours worked per week. Husbands also have higher average wage rate and higher education than wives. On average, married men work harder than single men.

---

[8]The deflator can be found at http://www.census.gov/hhes/www/income/income05/cpiurs.html

6 Estimation

6.1 Estimation Procedure For Married Couples

To estimate the model, I need some unobserved heterogeneity in the labor supply functions. Since I do not observe wages for those who do not work, I also need to specify a stochastic model of human capital to explain market wages. In this case, the proof of identification raises further theoretical difficulties. Blundell et al. (2007) show that the presence of unobservable heterogeneity does not invalidate the main conclusions. In general, a necessary condition for the identification in this context is that there exists a variable which influences the wife's wage without affect the sharing rule and the husband's wage, and vice versa. I take a standard human capital approach to wages. I estimate education interact with year dummies in the wage equations, so that the identification of labor supplies does not rely on the exclusion of education, instead, it relies on the way that the returns to education have changed.

$$w_{it}^f = \theta^f + \theta_{1t}^f edu_{it}^f + \theta_2^f age_{it}^f + \theta_3^f (age_{it}^f)^2 + \omega_{it}^f \tag{18}$$

$$w_{it}^m = \theta^m + \theta_{1t}^m edu_{it}^m + \theta_2^m age_{it}^f + \theta_3^m (age_{it}^m)^2 + \omega_{it}^m \tag{19}$$

Using above estimated wage equations I can impute wages for those who do not work. Then I compute permanent and transitory wages. There are very few empirical studies considers collective labor supply with nonparticipation, Vermeulen (2006) estimate female labor supply and Blundell et al. (2007) jointly estimate female labor supply and male participation. Here I jointly estimate husband and wife's labor supply functions and consider participation decisions from both sides. I estimate four labor supply functions, h_f and h_m are labor supply functions when both are working, h_{f0} is female labor supply when their spouses are not working, h_{m0} is male labor supply when their spouses are not working. The likelihood function I estimate is as follows:

$$L = \prod_{h_f^*>0,h_m^*>0} pr(h_m^*>0, h_f^*>0)f(h_m,h_f|h_m^*>0,h_f^*>0) \times \prod_{h_f^*<0,h_m^*<0} pr(h_m^*<0,h_f^*<0) \times \prod_{h_f^*<0,h_m^*>0}$$

$$pr(h_m^*>0,h_f^*<0)f(h_m|h_m^*>0,h_f^*<0) \times \prod_{h_f^*>0,h_m^*<0} pr(h_m^*<0,h_f^*>0)f(h_f|h_m^*<0,h_f^*>0)$$

$$\tag{20}$$

17

After estimate labor supply functions, I can calculate partial derivatives of the sharing rule ϕ_1 from equation (9). Then I estimate s_1 and s_2 from equation (15) and (16), then recover parameters r_1 and r_2 in equation (17), and finally recover the other two sharing rules which are associated with nonparticipation case.

6.2 Estimation Procedure for Single Agents

I also want to contrast married couples behavior with single individuals to see how their labor supply differs in response to shocks. For single agents who live by himself, they do not have risk sharing or bargaining decision, hence the standard labor supply model applies. I estimate labor supply functions separately for single males and single females. The wage equations for female and male are exactly the same as in (23) and (24). The labor supply and likelihood contributions are also straightforward:

$$h_{it}^j = j_0 + j_1 w_{it}^j + j_2 y_{it} + j_3' z + v_{it}^j \tag{21}$$

6.3 Estimation Results

To be added.

7 Conclusion

To be added.

Appendix

A The Relation between Structural Parameters and Reduced Form Parameters

After estimate the reduced form parameters a's and b's in equation (6), I can derive structural parameters f's and m's of labor supply functions in equation (5) by following:

$$a_0 = f_0, \ a_1 = f_2, \ b_0 = m_0, \ b_1 = m_2 \tag{22}$$

$$a_6^{'} = f_5^{'}, \ b_6^{'} = m_5^{'}, \tag{23}$$

$$a_2 = f_1 + f_3, \ b_2 = m_3 \tag{24}$$

$$a_3 = -f_3, \ b_3 = m_1 - m_3 \tag{25}$$

$$a_4 = f_1 + f_4, \ b_4 = m_4 \tag{26}$$

$$a_5 = -f_4, \ b_5 = m_1 - m_4 \tag{27}$$

Equivalently,

$$f_1 = a_2 + a_3 = a_4 + a_5 \tag{28}$$

$$m_1 = b_2 + b_3 = b_4 + b_5 \tag{29}$$

$$f_3 = -a_3, \ m_3 = b_2 \tag{30}$$

$$f_4 = -a_5, \ m_4 = b_4 \tag{31}$$

By imposing $a_2 + a_3 = a_4 + a_5$ and $b_2 + b_3 = b_4 + b_5$, structural parameters are exactly identified.

References

Altonji, J., F. Hayashi, and L. Kotlikoff (1992). Is the Extended Family AL-truistically Linked? Direct Tests Using Micro Data. *American Economic Review 82*(3), 1177–98.

Blundell, R., P.-A. Chiappori, T. Magnac, and C. Meghir (2007, April). Collective Labor Supply: Heterogeneity and Nonparticipation. *Review of Economic Studies 74*(2), 417–45.

Browning, M., F. Bourguignon, P.-A. Chiappori, and V. Lechene (1996, December). Income and Outcomes: A Structural Model of Intrahousehold Allocation. *Journal of Political Economy 102*(6), 1067–96.

Chiappori, P.-A. (1988). Rational Household Labor Supply. *Econometrica 56*(1), 63–89.

Chiappori, P.-A., B. Fortin, and G. Lacroix (2002). Marriage Market, Divorce Legislation and Household Labor Supply. *Journal of Political Economy 110*(1), 37–72.

Cochrane, J. H. (1991). A Simple Test of Consumption Insurance. *Journal of Political Economy 99*(5), 957–76.

Dercon, S. and P. Krishnan (2000, June). In Sickness and in Health: Risk Sharing within Households in Rural Ethiopia. *Journal of Political Economy 108*(4), 688–727.

Donni, O. (2003). Collective Household Labor Supply: Nonparticipation and Income Taxation. *Journal of Public Economics 87*, 1179–98.

Fafchamps, M. and S. Lund (2001, August). Risk sharing networks in rural philippines. Working Papers 97014, Stanford University, Department of Economics. available at http://ideas.repec.org/p/wop/stanec/97014.html.

Gottschalk, P. and R. Moffitt (1994). The Growth of Earnings Instability in the U.S. Labor Market. *Brookings Papers on Economic Activity 1994*(2), 217–272.

Lise, J. and S. Seitz (2004). *Consumption Inequality and Intra-Household Allocations.* Queen's Economics Department Working Paper No. 1019.

Lundberg, S. (1985, January). The Added Worker Effect. *Journal of Labor Economics 3*(1), 11–37.

Maloney, T. (1987). Employment Constraints and the Labor Supply of Married Women: A Reexamination of the Added Worker Effect. *The Journal of Human Resources 22*(1), 51–61.

Mazzocco, M. (2004, May). Saving, Risk Sharing, and Preferences for Risk. *American Economic Review 94*(4), 1169–82.

Mazzocco, M. (2005, March). Individual Rather Than Household Euler Equations: Identification and Estimation of Individual Preferences Using Household Data. University of Wisconsin-Madison.

Mazzocco, M. (2006a, March). Household Intertemporal Behavior: a Collective Characterization and a Test of Commitment. University of Wisconsin-Madison.

Mazzocco, M. (2006b, May). Intertemporal Behavior and Household Structure. University of Wisconsin-Madison.

Mazzocco, M. and S. Saini (2006, October). Testing Efficient Risk Sharing with Heterogeneous Risk Preferences: Semi-parametric Tests with an Application to Village Economies. UCLA and University of Wisconsin-Madison.

Moffitt, R. and P. Gottschalk (2002, March). Trends in the Transitory Variance of Earnings in the United States. *Economic Journal 112*(478), C68–73.

Stephens, M. (2002). Worker Displacement and the Added Worker Effect. *Journal of Labor Economics 20*(3), 504–37.

Townsend, R. M. (1994, May). Risk and Insurance in Village India. *Econometrica 62*(3), 539–91.

Vermeulen, F. (2006). A Collective Model for Female Labor Supply with Non-participation and Taxation. *Journal of Population Economics* (19), 99–118.
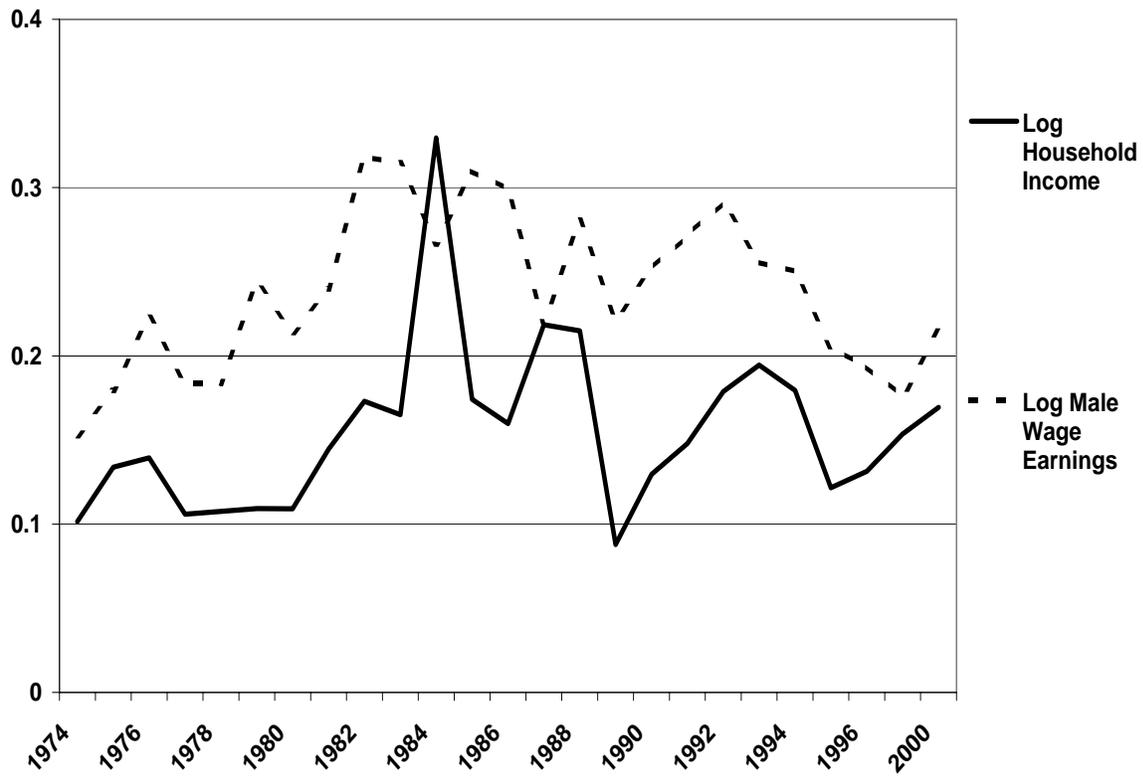
Figure 1: Transitory Variances of Log Household Income and Male Log Earnings, Married Households from PSID 1974-2000

Table 1: Comparison of Transitory Variances for Married and Single Agents

	Transitory Variances		
	Log Household Earnings	*Log Household Income*	
Single Males	0.234	0.495	
Single Females	0.222	0.464	
Married Couples	0.207	0.214	
	Log Wage rate	*Log Earnings*	*Log Hours*
Single Males	0.118	0.259	0.056
Single Females	0.107	0.237	0.058
Married Males	0.144	0.215	0.061
Married Females	0.112	0.230	0.065

Note: transitory variances are calculated as: $var(\epsilon_{it}) = \frac{1}{N}\sum_i^N \frac{1}{(T_i-1)}\sum_i^{T_i}(y_{it-}\overline{y}_i)^2$

Table 2: Summary Statistics for Married Couples

Variable	Mean	Std. Dev.	Min	Max
Age of husband	47.69	10.74	20	64.00
Age of wife	45.58	10.55	20	64.00
Husband is black	0.06	0.23	0	1.00
Husband is American Indian, Aleut or Eskimo	0.01	0.08	0	1.00
Husband is Asian or Pacific Islander	0.03	0.16	0	1.00
Weeks worked last month for husband	4.04	1.16	0	5.00
Weeks worked last month for wife	3.82	1.44	0	5.00
Husband's highest grades completed	18.25	6.04	1	26.00
Wife's highest grades completed	17.90	5.78	1	26.00
Household Total Income	6,210.81	4,964.48	0	119,319.20
Household total non-labor income	298.17	844.37	0	75,307.84
Household total labor income	5,734.83	4,870.65	0	117,398.00
Husband's labor income	2,742.51	3,088.88	0	61,621.53
Wife's labor income	1,794.06	1,829.57	0	53,199.61
Husband's wage rate	14.70	20.68	0	2,361.95
Wife's wage rate	10.89	15.99	0	2,136.42
Husband's hours worked per week	34.93	20.55	0	140.00
Wife's hours worked per week	31.47	17.94	0	152.00
Husband's weeks worked for entire sample (52 months)	145.00	60.43	1	208.00
Wife's weeks worked for entire sample (52 months)	136.23	63.877	1	208.00

Table 3: Summary Statistics for Single Males

Variable	Mean	Std. Dev.	Min	Max
age	37.45743	11.79012	20	64
weeks worked last month	3.409777	1.798711	0	5
highest grades completed	16.66366	6.037547	1	26
Household Total Income	3998.57	3881.46	0	91489.53
Household total non-labor income	403.0048	915.0597	0	75142.32
Individual earnings	1808.902	2340.053	0	67155.5
hourly wage rate	9.804255	13.53211	0	1194.961
hours worked per week	30.81745	21.54794	0	180
white	0.821039	0.3833202	0	1
black	0.142811	0.349881	0	1
American Indian, Aleut or Eskimo	0.012819	0.1124937	0	1
Asian or Pacific Islander	0.02333	0.1509507	0	1
widowed	0.023622	0.1518687	0	1
never married	0.616499	0.4862396	0	1
divorced	0.301107	0.4587399	0	1
separated	0.058773	0.2351988	0	1

Table 4: Summary Statistics for Single Females

Variable	Mean	Std. Dev.	Min	Max
age	42.40807	12.9786	20	64
weeks worked last month	3.261167	1.894193	0	5
highest grades completed	17.48171	6.21372	1	26
Household Total Income	3563.888	3513.316	0	80553.8
Household total non-labor income	354.6942	780.294	0	64892.81
Household total earnings	3071.715	3481.657	0	79148.13
Individual earnings	1626.39	1878.883	0	52318.04
hourly wage rate	9.264036	11.90607	0	1434.435
hours worked per week	29.30728	20.36094	0	198
white	0.801759	0.3986755	0	1
black	0.161129	0.3676502	0	1
American Indian, Aleut or Eskimo	0.012375	0.1105534	0	1
Asian or Pacific Islander	0.024737	0.1553237	0	1
widowed	0.124298	0.3299221	0	1
never married	0.460249	0.4984185	0	1
divorced	0.357634	0.4793046	0	1
separated	0.057819	0.2334007	0	1