How Do Wage Shocks Affect Married Couples' Labor Supply? - Evidence from the Collective Model

Sisi Zhang*

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Abstract

In this paper I study how married couples respond to each other's adverse wage shocks by adjusting labor supply and making intra-household transfers. I develop a collective labor supply model, where wages are stochastic and intra-household allocation depends on both permanent wage and stochastic wage shocks. I estimate this model using Survey of Income Program Participation (SIPP) quarterly data from October 2000 to February 2003. Empirical results show the following: (1) household smoothing coming from intra-household transfers to the member with lower permanent wage; (2) wife's wage shocks have a larger effect on joint labor supply decisions while husband's wage shocks do not have significant effect; (3) wife's permanent wage and wage shocks have opposite effect on household joint labor supply decision.

JEL Codes: D12, D13, D81, J22.

Keywords: Collective Labor Supply, Wage Shock, Permanent Wage, Intra-household Allocation.

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 am especially grateful to Peter Gottschalk and Shannon Seitz for invaluable advice. I would also like to thank Susanto Basu, Kathy Bradbury, Donald Cox, Jeremy Lise, Arthur Lewbel, John Knowles, Aloysius Siow, Kit Baum, Bo Zhao, the session participants at 41st Annual Meeting of the Canadian Economic Association (2007), 2007 International Symposium on Contemporary Labor Economics at Xiamen University, and seminar participants at the Federal Reserve Bank of Boston and Luojia Young Scholars Seminar on Economics and Management at Wuhan University for helpful comments. The usual disclaimer applies.

2002). Such increases in income volatility have been of concern to policy makers since it 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 joint labor supply or savings decisions or intra-household allocation. The goal of this paper is to investigate the following question: how do married couples make joint labor supply decisions and intra-household allocations in response to transitory wage shocks and permanent wage changes? 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 intra-household insurance with public insurance policies may 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 the link between individual earnings inequality and household income inequality. If couples joint decision respond to permanent and transitory wage changes differently, then policies that protect against low permanent wage such as food stamp or minimum wage legislation and policies that insure against transitory shocks such as unemployment benefit would have different implications.

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 household risk sharing is efficient, individual consumption should be independent of idiosyncratic shocks. They treat leisure as exogenous and focus on such ex-ante savings decision as insurance mechanism, therefore can not draw any implications on labor supply. However, it is natural to assume that individuals not only smooth consumption via ex-ante savings decision, but may also making ex-post labor supply and participation decision. In this paper I focus on studying how wage shocks affect household members' labor supply decision.

There are several empirical studies that also explain how household members adjust labor supply in response to adverse 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), Juhn and Potter (2007)). These studies focus on how wife's labor supply respond to husband's unemployment shocks. Lundberg (1985) has found a small but significant added worker effect. Recent studies by Juhn and Potter (2007) use matched March CPS files and find that such effect is still important among a subset of couples but the overall value of marriage as a risk-sharing arrangement has diminished due to the greater positive co-movement of employment within couples. These studies focus on unemployment shocks and focus on one-sided effect. When it comes to wage shocks and the response from both husband and wife's side, the question becomes more complicated.

To study household joint labor supply decision, a nice framework is collective model first developed by Chiappori (1988). Under the very weak assumption of Pareto efficiency, the unobserved intra-household transfers can be identified from the observations of labor supply. Such intra-household allocation usually depends on husband and wife's wage, which the existing literature interpret as a measurement of their bargaining power that affects the Pareto weight of the joint utility maximization. However, their intra-household allocation process may not only depend on bargaining power but also depend on how they are able to insure each other and compensate for the wage loss, either long term wage loss or short run idiosyncratic shocks, and these two stories would generate opposite labor supply predictions.

In this paper I develop a structural model based on collective framework to investigate the following question: how do wage shocks and permanent wage affect intra-household allocation, which in turn affect married couples' joint labor supply and participation decision? In my model, permanent wage and transitory wage shocks could affect household decision differently, which differs from existing collective model where intra-household allocation only depends on wage. My model also provides insights on household smoothing behavior, for instance, whether they smooth over long-run wage changes or short-run wage changes more. In addition, I also allow intra-household allocation mechanism to differ depending on participation decision, as household smoothing may be constrained when one of the partner does not work. The estimation of this model may also explain the stylized facts that for married couples, income fluctuation at household level are much lower than at individual level, and married couples income fluctuation are lower than single individuals.

I use Survey of Income and Program Participation (SIPP) quarterly data from October 2000 to February 2003 to estimate the model. From the observations of joint labor supply, I identify the unobserved intra-household allocation mechanisms when both husband and wife works, when husband does not work and when wife does not work. Estimation results show that female permanent and transitory wage have opposite effects on intra-household allocation; household smoothing may come from intra-household transfer to the member with lower permanent wage. What is interesting is when I decompose wage into two components, I find that the bargaining effect in the existing literature is actually coming from transitory wage. There is an asymmetric in husband and wife's responses and there is also evidence of insurance against high volatility of the shocks.

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 households or extended families using data from 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 loss, 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.

The above risk sharing studies focus on consumption smoothing, where utility only depends on one dimensional consumption, and risk sharing comes from ex-ante savings decision. While there is another stream of literature that studies how people share income risk via ex-post labor supply adjustment. This is usually referred as "added worker effect" literature (Lundberg (1985), Maloney (1987), Stephens (2002), Juhn and Potter (2007)), 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 participation decision in response to husbands' unemployment, under the assumption that husbands are the primary earners in the households and most of them work full-time, thus they do not respond to wive's unemployment shocks. Although labor supply elasticities for married women are higher than married men, it is still worth to explore labor supply responses from both sides as a result of household smoothing or risk sharing mechanism.

In order to examine how household members joint making decisions, a nice framework is the collective model first developed by Chiappori(1988). 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 Pareto 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 observations 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-sectional data. Recent studies extend such collective framework to the stochastic world, where household members 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. He shows that the main conclusion in the static collective model still holds when introducing stochastic shocks. In his model household members can save jointly by using a risk-free asset thus he focuses on savings decision as a insurance mechanism. He has not yet addressed the interesting issue of joint labor supply decision as a mechanism for intra-household insurance. 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. Therefore, this intertemporal framework can not be generalized to the study of labor supply as a mechanism of intra-household risk sharing. [1]

Most collective labor supply models assume both household members supply positive hours, since corner solutions largely complicates the model. As static models only requires cross-sectional data, this is not a quite restrictive assumption although it causes selection bias. However, when examining household behavior over time using panel data, every individual participates in each period would be a very restrictive assumption. 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. The estimates of the sharing rule show that male wages and employment have a strong influence on bargaining power within couples. Donni (2003) develops a more general framework 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 spouse's labor supply.

[1] 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 although it causes selection issue in this model. My sample only includes those who remain married for the entire sample period. But I also compare married couples' behavior with single agents to see how their labor market decision differs.

3 Stylized Facts of Income Volatility and Household Smoothing

In this section I document stylized facts on income volatility at household level and individual level for married couples and singles. These facts suggests some evidence of household smoothing through joint labor supply decision, which is also the motivation of this paper. Following Moffitt and Gottschalk (2002), I measure income volatility by computing variance of transitory income component [2].

Figure 1 takes data from from 1974-2000 waves of Panel Study of Income Dynamics (PSID). In this figure, I compare household income volatility and individual earnings volatility for married couples. Over the past thirty years household income volatility is always higher than individual earnings volatility (except for one year), which suggests married couples may have certain insurance mechanism to consume idiosyncratic shocks at individual level, so that income volatility at household level are much lower. [3] Since I compare individual earnings volatility with household income instead of household wealth volatility which includes savings, this stylized fact is more in favor of the story of ex-post labor supply adjustment as household smoothing mechanism.

Table 1 compares income volatility for singles versus married couples using SIPP 2001 panel, the primary data source in this paper. [4] If married couples can insure each other against income shocks, then their income fluctuation at household level should be smaller than singles who can not provide such insurance. Since household income for married couples is the sum of two person individual income, to make it comparable, I calculate household income volatility for singles by randomly matching single males and single females and sum up each two agents' income to get "household income" or "household earnings" for two agents.

[2] Let $y_{it} = \mu_i + \nu_{it}$ where ν_{it} is transitory component for income or earnings. These two components are independent. 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.

[3] I compute individual earnings volatility using male wage earnings only, since including both male and female will generate larger volatility due to the gender wage gap.

[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 and sample cuts can be found in data section. The reason that I use this method instead of the ones for Figure 1 is because SIPP only has 12 time periods and only covers 3 years. While the assumption of previous model only valid when there are certain years lag so that the transitory fluctuations disappears.

These pseudo couples could not have household smoothing behavior while true couples might have. The first two rows of Table 1 compares pseudo couples with true couples household income or household earnings volatility, true couples have much lower volatility than pseudo couples (0.141 v.s. 0.092, and 0.135 v.s. 0.085 respectively). However, this may because true couples have lower wage or hours volatility which is the primary component of household income. The bottom rows shows that on the opposite, true couples actually have higher wage and hours fluctuations. [5] This suggests that married couples not only adjust labor supply in response to their own wage shocks, but also adjust labor supply in response to spouse's wage shocks.

In short, from both PSID and SIPP, two most comprehensive longitudinal dataset in U.S., evidence show that income volatility at household level are much smaller than at individual level for married couples, and married couples have lower household income volatility than singles. These stylized facts suggest there may be household smoothing going on. Next I build a structural model of household joint decision, the estimation of this model provides explanations of these stylized facts.

4 Theoretical Framework

4.1 Model Set Up

In this section I present a model to study how wage shocks and permanent wage affect household joint labor supply via intra-household transfers. This model is based on Chiappori's (1988) and Mazzocco (2004) collective labor supply model. I consider a two-member household with the presence of 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. For simplicity, I further assume there is no

[5] I take logs for variance calculation, thus the statistics does not include those who do not work.

public consumption or domestic production [6]. 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 so that the wage rate is a sum of permanent wage and a wage shock [7]. Further more, denote $\overline{w}_i$ as the permanent wage and let ϵ_{wi} denote the mean zero transitory wage shocks. This model assumes 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. Under the very weak assumption of Pareto efficiency, the unobserved intra-household transfers and individual preferences can be identified up to an additive constant.

Husband and wife choose labor supply h^f, h^m and consumptions C^f, C^m solve the following Pareto problem:

$$\begin{aligned}
&\max \mu U^f(1-h^f, C^f) + (1-\mu)U^m(1-h^m, C^m) \\
&s.t. C^f + C^m \leq w^f h^f + w^m h^m + y \\
&w^f = \overline{w}^f + \epsilon^{wf}, w^m = \overline{w}^m + \epsilon^{wm}
\end{aligned} \tag{1}$$

where scalar μ is Pareto weight $\in [0,1]$. In this context, μ represents wife's bargaining power within the household which may depend on husband and wife's wage and non-labor income (Chiappori 1988), as well as some distribution factors that affect their bargaining position but not preferences (Chiappori, Fortin and Lacroix 2002). Chiappori (1988) has shown that under the assumption of Pareto efficiency, according to the Second Welfare Theorem, the household decision process can be decentralized into a two-stage problem given intra-household transfers. Mazzocco (2004) further shows that when introducing stochastic shocks into the model, the main conclusion is still valid. In my model when wages stochastic, in the first stage before the shocks are realized, they agree upon certain sharing rule

[6] The assumption of egoistic preference can be relaxed by introducing a "caring" parameter, and the model can be identified in a non-parametric context. The assumption of no public consumption or home production can be easily relaxed given data availability. SIPP does not contain consumption data thus I make the above assumptions, which are also the assumptions for most collective models in the literature.

[7] Non-labor income includes asset income, private and public transfers. In most datasets, non-labor income y is not separable between household members, thus I also assume they pool their non-labor income, in the sense that y is not divided further into y_f and y_m.

to decide how to make intra-household transfers, contingent on the realized shocks. In the second stage when shocks are coming and the transfers have taken place, each one separately chooses labor supply and private consumption, subject to the corresponding budget constraint.

Denote the unobserved intra-household transfers as sharing rule ϕ, which is the amount of non-labor income that allocated to the wife. It could be larger than the total amount of non-labor income, in which case husband not only transfers all the non-labor income but also transfers part of his own earnings to the wife. This sharing rule can also be a negative value, in which case wife transfers some of her earnings plus total non-labor income to the husband. Then $y - \phi$ is the amount of non-labor income that transfers to the husband. Existing collective models specify the sharing rule as a function of husband and wife's (realized) wages and non-labor income (Chiappori 1988). These wages enters sharing rule as a measure of bargaining power. The larger the wife's wage is, the larger her bargaining power in the household, hence she can declare a larger proportion of non-labor income, which could reduce her labor supply due to this income effect. Therefore, from the observations of labor supply on can identify the unobserved intra-household allocation mechanism. The sharing rule may also depend on some distribution factors that affect couple's outside option hence affect their bargaining power in the household. 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. Motivated by Gottschalk and Moffitt (1994), that permanent wage is mainly determined by skill prices while transitory wage shock is more related to job instability, illness, etc., I emphasize that permanent wages and transitory wage shocks have different impact on the sharing rule. Unlike all the existing literature that the sharing rule depends on wife and husband's wage, I specify the sharing rule as a function of wife and husband's permanent wage and transitory wage shock:

$$\phi = \phi(y, \overline{w}^f, \overline{w}^m, \epsilon^{wf}, \epsilon^{wm}) \tag{2}$$

In the first stage, couples agree upon the above sharing rule to share income conditional on realized shocks. In the second stage, after the shocks are realized, their pooled resources have been allocated according to this sharing rule. Since preferences are egoistic, each one maximized utility subject to private budget constraint:

$$
\begin{aligned}
maxU^f(1-h^f, C^f) \\
s.t.C^f = w^f h^f + \phi(y, \overline{w}^f, \overline{w}^m, \epsilon^{wf}, \epsilon^{wm}) \\
maxU^m(1-h^m, C^m) \\
s.t.C^m = w^m h^m + y - \phi(y, \overline{w}^f, \overline{w}^m, \epsilon^{wf}, \epsilon^{wm})
\end{aligned}
\tag{3}
$$

Both husband and wife can choose either positive hours work or zero hours. For the time being I focus on interior solutions, and I will discuss the corner solutions in next section. The first order conditions from utility maximization implies labor supply is a function of one's own wage and the sharing rule.

$$
\begin{aligned}
h^f &= h^f(w^f, \phi(y, \overline{w}^f, \overline{w}^m, \epsilon^{wf}, \epsilon^{wm})) \\
h^m &= h^m(w^m, y - \phi(y, \overline{w}^f, \overline{w}^m, \epsilon^{wf}, \epsilon^{wm}))
\end{aligned}
\tag{4}
$$

A standard labor supply model predicts that wage influence labor supply through income and substitution effect. In this model wage shocks could have additional effect on labor supply through sharing rule. I do not specify a priori which direction permanent wage or wage shocks should affect labor supply.

One can specify certain utility functional forms and derive labor supply functions accordingly. Alternatively I can specify labor supply functional forms and back up indirect utility functions. In this model I allow for unobserved heterogeneity and non-participation, which largely complicates the model and raises the issue of identifiability of the model from available data, since preference heterogeneity will also reflect itself in the sharing rule. Therefore, building upon the empirical labor supply literature (Blundell and Macurdy (1999)), I write a simple but already rich model where all structural functions (labor supply and sharing rule) are linear and additive in the heterogeneity terms [8]:

$$
\begin{aligned}
h^f_{it} &= \alpha_0 + \alpha_1 w^f_{it} + \alpha_2 \phi(y, \overline{w}^f_{it}, \overline{w}^m_{it}, \epsilon^{wf}_{it}, \epsilon^{wm}_{it}) + \alpha_3' z + v^f_{it} \\
h^m_{it} &= \beta_0 + \beta_1 w^m_{it} + \beta_2 (y - \phi(y, \overline{w}^f_{it}, \overline{w}^m_{it}, \epsilon^{wf}_{it}, \epsilon^{wm}_{it})) + \beta_3' z + v^m_{it}
\end{aligned}
\tag{5}
$$

[8] Chiappori et al. (2002) and Blundell et al. (2007) use semi-log linear labor supply functions and sharing rule

where unobserved heterogeneity v_{it}^m and v_{it}^f comes from preference shocks that affects labor supply, and I allow them to be correlated with each other. These preference shocks also drives husband and wife's participation decisions. z includes sets of control variables such as husband and wife's education, age, race, year dummies, z is the same for both equations. From above labor supply functions, permanent and transitory wage may affect labor supply in different ways, and they have additional effect via sharing rule as well as the standard income and substitution effect. The sharing rule is also linear in all its argument:

$$\phi_1 = \phi_{10} + \phi_y y_{it} + \phi_{\overline{w}_f} \overline{w}_{it}^f + \phi_{\overline{w}_m} \overline{w}_{it}^m + \phi_{\epsilon f} \epsilon_{it}^{wf} + \phi_{\epsilon m} \epsilon_{it}^{wm} \tag{6}$$

I can derive the reduced form labor supply functions by plugging sharing rule into the structural labor supply functions:

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

From the estimation of above reduced form parameters, I can identify the partial derivatives of the sharing rule. The intuition for the identification is that changes in wife's wage and non-labor income only affects husband's labor supply through the sharing rule, and vice versa, changes in husband's wage and non-labor income only affects wife's labor supply through the sharing rule. Details of identification of the sharing rule can be found in Appendix. From the over-identification of the partial derivative of sharing rule with respect to non-labor income, I get testable restrictions for this collective model:

$$\frac{a_1(b_3 - b_2)}{a_1(b_3 - b_2) + b_1(a_2 - a_4)} = \frac{a_1(b_5 - b_4)}{b_1(a_5 - a_3) - a_1(b_5 - b_4)} \tag{8}$$

4.2 Participation Choice

Up to now the model is set up in a way that both husband and wife work positive hours in each period, thus first order conditions are sufficient to back up the sharing rule and preferences. However, participation choice also plays an important role in couples joint decision. On one hand, couples can choose to work at any given hours and can also choose to work zero hours, which is non-participation. 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 start working again. On the other hand, the intra-household allocation mechanism may change when one of the partners does not work. The intuition is that when husband gets an unemployment shock, he could not provide same insurance to the household as when he has a job, and in terms of bargaining interpretation in the collective literature, although I can still estimate his potential wage using Mincer regression, this potential wage would not act as the same bargaining power as when he actually earns this much. In short, this participation choice is part of couple's joint decision and it also affect the sharing rule, and it largely complicates the model where both agents work positive hours. Blundell et al. (2007) estimate a collective 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 theory when both husband and wife both have participation choices and continuous labor supply decision.

Depending on participation choices, there will be four regimes that married couples can choose. In previous section I discuss the case that both husband and wife work positive hours, define as participation set P, and I identify the sharing rule ϕ_1 accordingly. In this section following Donni (2003) I identify the sharing rule ϕ_2 on wife's non-participation set (denoted as N_f), when husband works but wife does not, and the sharing rule ϕ_3 on husband's non-participation set (denoted as N_m). There will be the fourth case where neither of them participate (N_{mf}), but in this case the sharing rule is not identified, since I do not observe labor supply from either agents. The basic identification strategy on N_f and N_m 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 partners work, provide boundary conditions for the partial derivatives for the nonparticipation set N_f and N_m.

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. [9]

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 column vector of variables in equation (7):

$$h^f = a'x + v^f \tag{9}$$

$$h^m = b'x + v^m \tag{10}$$

The sharing rule for both partner's participation set depends on their relative permanent and transitory income. When husband does not work, his earnings is zero, but this does not mean that his bargaining power in the household drops to zero. The decision now might depend on his potential earnings. Therefore, it is reasonable to estimate another sharing rule which applies to husband's nonparticipation set. Since the structural labor supply equation for the wife is a function of her own wage and the sharing rule, the reduced form female labor supply also switches regime, let the parameters change to:

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

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

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

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:

$$A'x = a'x + s_1(b'x) \tag{13}$$

$$B'x = b'x + s_2(a'x) \tag{14}$$

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

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

(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 does not participate but wife does, 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:

$$\begin{aligned} \phi_2' x &= \phi_1' x + r_1(b'x) \\ \phi_3' x &= \phi_1' x + r_2(a'x) \end{aligned} \tag{15}$$

where r_1 and r_2 are free parameters. Using restrictions from (11), (15), (16) and (17), rs can be written as a function of s. Hence the sharing rules with one of the partners does not work can be identified.

4.3 Unitary Model Restrictions

In previous sections I derive the restrictions implied by collective model, as given in equation (8). The hypothesis testing against this restriction can lead to either rejecting collective model or not rejecting collective model. In this section I write out the unitary model, where each household is considered as a single unit. In the unitary model, preferences only depend on total household consumption instead of individual consumption. This is a direct application of Hicks composite commodity theorem, that since C^f and C^m have identical prices, they cannot be identified in this general setting. Household joint decision is to maximize a single utility function:

$$\begin{aligned} &\max U^H(1 - h^f, 1 - h^m, C) \\ &s.t. C = w^f h^f + w^m h^m + y \\ &0 \le h^f \le 1, 0 \le h^m \le 1 \end{aligned} \tag{16}$$

First I focus on interior solutions. Given the same labor supply functions as in collective model equation (7), the neoclassical Slutsky equations imply the following:

$$
\begin{aligned}
&b_2 = a_3 = 0 \\
&a_2 b_1 = 0 \\
&b_3 a_1 = 0
\end{aligned} \tag{17}
$$

On the other hand, when the husband does not work, the income effect of male wage on female labor supply must be 0 since he is not working, and when the wife does not work, the income effect of female wage on male labor supply is also 0:

$$
\begin{aligned}
&\frac{\partial h_N^f}{\partial \overline{w}_m} = 0 \Rightarrow A_3 = 0 \\
&\frac{\partial h_N^m}{\partial \overline{w}_f} = 0 \Rightarrow B_2 = 0
\end{aligned} \tag{18}
$$

5 Data

The data I use for estimation 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 household insurance in the United States. First, SIPP provides quarterly information on wage rate, hours worked, while PSID interviewed annually before 1996 and every other year after 1996, which provides less frequent hence limited information on wage and labor supply changes. 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.

I use SIPP 2001 panel covers time period from December 2000 to February 2003. The main sample cuts in the estimation include individuals who were 20 to 59 and who did not have children less than 18 years old. [10] Since the model only involves two agents, I excludes married couples who live with parents or other relatives. This gives me a sample of 6,496 households with 43,819 observations.

[10] Since I assume there is no public consumption or home production, such assumption is more realistic for the households that do not have children less than 18 years old.

All wage and income variables are deflated with CPI-U-RS and set base period to January 2000. [11]

5.1 Correlation between Labor Supply and Spouse's Wage

Table 2 describes the raw correlation between one's labor supply and spouse's permanent wage and wage shocks. Wife's labor supply is positively correlated with husband's wage shocks, which means an adverse wage shock to the husband will reduce wife's labor supply. On the other hand, a drop in husband's permanent wage increases wife's labor supply, which implies that when husband suffers from long term wage loss, the wife works harder to pay all the bills. Notice that wife's labor supply respond oppositely to husband's wage shock and permanent wage. While from husband's labor supply, I do not observe this opposite pattern. The negative correlation of wife's permanent wage and husband's labor supply may also tell the story of insurance against long term wage loss. These raw correlations do not tell us causal relationship and which effects are significant. In the next section I estimate the model and identify the structural intra-household transfer scheme.

6 Estimation

6.1 Estimate Permanent Wage and Wage Shocks

In order to investigate whether one's labor supply response to spouse's permanent wage and wage shocks differently, it is crucial to obtain good estimates of permanent wage and wage shocks from observations of quarterly wage rate. There are several ways to decompose wage into a permanent and a transitory component. The simplest way is to take the average of the wage as permanent wage, then take the deviation from the mean as the transitory wage. Following Gottschalk and Moffitt (2007), I revise this simplest version by allowing a time-varying loading factor on the permanent component, which also allow permanent wage to change with calendar time. Wages can be described using the following equation:

$$y_{it} = \alpha_t \mu_i + \nu_{it} \tag{19}$$

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

where α_t is the loading factor, which captures the changes in aggregate skill prices. μ_i is the individual specific time invariant component. $\alpha_t \mu_i$ represents the permanent component and residual ν_{it} is wage shock. This model assumes that the underlying evolution of skills is always the same, but skill prices differ in each year (α_t).

I apply Gottschalk and Moffitt's latest method to estimate α_t from the variance-covariance matrix of the wages. Then take the deviation of y_{it} in each year and divided by α_t, in which I cancel out ν_{it}. Then calculate the average for each individual to get μ_i. The transitory wage shocks are simply the difference between y_{it} and $\alpha_t \mu_i$. Summary statistics can be found at Table 3.

6.2 Estimation of Reduced Form Labor Supply Functions

I first specify a stochastic model of human capital to predict permanent wages for those who do not work. [12] 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 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.

$$\begin{aligned} w_{it}^j = & \theta_0^j + \theta_1^j edu_{it}^j + \theta_2^j age_{it}^j + \theta_3^j (age_{it}^j)^2 + \theta_4^j edu_{it} D1 + \theta_5^j edu_{it} D2 \\ & + \theta_6^j edu_{it} D3 + \omega_{it}^j \ (j = f, m) \end{aligned} \tag{20}$$

where $D1$, $D2$, $D3$ are three year dummies represents whether the observation is in year 2000, 2001, 2002. Using above estimated wage equations I can impute permanent wages for those who do not work. I use Full Information Maximum

[12] Notice that wage shocks for non-participants are not identifiable. All I observe is one gets an adverse wage shock which drives his wage below reservation wage so that he chooses not to work. This wage shock can be anything within a range from negative infinity to a value that drive his wage slightly below the reservation wage.

Likelihood to estimate four labor supply functions jointly:

$$L = \left[\phi(\frac{h^f - a'x}{\sigma_{vf}}, \frac{h^m - b'x}{\sigma_{vm}})\right]^{D(hf>0,hm>0)} \times \left[\int^{-A'x}\int^{-B'x}\phi(\frac{v_f}{\sigma_{vf}}, \frac{v_m}{\sigma_{vm}})dvfdvm\right]^{D(hf<0,hm<0)}$$
$$\left[\int^{-B'x}\phi(\frac{h_N^f - A'x}{\sigma_{vf}}, \frac{v_m}{\sigma_{vm}})dv_m\right]^{D(hf>0,hm<0)} \times \left[\int^{-A'x}\phi(\frac{h_N^m - B'x}{\sigma_{vm}}, \frac{v_f}{\sigma_{vf}})dv_f\right]^{D(hf<0,hm>0)} \tag{21}$$

these four labor supply equations are corresponding to equation (9)-(12). h^f and h^m are labor supply functions when both are working, h_N^f is female labor supply when their spouses are not working, h_N^m is male labor supply when their spouses are not working. Assume v_f and v_m are jointly normally distributed, which drive husband and wife jointly choose either of the four regimes.

Table 4 displays estimation results. Control variables are husband and wife's age, age square, four education dummies (less than high school, high school, college drop outs, above college, race dummy (white=1), and three year dummies. One interesting result is that when husband works, a negative wage shock to wife reduces her own labor supply (0.05)[13], when husband does not work, a negative wage shock to wife increases her labor supply (-0.16). The intuition is when husband works, he could provide insurance against wife's adverse wage shocks, but when he does not work, he could not provide much insurance, thus wife has to compensate herself by working more. I also observe same pattern for husband's labor supply, but the coefficient is not significant.

Next I test restrictions implied by collective model (equation 8) and unitary model (equation 17 and 18). Efficiency assumption implied by collective model can not be rejected, ($Prob > \chi^2 = .86$), while unitary model can be rejected ($Prob > \chi^2 = .00$).

From reduced form labor supply estimation, I can uncover the unobserved structural estimates of the sharing rule. For the time being I estimate the sharing rule ϕ_1 when both of them are working as follows:

$$\phi = \phi_0 + .330y - .042\overline{w}_f + .104\overline{w}_m + .470\epsilon_{wf} + .016\epsilon_{wm}$$
$$(.021^{**}) \quad (.013^{**}) \quad (.011^{**})(.020^{**}) \quad (.020)$$

[13] A positive coefficient implies that a positive shock increases labor supply, hence a negative shock reduces labor supply

Female wage shock and permanent wage have significant effect on intra-household allocation and two effects are in opposite direction, while male wage shock does not have significant effect on sharing rule. The increase in permanent wage reduces one's share of household resources suggests married couples may insure against wage loss that lasts for several periods, and this household smoothing behavior provides a plausible explanation to the stylized facts I present in Section 3. In existing empirical studies on collective labor supply, sharing rule is a function of wife and husband's wage, and the coefficient is positive for female wage and negative for male wage. This is interpreted as wage is a measurement of bargaining power, the more one earns, the larger bargaining power he has, the more he can get from intra-household allocation. However, in my model, when I decompose wage into two components, I find that the bargaining effect established in the literature is actually coming from the transitory wage component. Also, husband and wife have asymmetric response to each other's wage shocks or permanent wages.

6.3 Explorative Analysis on Wage Volatility

In this section I explore whether married couples joint labor supply decisions are also affected by the variance of the wage shocks. Table 5 displays a reduced form estimation of female and male labor supply functions using bivariate Tobit model, which jointly estimate two equation but also takes censoring into account. The estimated coefficient of female labor supply response to the standard deviation of spouse's shock is 0.038 and it is significant, which implies if husband has higher wage volatility, wife will work more. The coefficient of male labor supply in response to spouse's wage shock variation is 0.383 and it is also significant, which implies if wife has higher wage volatility, husband will work more. This reduced form estimation again in line with household smoothing story, which may potentially explain stylized facts I present in the beginning.

7 Conclusion

In this paper I study on how married couples insure against each other's adverse wage shocks by adjusting labor supply and making intra-household transfers. I develop a structural model based on collective framework, where wage are stochastic and the intra-household allocation depends on both permanent wage and stochastic wage shocks. I first estimate permanent wage and wage shocks for each individual, then estimate model using SIPP 2001 panel. Empirical results suggest the following: (1) Collective model can not be rejected but unitary model can be rejected. (2) Wife's permanent wage and wage shocks affect intra-household allocation in opposite directions, while husband wage shock does not have a significant effect. (3) Household smoothing may come from intra-household transfer to the member with lower permanent wage. (4) There is a asymmetric response from husband and wife's side. (5) Explorative analysis suggests household members may also insure each other against high volatility of the shocks. These results explains why married couple's household income volatility are much lower than at individual level, and it also provides policy implications that policies that protect against low permanent wage would have different effect on household behavior from policies that insure against transitory wage loss.

Appendix

A Derivation of the Sharing Rule on Participation Set

Plug sharing rule (equation 6) into the structural labor supply functions (equation 5):

$$\begin{aligned}
h_{it}^{f} &= (\alpha_{10} + \alpha_2\phi_{10}) + \alpha_2\phi_{1y}y + (\alpha_1 + \alpha_2\phi_{1\overline{w}f})\overline{w}^{f} + \alpha_2\phi_{1\overline{w}m}\overline{w}^{m} \\
&+ (\alpha_1 + \alpha_2\phi_{1\epsilon f})\epsilon^{f} + \alpha_2\phi_{1\epsilon m}\epsilon^{m} + v_{it}^{f} \\
h_{it}^{m} &= (\beta_0 - \beta_2\phi_{10}) + \beta_2(1-\phi_{1y})y - \beta_2\phi_{1\overline{w}f})\overline{w}^{f} + (\beta_1 - \beta_2\phi_{1\overline{w}m})\overline{w}^{m} \\
&- \beta_2\phi_{1\epsilon f}\epsilon^{f} + (\beta_1 - \beta_2\phi_{1\epsilon m})\epsilon^{m} + v_{it}^{f}
\end{aligned} \tag{22}$$

which is a one-to-one mapping to the reduced form labor supply functions:

$$\begin{aligned}
h_{it}^{f} &= a_0 + a_1 y_{it} + a_2\overline{w}_{it}^{f} + a_3\overline{w}_{it}^{m} + a_4\epsilon_{it}^{wf} + a_5\epsilon_{it}^{wm} + a_6' z + v_{it}^{f} \\
h_{it}^{m} &= b_0 + b_1 y_{it} + b_2\overline{w}_{it}^{f} + b_3\overline{w}_{it}^{m} + b_4\epsilon_{it}^{wf} + b_5\epsilon_{it}^{wm} + b_6' z + v_{it}^{m}
\end{aligned} \tag{23}$$

the unknown parameters are α_1, α_2, β_1, β_2, ϕ_{10}, ϕ_{1y}, $\phi_{1\overline{w}f}$, $\phi_{1\overline{w}m}$, $\phi_{1\epsilon f}$, $\phi_{1\epsilon m}$. First treat ϕ_{1y} as known and solve all other parameters recursively. The partial derivatives for the sharing rules are:

$$\begin{aligned}
\phi_y &= \frac{a_1(b_3 - b_2)}{a_1(b_3 - b_2) + b_1(a_2 - a_4)} = \frac{a_1(b_5 - b_4)}{b_1(a_5 - a_3) - a_1(b_5 - b_4)} \\
\phi_{\overline{w}_f} &= -\frac{b_2(1-\phi_y)}{b_1}, \phi_{\overline{w}_m} = \frac{a_3\phi_y}{a_1} \\
\phi_{\epsilon f} &= -\frac{b_3(1-\phi_y)}{b_1}, \phi_{\epsilon m} = -\frac{a_5\phi_y}{a_1}
\end{aligned} \tag{24}$$

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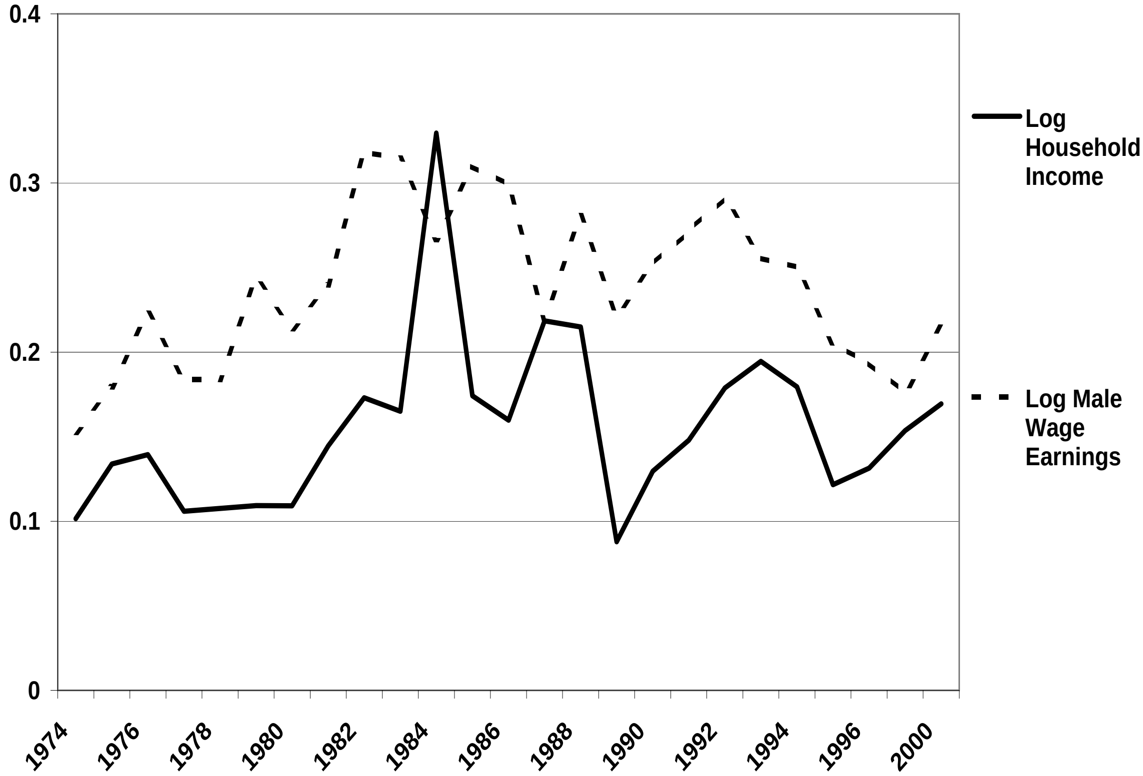

Figure 1: Transitory Variances of Log Household Income and Male Log Earnings, Married Households from PSID 1974-2000

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

	Transitory Variances		
	Log Household Earnings	*Log Household Income*	
Singles(random match)	0.141	0.135	
Married Couples	0.092	0.085	
	Log Wage rate	*Log Earnings*	*Log Hours*
Single Males	0.044	0.174	0.036
Single Females	0.047	0.180	0.040
Married Males	0.058	0.169	0.041
Married Females	0.074	0.224	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: Correlation between Labor Supply and Spouse's Permanent or Transitory Wage

	Female Labor Supply	Male Labor Supply
Spouse's wage shock	0.0057	-0.0036
Spouse's permanent wage	-0.0542	-0.0115

Table 3: Summary Statistics

Variable	**Mean**	**Std. Dev.**
Male age	41.1	9.54
Female age	39.0	9.56
Male hourly wage	18.35	15.17
Female hourly wage	12.52	15.56
Male hours worked	35.4	20.38
Female hours worked	24.2	20.08
Non-labor income/100	2.93	7.80
Female transitory wage	0.02	6.84
Female permanent wage	11.69	11.98
Male transitory wage	0.02	6.23
Male permanent wage	17.87	13.06
Male highest grade	18.8	5.94
Female highest grade	18.6	5.89

Table 4: FIML Estimation of Reduced Form Labor Supply Functions

	Hf(1)	Hm(1)	Hf(2)	Hm(2)
	$Hf > 0, Hm > 0$		$Hf > 0, Hm = 0$	$Hf = 0, Hm > 0$
wife's permanent wage	0.57**	-0.03**	0.12*	-0.03
	(0.01)	(0.01)	(0.05)	(0.05)
husband's permanent wage	-0.11**	0.35**	-0.11*	0.00
	(0.01)	(0.01)	(0.06)	(0.02)
wife's transitory wage	0.05*	0.02	-0.16*	
	(0.03)	(0.02)	(0.09)	
husband's transitory wage	-0.02	0.01		-0.05
	(0.02)	(0.02)		(0.04)
non-labor income	-0.33**	-0.50**	0.00	-0.13**
	(0.02)	(0.02)	(0.05)	(0.03)

Notes: Standard error in parentheses, * significant at 5%; ** significant at 1%

Table 5: Labor Supply Response to Variance of Shocks

	Female Labor Supply		Male Labor Supply	
	coef	std error	coef	std error
wife's permanent wage	0.963**	0.014	-0.433**	0.017
husband's permanent wage	0.182**	0.011	-0.091**	0.013
std deviation of wife's shock	-0.530**	0.027	0.383**	0.010
std deviation of husband's shock	0.038**	0.023	-0.076**	0.024
non-labor income	-0.256**	0.019	-0.238**	0.020

* significant at 5%; ** significant at 1%