Show me the Money:

Intra-Household Allocation under Incomplete Information

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Abstract:

There is evidence that individuals will sometimes withhold income transfers, such as bonuses, gifts, and cash transfers, from other members of the household (Ashraf (2009); Vogley and Pahl (1994)). In this paper, I show that the incentives to hide income under incomplete information over the quantity of resources available to the household differ for three different household resource management structures. I illustrate this with a simple two-stage game. In the first stage, one spouse receives a monetary transfer that is unobserved by her spouse, and she must decide whether to reveal or to hide it. In the second stage, spouses bargain over the allocation of resources between a household good and private expenditure. The three models differ in the resource allocation mechanism that takes place in second stage of the game: housekeeping allowance, independent management, and joint management. Results indicate that hiding is more likely to occur in households with a housekeeping allowance contract, compared to independent or joint management. However if the spouse with the information advantage has low bargaining power, hiding is even more likely to occur relative to non-cooperative contracts.

Key words: incomplete information, household bargaining, resource management systems, income-hiding.

JEL Classification: D13, D82, J12.

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1. Introduction

Households are characterized by two main forms of interdependence between members: household public goods and caring, or how much one’s welfare is affected by the other’s. Household public goods can be thought of as those that benefit all members independently of who provides them, for instance investment in children’s human capital, such as education and health, provides welfare to both spouses even if it is the mother that makes sure her child gets the proper nutrition. It is often argued that, because families involve long-term, repeated interaction and caring, households will realize there are opportunities for Pareto improvement and therefore cooperation will evolve over time (Browning, et al., (2008)). However, there is increasing evidence of non-cooperative behavior and inefficient allocation of resources within the household as a result of asymmetric information (Udry, (1996); Chen (2009); de Laat (2009); Ashraf, (2009); Robinson (2012); Schaner (2012); Castilla (2013); Castilla and Walker (2013)).

Cultural and socio-economic norms determine the resource allocation management contract within the household, which in turn establishes the distribution of responsibilities and control over resources (Vogler and Pahl (1994); Hoffman, (2009), Duflo and Udry, (2004); Anderson and Baland, (2002)). For instance, Vogler and Pahl (1994) find that husbands in England prefer bonuses to being paid for extra hours because they are able to maintain discretion on the way those additional resources are allocated. Duflo and Udry (2004) find that, in Cote d’Ivoire, only the proceeds from yam production are allocated towards child human capital investments, whereas farm income from other men and women controlled crops is used for the owner’s private expenditures. Thus, if there is a negative shock affecting yam production, the decrease in the amount allocated towards child investments will not necessarily be compensated
with resources coming from other sources. Anderson and Baland (2002) find that in poor households in Kenya men withhold a proportion of their income because it is commonly believed that they have the right to personal spending money. Hoffman (2009) finds that in Uganda, where Malaria is widespread, women when given cash to buy mosquito nets used them on themselves because they perceive that by purchasing the nets they are buying usage rights, whereas when the nets are given to women for free they use them on their children.

There is substantial sociological literature on the processes of intra-household decision making which emphasizes the importance of financial management structures in the family and the role that information can play in making decisions within a marriage (Wooley, (2001); Pahl (1990)). The sociology literature has focused on developing a typology of household allocation systems (Pahl (1983)) that vary on each spouse’s sphere of responsibility for managing household money, whereas economics focuses on modeling the decision-making process. Pahl identifies four allocation systems, three of which involve separate spheres, the whole wage system, the housekeeping allowance system and the independent management system, while the shared system involves joint spheres of responsibility (Pahl (1983)). These systems consist of an implicit or explicit contract of how the resources are managed within the household, and vary depending upon who has access and control over resources.

The whole-wage system can be divided into female and male managed. This system characterizes low income households, with labor specialization among spouses. In the male whole wage system, the husband manages all of the resources. In actuality, this system is mostly observed in households where the wife is not employed (Pahl (1990)). This case corresponds to the unitary model of the household, where there is one person that has all the bargaining power and thus makes all the decisions. In the female whole wage system, husbands hand all of their
income minus the proportion they will use for personal spending to their wives and the wife is in charge of all the budgeting of the household thereafter (Pahl (1983) in Pahl (1990)). In the housekeeping allowance system, the husband hands a fixed pre-contracted sum to his wife for household spending and keeps the rest of his income for his own spending. This system is associated to middle class couples where the husband is the only earner (Pahl (1983); Pahl (1990)). Both of these systems resemble the separate spheres model (Lundberg and Pollak (1993)), where there is gender specialization, but they generate different incentives for income withholding. Gray (1979) found that, in households where the husband handed over his entire wage to his wife, he was less likely to earn money from overtime work relative to husbands who gave their wives a fixed housekeeping allowance. In the latter case extra earnings were retained by the husband, thus generating a greater incentive for him to do overtime (Pahl, (1983)).

In the independent management system, each spouse handles her resources separately, and thus neither has access to all of the household money (Pahl (1994)). This system resembles the voluntary contributions model, in the sense that each spouse decides on the optimal allocation of her own resources independently of his or her spouse (Browning, Chiappori and Lechene (2010); Chen and Wooley (2001)). It has been found in households with high income levels where both spouses are earners and have similar levels of education (Pahl (1990)). Finally, in the pooling or joint management system both partners have access to all or nearly all of the household resources and both are thought to be responsible for management and expenditure from the common pool. This system is characteristic of middle income couples where both spouses work (Pahl (1990)). This is the case of a collective household, where the partners bargain over the way the common pool is allocated (Browning and Chiappori, (1998)).
In what follows I illustrate the incentives to hide income under incomplete information over the quantity of resources available to the household and use simple models to show they differ for three different household resource management structures. I model this with a two-stage game. In the first stage, one spouse receives a monetary transfer that is unobserved by her spouse, and she must decide whether to reveal or to hide it. In the second stage, spouses bargain over the allocation of resources between a household good and private expenditure. The three models differ on the contract between spouses regarding the resource management contract in the second stage. The first model corresponds to the case where each spouse handles his or her own resources independently and makes individual contributions towards the household public good. The second model corresponds to a household under a housekeeping allowance system, where there is gender specialization. Both models have multiple equilibria: when both spouses make strictly positive contributions towards the household public good in the first model, or when the husband provides a strictly positive housekeeping allowance to his wife in the second, there exist incentives to hide income because the husband’s contribution is decreasing in his wife’s resources. There are also corner solutions that imply free-riding, where no incentives for hiding exist because one spouse’s allocations are unaffected by the other. The third model considers a collective household where spouses bargain over the way the joint pool of resources is allocated.

The results indicate that when one spouse receives a monetary transfer that is unobservable to her spouse, in equilibrium income hiding is more likely to occur in a household with a housekeeping allowance contract relative to both, an independent management and a joint management household. A joint management (or collective) household is the least likely to observe hiding, as long as the spouse with the information advantage has enough bargaining power. If it is not the case, hiding in a collective household is more likely relative to non-cooperative contracts.
2. Intra-Household Allocation under Incomplete Information

In the model there are two family members, \( f \) and \( m \). The household resource allocation decision is made in two stages. In the first stage household member \( f \) receives a monetary transfer \( (T) \) that is not observable to household member \( m \). Household member \( f \) has to decide whether to reveal that she received a transfer or to keep it for private consumption. If she reveals, she will have to bargain with household member \( m \) over how the resources are allocated, while if she hides she can maintain complete discretion over how to spend the transfer. For simplicity \( T \) is assumed to be observable with probability zero and it is also assumed that \( m \) cannot observe \( f \)'s private consumption choices. In order for hiding to be possible there must be asymmetric information with respect to income and to at least one expenditure alternative, otherwise, through expenditure the uninformed spouse could infer the presence of additional resources. The public good allocation, however, is perfectly observable by both spouses. In the second stage, each household member makes his consumption choices conditional on the amount of the transfer member \( f \) revealed. The idea of the model is to mimic monetary transfers that are independent of household members’ labor market decisions, such as gifts, bonuses, or government transfers.

Both family members have preferences over consumption of one private (or personal) good, denoted \( x_i \), and one household public good, \( Q \). I assume that both family members face the same price for private goods which is normalized to 1 (one can think about the private good as being money for discretionary expenditure), and \( p \) is the price for the public good (\( Q \)). It is also assumed that utility is separable in \( x \) and \( Q \):

\[
U_i = U(Q, x_i) = u_i(x_i) + v_i(Q) \quad \text{for } i = f, m
\]  

(1)
The functions \( u(\cdot) \) and \( v(\cdot) \) satisfy the standard assumptions that \( u' > 0 \), \( v' > 0 \), \( u'' < 0 \), \( v'' < 0 \), and \( u'(0) = \infty \), \( v'(0) = \infty \), implying \( x_i \) and \( Q \) are normal goods. I allow each spouse to have different preferences over private and public goods. The household public goods are assumed to be non-rival in utility, so they are of the Samuelson type. For instance, a clean house provides utility to both members of the household, while food provides utility only to the person that consumed it. In what follows I illustrate the incentives to hide through three models that differ on the contract between spouses regarding the resource allocation mechanism, and show the conditions under which it is optimal for one spouse to hide a monetary transfer from the other.

2.1 Independent Resource Management Household

A voluntary contributions model based on Lechene and Preston (2005) is used to illustrate case where no spouse has access to all household resources, which in the sociology literature would be considered an independent resource management system. In this game each spouse decides separately how to allocate her resources between the household public good and private consumption, taking the other’s contribution as given. The benchmark case where there is perfect information is solved first. The optimization problem of spouse \( i \) is to maximize the objective function, which is of Cobb-Douglas form, subject to her own budget constraint and taking \( j \)'s household good contribution, \( Q_j \), as given.

\[
\max_{Q_m \geq 0} U_m(q, x_m) = \alpha_m \log(x_m) + (1 - \alpha_m) \log(Q_f + Q_m) \quad \text{s.t.} \quad x_m = Y_m - pQ_m
\]  

\[
(2)
\]

\[
\max_{Q_f \geq 0} U_j(q, x_j) = \alpha_f \log(x_j) + (1 - \alpha_f) \log(Q_f + Q_m) \quad \text{s.t.} \quad x_j = Y_f + T - pQ_f
\]  

\[
(3)
\]
Because the problem is symmetric, solving the problem for each spouse yields the following reaction functions:

\[ Q_i(Q_j) = \left[ \frac{(1-\alpha_i)Y_i - \alpha_i p Q_j}{p} \right] \quad \text{for } i=f, m=j \]  

(4)

The equilibrium is given by:

\[ Q_f^{C^*} = \left[ \frac{(1-\alpha_f)Y_f + T - \alpha_f (1-\alpha_m)Y_m}{(1-\alpha_f \alpha_m)p} \right], \quad Q_m^{C^*} = \left[ \frac{(1-\alpha_m)Y_m - \alpha_m(1-\alpha_f)(Y_f + T)}{(1-\alpha_f \alpha_m)p} \right]. \]  

(5)

A corner solution where free riding \(^2\) occurs is feasible when \((1 - \alpha_f)(Y_f + T) < \alpha_f(1 - \alpha_m)Y_m\) for \(f\), and when \((1 - \alpha_m)Y_m < \alpha_m(1 - \alpha_f)(Y_f + T)\) for \(m\). Definition 1 specifies the conditions that must be met for an interior solution to exist.

**Definition 1**: Given \(Y_m\), there exists a \(\bar{Y}_f = \frac{\alpha_f(1-\alpha_m)Y_m}{(1-\alpha_f)}\) such that if \(Y_f + T \leq \bar{Y}_f\) the Nash equilibrium is a corner solution with \(Q_f = 0\); given \(Y_f\), there exists a \(\bar{Y}_m = \frac{\alpha_m(1-\alpha_f)(Y_f + T)}{(1-\alpha_m)}\) such that if \(Y_m \leq \bar{Y}_m\) the Nash equilibrium is a corner solution with \(Q_m = 0\); and an interior solution exists with \(Q_m, Q_f > 0\) when \(Y_f > \bar{Y}_f\) and \(Y_m > \bar{Y}_m\).

The interior equilibrium is non-cooperative in the sense that no binding agreements are made, but it is self-enforcing as it is each spouse’s best response to make strictly positive contributions if the conditions \(Y_f > \bar{Y}_f\) and \(Y_m > \bar{Y}_m\) are met. This conditions imply that spouses incomes are similar, which aligns with evidence indicating that an independent management system is usually found among upper-middle class couples, with similar levels of education, where both spouses

\(^2\) Browning, et al. (2008) show that for multiple public goods, at most both household members will contribute to one, and for the rest they will specialize in the provision based upon relative preferences towards the public goods. They show that when household members specialize, which is equivalent to the separate spheres case, these outcomes can be used as the non-cooperative threat points to the bargaining game. This is possible because unless both players make strictly positive contributions to all public goods, there is free-riding and so outcomes are inefficient, thus there can be gains from bargaining.
work (Vogler and Pahl, (1994)). Definition 2 states the properties of the equilibrium allocations with respect to changes in each spouses’ income for all three cases.

**Definition 2:** Comparative statics when all income sources are known are as follows:

**Case (i):** If \( Y_m \in \left[0, \frac{\alpha_m(1-\alpha_f)(Y_f+T)}{(1-\alpha_m)}\right] \) then \( Q_m^{VC^*} = 0, \ x_m^{VC^*} = Y_m, \ x_f^{VC^*} = \alpha_f Y_f, \ Q_f^{VC^*} = \frac{(1-\alpha_f)Y_f}{p}. \)

Thus, An increase in \( Y_f \) or \( T \) results in \( \frac{\partial x_f}{\partial y_f} = \frac{\partial x_f}{\partial T} > 0; \frac{\partial Q_f}{\partial y_f} = \frac{\partial Q_f}{\partial T} > 0; \frac{\partial x_m}{\partial y_f} = \frac{\partial x_m}{\partial T} = 0, \) while an increase in \( Y_m \) results in \( \frac{\partial x_m}{\partial y_m} > 0; \frac{\partial Q_m}{\partial y_m} > 0; \frac{\partial Q_f}{\partial y_m} = \frac{\partial x_f}{\partial y_m} = 0. \)

**Case (ii):** If \( Y_f + T \in \left[0, \frac{\alpha_f(1-\alpha_m)Y_m}{(1-\alpha_f)}\right], \) then \( Q_f^{VC^*} = 0, \ x_f^{PC^*} = Y_f, \ x_m^{VC^*} = \alpha_m Y_m, \ Q_m^{VC^*} = \frac{(1-\alpha_m)Y_m}{p}. \) Thus an increase in \( Y_f \) or \( T \) results in \( \frac{\partial x_f}{\partial y_f} = \frac{\partial x_f}{\partial T} > 0; \frac{\partial Q_f}{\partial y_f} = \frac{\partial Q_f}{\partial T} > 0; \frac{\partial x_m}{\partial y_f} = \frac{\partial x_m}{\partial T} = 0, \) while an increase in \( Y_m \) results in \( \frac{\partial x_m}{\partial y_m} > 0; \frac{\partial Q_m}{\partial y_m} > 0; \frac{\partial Q_f}{\partial y_m} = \frac{\partial x_f}{\partial y_m} = 0. \)

**Case (iii):** In an interiors equilibrium, if \( Y_f + T > \frac{\alpha_f(1-\alpha_m)Y_m}{(1-\alpha_f)} \) and \( Y_m > \frac{\alpha_m(1-\alpha_f)(Y_f+T)}{(1-\alpha_m)}. \) Thus \( Q_m, Q_f > 0, \) an increase in \( Y_f \) or \( T \) results in \( \frac{\partial x_f}{\partial y_f} = \frac{\partial x_f}{\partial T} > 0; \frac{\partial Q_f}{\partial y_f} = \frac{\partial Q_f}{\partial T} > 0; \frac{\partial x_m}{\partial y_f} = \frac{\partial x_m}{\partial T} < 0; \frac{\partial x_m}{\partial y_f} = \frac{\partial x_m}{\partial T} > 0, \) while an increase in \( Y_m \) results in \( \frac{\partial x_f}{\partial y_m} > 0; \frac{\partial Q_f}{\partial y_m} < 0; \frac{\partial Q_m}{\partial y_m} > 0; \frac{\partial x_m}{\partial y_m} > 0. \)

If spouse \( m \) is the sole provider of the public good, an increase in \( f \)'s resources will only impact \( f \)'s private consumption. If spouse \( f \) is the sole provider of the household public good, an increase in \( f \)'s income doesn’t impact \( m \)'s private or public good consumption. In either case, changes in \( Y_f \) have no impact on \( m \)'s allocations. When both spouses are making positive contributions an increase \( f \)'s income increases both \( f \) and \( m \)'s private consumption, and \( f \)'s contribution to the public good, but \( m \)'s contribution decreases. This is the source of the incentives to hide income.
Thus $f$, can be made better off by hiding because it prevents $m$ from reducing his contribution towards the public good, such that she can maintain the same household good consumption, in addition to the possibility of increasing her private consumption.

Now consider the case when $f$ receives a transfer ($T$) that is observable to household member $m$ with probability zero. Spouse $f$ then has to decide whether to allocate the monetary transfer ($T$) between private and household good consumption, thus directly or indirectly informing $m$ about the increase in her resources, or to hide it and spend it all on private consumption. If they are at a corner solution and the transfer does not increase $f$’s income enough to move to an interior solution, then there is no incentive to hide the transfer because a change in $Y_f$ only impacts $f$’s choices. However, the transfer can be such that $Y_f + \Delta Y_f > \bar{Y}_f$ in which case the free-riding equilibrium for Case (i) would turn into an interior equilibrium\(^3\). If they are at an interior equilibrium, an increase in $f$’s resources decreases $m$’s contribution towards the public good and so if the conditions described in Proposition 1 are met, in equilibrium $f$ will hide the transfer from $m$.

**Proposition 1:** Given $Y_f, Y_m$, when $Y_f + T > \bar{Y}_f$ and $Y_m > \bar{Y}_m$, there exists a threshold level of transfer $\bar{T} = \frac{a_f a_m}{(1-a_f a_m)} (Y_f + Y_m)$ such that for any $T < \bar{T}$ the Subgame Perfect Nash Equilibrium of the game is to hide the transfer.

Hiding occurs in equilibrium if the change in utility for every unit of $T$ of revealing the transfer is less than the change in utility of not revealing the transfer and allocating it to private

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\(^3\) Two more cases are possible that are not examined in this paper. The first is when the transfer is such that an interior solution becomes possible when it is revealed. The second arises when the transfer increases the wife’s resources enough to move them from an interior to a corner solution.
consumption. The decision to hide, however, depends on the size of the transfer: if the transfer is smaller than the proportion \( \frac{a_f a_m}{1 - a_f a_m} < 1 \) of joint household income, spouse \( f \) is better off hiding the transfer and allocating it to private consumption. This result is intuitive as once a large enough transfer is received, on the margin, the reduction in the contribution of the spouse towards the public good becomes irrelevant. Note that the transfer threshold level depends on relative preferences for private and public consumption between household members; the transfer threshold level increases as either \( f \)'s and/or \( m \)'s preference for private consumption increase relative to household good consumption. This is particularly interesting, because the decision to hide does not only depend on \( f \)'s relative preferences between private and public good consumption. If \( m \) prefers private consumption more, he would be more likely to reduce his contribution towards the public good as \( f \)'s resources increase, also strengthening the incentives to hide.

2.2 Housekeeping Allowance Resource Management Model

Now I model the case when there is gender specialization, such that the husband is in charge of providing an allowance to his wife, while the wife specializes in the provision of the public good. In the sociology literature this is known as the housekeeping allowance system. As in the Lundberg and Pollak (1993) separate spheres model, spouses make no binding commitments other than the housekeeping allowance \( t \) contracted prior to the realization of incomes of both spouses. After income is realized, the husband chooses a supplementary allowance he gives his wife \( s \), and the wife chooses the household good allocation \( Q \). The timing of the game is as follows: first, spouse \( f \) receives a monetary transfer \( T \) that is unobservable to spouse \( m \) and
chooses whether to reveal the transfer or to hide it. Then spouse $m$ chooses the supplementary allowance ($s$). Finally, spouse $f$ decides the public good provision conditional of both $T$ and $s$. The model is solved by backwards induction.

Consider the benchmark case where all sources of income are common knowledge. Spouse $f$ solves the following optimization problem,

$$\max_{Q \geq 0; x_f \geq 0} U_f = \alpha_f \log(x_f) + (1 - \alpha_f)\log(Q) \quad \text{s.t.} \quad x_f \leq Y_f + T + t + s - pQ \quad (6)$$

The First-Order condition for $Q$ is

$$\frac{(1-\alpha_f)(Y_f+T+t+s)}{p} \leq Q \quad (7)$$

As long as $Y_f + T + t + s > 0$, the household good allocation is strictly positive. The housekeeping allowance is the husband’s way to increase his household good consumption, but the correspondence is not one-to-one.

Taking spouse $f$’s first-order condition as given, spouse $m$ solves:

$$\max_{s \geq 0; x_m \geq 0} U_m = \alpha_m \log(x_m) + (1 - \alpha_m)\log(Q)$$

$$\quad \text{s.t.} \quad x_m \leq Y_m - t - s; Q \geq \frac{(1-\alpha_f)(Y_f+T+t+s)}{p} \quad (8)$$

The equilibrium supplementary allowance is:

$$(1 - \alpha_m)Y_m - \alpha_m(Y_f + T) - t \leq s \quad (9)$$

As in the independent management model, the properties of the corner solution equilibrium are different from the properties of the interior equilibrium; whether $m$ makes a supplementary allowance depends on how his income compares to $f$’s. It is obvious that if $(1 - \alpha_m)Y_m \leq \alpha_m(Y_f + T) + t$ the supplementary allowance is non-positive. This suggests that if $f$’s resources are large relative to $m$’s, then $m$ chooses not to supplement his allowance.
**Definition 3:** Given $Y_f, T, t$ and $Y_m$ there exists a $\overline{Y}_m = \frac{\alpha_m(Y_f+T)+t}{(1-\alpha_m)}$ such that if $Y_m \leq \overline{Y}_m$ the Subgame Perfect Nash equilibrium is a corner solution with $s = 0$ and $Q > 0$. When $Y_m > \overline{Y}_m$ there is an interior equilibrium where $s > 0$ and $Q > 0$.

Definition 4 states the properties of the equilibrium with respect to changes in income and provides the foundations as to why in a corner equilibrium there are no incentives to hide a monetary transfer from $m$.

**Definition 4:** The comparative statistics of the equilibria are as follows:

Case (i): If $Y_m \leq \frac{\alpha_m(Y_f+T)+t}{(1-\alpha_m)}$, $s = 0$, $Q = \frac{(1-\alpha_f)(Y_f+T+t)}{p}$, $x_f = \alpha_f(Y_f)$, $x_m = Y_m - t$, and an increase in $Y_f$ or $T$ results in $\frac{\partial x_f}{\partial Y_f} > 0$; $\frac{\partial Q}{\partial Y_f} > 0$; $\frac{\partial s}{\partial Y_f} = \frac{\partial x_m}{\partial Y_f} = \frac{\partial s}{\partial T} = \frac{\partial x_m}{\partial T} = 0$, while an increase in $Y_m$ results in $\frac{\partial x_m}{\partial Y_m} > 0$; $\frac{\partial s}{\partial Y_m} = \frac{\partial x_f}{\partial Y_m} = 0$.

Case (ii): If $Y_m > \frac{\alpha_m(Y_f+T)+t}{(1-\alpha_m)}$, $s = (1 - \alpha_m)Y_m \alpha_m(Y_f + T) - t$, $x_m = \alpha_m(Y_f + Y_m)$, $Q = \frac{(1-\alpha_f)(1-\alpha_m)}{p}(Y_f + Y_m)$, $x_f = \alpha_f(1 - \alpha_m)(Y_f + Y_m)$, and an increase in $Y_f$ or $T$ results in $\frac{\partial x_f}{\partial Y_f} > 0$; $\frac{\partial Q}{\partial Y_f} > 0$; $\frac{\partial x_m}{\partial Y_f} = \frac{\partial x_m}{\partial T} > 0$; $\frac{\partial s}{\partial Y_f} = \frac{\partial s}{\partial T} < 0$.

If spouse $m$ is not making a positive supplementary allowance, changes $f$’s resources have no impact on $m$’s allocations. Now consider the case when $f$ receives a transfer ($T$) that is observable to household member $m$ with probability zero. Spouse $f$ again has to decide whether to allocate the monetary transfer ($T$) between private and household good consumption. If the distribution of
income is such that \( Y_m \leq \frac{\alpha_m(Y_f+T)+t}{(1-\alpha_m)} \), then there is no incentive to hide the transfer because a change \( f \)'s income only impacts her own allocations\(^4\). When \( m \) chooses to supplement his allowance, an increase in \( f \)'s resources increases both \( f \) and \( m \)'s private consumption and the public good, though it decreases \( m \)'s supplementary transfer in the amount \(-\alpha_m\) per unit of transfer. This is the source of the incentive to hide income. If \( f \) reveals that her resources have increased, in order to increase her public good consumption, she will first have to compensate the reduction in spouse \( m \)'s housekeeping allowance, and then supplement her private and household good consumption. If she hides however, she can keep her household good consumption unchanged by preventing \( m \) from reducing his allowance, and increase her private consumption in the amount of the transfer.

Now consider the case when \( f \) receives a transfer (\( T \)) and has to decide whether to allocate \( T \) between private and household good consumption, or to hide it and spend it all on private consumption.

**Proposition 2:** Given \( Y_f, Y_m \) when \( Y_m > \frac{\alpha_m(Y_f+T)+t}{(1-\alpha_m)} \), there exists a threshold level of transfer \( \bar{T} = \frac{\alpha_f(1-\alpha_m)(Y_f+Y_m)}{(1-\alpha_f)} \) such that for any \( T < \bar{T} \) the Subgame Perfect Nash Equilibrium of the game is to hide the transfer.

As in the previous section, hiding is the equilibrium if the change in utility per unit change of transfer when hiding exceed the change in utility of revealing. The decision to hide depends not only on the relative change in marginal utility of private and public consumption for both

\(^4\) As in the independent management case, there exists another case that is not being examined in this paper, corresponding to when the transfer is such that, if revealed, it makes the interior equilibrium possible.
household members, but on the size of the transfer as well, such that small transfers will be hidden. The condition to hide in the independent management case depends on the size of the transfer as well, but the threshold level of transfer required to induce revelation is smaller in the independent management case. Thus hiding is more likely to occur in a housekeeping allowance resource management system, relative to households under independent management.

2.3 Collective Household Model

In this section, I describe the equilibrium allocations that result when spouses bargain over public and private consumption, which corresponds to the joint resource management system. In this type of household, both spouses have access to all of the household resources and are able to make binding commitments (contrasting with the previous two cases). The Browning and Chiappori (1998) collective household model is more general relative to other bargaining models that assume specific threat points and functional forms of the household welfare function. In this version of the collective household model, everything but the monetary transfer received by $f$ is common knowledge, such that the decision to hide can be thought of as the step prior to choosing to pool income every time new resources are available to each household member. I allow household members to have different preferences, bargain over all allocations, and assume they can negotiate binding agreements with zero transaction costs.

The collective equilibrium is solved in two stages. In the first stage, $f$ receives a monetary transfer $T$ and decides whether or not to reveal it. Given that this is a cooperative setting, revelation in this case is equivalent to pooling. In the second stage, $f$ and $m$ bargain over the public good allocation and the share of the remaining resources that each will get for their private
consumption. These resources are divided according to a sharing rule that depends on each spouse’s bargaining power. In the second stage, the objective function of the collective household is the bargaining power weighted sum of each member’s utility:

\[ C = \mu(Y_f, Y_m, I, z) U_f + \left(1 - \mu(Y_f, Y_m, I, z)\right) U_m \]  

(10)

Where \( \mu = \mu(Y_f, Y_m, I, z) \) is the bargaining power of spouse \( f \) and \( \left(1 - \mu(Y_f, Y_m, I, z)\right) \) is the bargaining power of spouse \( m \). This is the weight given to each spouse’s utility in the household welfare function when bargaining, and it is partially determined by each spouse’s income (which influences outside options), as well as distribution factors\(^5\) (\( z \)) such as resources originally brought into the marriage. The unobservable income only influences bargaining power when it is revealed, such that \( I = T \) if spouse \( f \) reveals, and \( I = 0 \) if she hides. I do not specify a functional form for \( \mu \) in order to avoid making further assumptions about the relative influence additional resources would have over other factors that contribute to determine bargaining power, but are unaffected by changes in the quantity of resources. Thus, the bargaining weight is used as a generic way to incorporate the existence of an outside option if spouses fail to reach a bargaining agreement (threat point). Consistent with both non-cooperative equilibria within marriage, as well as divorce threat points, income increases spouse \( f \)’s bargaining power.

On the benchmark case, with perfect information, the collective household’s problem is to maximize (10) subject to the aggregate budget constraint. In this case, the budget constraint includes the transfer and bargaining power responds to the revelation of resources. Given that households with joint resource management systems have already found a way to cooperate and

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5 Any variable that has an impact on the decision process but affects neither preferences nor budget constraints is termed a distribution factor. In theory, a large number of variables fit this description. Factors influencing divorce, either directly (for example, the legislation governing divorce settlements and alimony payments) or indirectly (for example, the probability of remarriage, which itself depends on the number of available potential mates – what Becker calls marriage market factors (Browning, Chiappori and Weiss, 2008).
negotiate binding contracts, I solve the collective model assuming that the participation constraints do not bind, i.e. assuming that both spouses are better off cooperating than under any threat point. This is not a strong assumption given that spouses are bargaining over all allocations, such that the public good provision will be efficient (when information is revealed).

\[ \max_{Q,x_f \geq 0} \tilde{\mu} \{ \alpha_f \log(x_f) + (1 - \alpha_f) \log(Q) \} + (1 - \tilde{\mu}) \{ \alpha_m \log(x_m) + (1 - \alpha_m) \log(Q) \} \quad \text{s.t. } x_m \leq Y - x_f - pQ \]

where \( \tilde{\mu} \) is the new level of bargaining power given \( T, \tilde{\mu} = \mu(T > 0), \mu = \mu(T = 0) \) and \( Y = Y_f + T + Y_m \). The first-order conditions are:

\[ \frac{\partial c}{\partial Q} = [\tilde{\mu} (1 - \alpha_f) + (1 - \tilde{\mu})(1 - \alpha_m)] [Y - x_f] - [\tilde{\mu} (1 - \alpha_f) + (1 - \tilde{\mu})] pQ \leq 0 \quad (11) \]

\[ \frac{\partial c}{\partial x_f} = \tilde{\mu} \alpha_f [Y - pQ] - [\tilde{\mu} \alpha_f - (1 - \tilde{\mu}) \alpha_m] x_f \leq 0 \]

The first order conditions imply that in this case, there are no corner solutions. Solving the system yields the optimal demands when the transfer is revealed.

\[ Q^{B*} = [\tilde{\mu} (1 - \alpha_f) + (1 - \tilde{\mu})(1 - \alpha_m)] \left[ \frac{Y_f + Y_m + T}{p} \right] \quad (12) \]

\[ x_f^{B*} = \tilde{\mu} \alpha_f [Y_f + Y_m + T] ; \quad x_m^{B*} = (1 - \tilde{\mu}) \alpha_m [Y_f + Y_m + T] \]

The optimal demands respond to changes in aggregate income (i.e. income pooling feature) and to changes in individual income through bargaining power. Definition 5 states the properties of the equilibrium in response to changes in income and bargaining power.

**Definition 3**: An increase in aggregate income (\( Y \)) increases public and private consumption for both household members, whereas an increase in \( f \)'s bargaining power (\( \mu \)) increases her private consumption, decreases \( m \)'s private consumption, and can either increase or decrease public good consumption.
Definition 5 implies that if \( f \) receives a monetary transfer (\( T \)) she faces a trade-off between increasing her bargaining power and increasing her discretionary spending. If she hides the transfer, \( f \) may spend the entire amount without influence from her spouse. But, public goods are observable by both spouses. Therefore, if the wife is to successfully hide her additional income, she can spend it only on private consumption, which is unobservable. Conversely, if she reveals the transfer, the wife can increase her influence over intra-household allocation decisions, but her income will effectively be taxed via the bargaining process.

**Proposition 3:** Given \( Y_f, T \) and \( Y_m \), there exists a strictly positive threshold change in bargaining power \( \Delta \mu \) such that for any \( \frac{\partial \mu}{\partial \tau} < \Delta \mu = \left[ \frac{\bar{\mu}(1-\alpha_f)+(1-\bar{\mu})(1-\alpha_m)}{\bar{\mu}(\alpha_m-\alpha_f)+(1-\alpha_m)\alpha_f} \right] \left[ \frac{\alpha_f(1-\bar{\mu})[Y_f+Y_m]-(1-\alpha_f)\tau}{\alpha_f(Y_f+Y_m)+\tau[Y_f+Y_m]} \right] \) income-hiding is the Subgame Perfect Nash Equilibrium.

**Corollary 1:** The threshold change in bargaining power, \( \Delta \mu \), is strictly positive iff \( T < \bar{T} = \frac{\alpha_f(1-\mu)[Y_f+Y_m]}{(1-\alpha_f)} \).

Proposition 3 implies that the decision to hide money when bargaining depends not only on the change in bargaining power but on the size of the transfer. Corollary 1 implies that as long as the transfer is small relative to aggregate income, there exists a strictly positive change in bargaining power that needs to be exceeded to induce revelation. This result is intuitive because if the transfer is small bargaining power is less likely to change enough to overcome the threshold. Therefore she is less likely to influence household allocations towards her preferences and spending the entire transfer in private consumption is optimal. When the transfer is large bargaining power will increase enough and the threshold becomes trivial.
Finally, we compare the threshold levels of transfer such that hiding is the equilibrium for the three different management systems described in the previous sections.

**Proposition 4:** Given $Y_f, T$ and $Y_m$, hiding is more likely in the housekeeping allowance contract, relative to both the independent management and joint management (collective) households. Hiding is more likely in the independent management contract relative to a collective household, as long as \( \frac{\alpha_m(1-\alpha_f)}{1-\alpha_f \alpha_m} > (1 - \mu) \).

So hiding is more likely to occur in the housekeeping allowance case, relative to both, an independent and a joint management household. As long as spouse $f$ has enough bargaining power, hiding is less likely when spouses are able to make binding agreements. However, if the wife’s bargaining power is low, hiding is more likely in a non-cooperative contract.

**3. Conclusions**

In this paper I illustrated the possibility of income-hiding between household members when one spouse has an information advantage regarding the quantity of resources available to the household. I show the conditions that must be met for income hiding to occur in equilibrium for three different household resource management contracts, and find that hiding of income depends on the distribution of control over resources within the household. In general, results indicate that income-hiding is more likely to occur in a household with a housekeeping allowance contract, relative to both, an independent management and a joint management.
A joint management household is the least likely to observe hiding as long as the spouse with the information advantage has relatively large bargaining power.

**Technical Appendix:**

**Proof of Proposition 1:**

Once spouse $f$ receives the transfer and if $Y_m \in \left[ \frac{\alpha_m(1-\alpha_f)Y_f}{1-\alpha_m}, \infty \right]$ and $Y_f + T \in \left[ \frac{\alpha_f(1-\alpha_m)Y_m}{1-\alpha_f}, \infty \right]$ then the optimal demands are given by:

$$Q_f^{VC^*} = \left[ \frac{(1-\alpha_f)(y_f + T) - \alpha_f(1-\alpha_m)Y_m}{(1-\alpha_f)\alpha_m p} \right], \quad X_f^{VC^*} = \left[ \frac{\alpha_f(1-\alpha_m)(Y_f + T + Y_m)}{(1-\alpha_f)\alpha_m} \right]$$

$$Q_m^{VC^*} = \left[ \frac{(1-\alpha_m)Y_m - \alpha_m(1-\alpha_f)(y_f + T)}{(1-\alpha_f)\alpha_m p} \right], \quad X_m^{VC^*} = \left[ \frac{\alpha_m(1-\alpha_f)(Y_f + T + Y_m)}{(1-\alpha_f)\alpha_m} \right]$$

If $f$ hides the transfer however, the demands are:

$$Q_f^{VCH^*} = \left[ \frac{(1-\alpha_f)(y_f) - \alpha_f(1-\alpha_m)Y_m}{(1-\alpha_f)\alpha_m p} \right], \quad X_f^{VCH^*} = \left[ \frac{\alpha_f(1-\alpha_m)(Y_f + Y_m)}{(1-\alpha_f)\alpha_m} \right] + T$$

$$Q_m^{VCH^*} = \left[ \frac{(1-\alpha_m)Y_m - \alpha_m(1-\alpha_f)(y_f)}{(1-\alpha_f)\alpha_m p} \right], \quad X_m^{VCH^*} = \left[ \frac{\alpha_m(1-\alpha_f)(Y_f + Y_m)}{(1-\alpha_f)\alpha_m} \right]$$

Spouse $f$ hides $T$ if the marginal utility per unit of transfer of hiding is greater than the marginal utility per unit of transfer of revealing:

$$\frac{\partial u_f}{\partial r} \bigg|_R = \frac{1}{y_f + T + Y_m} < \frac{\alpha_f(1-\alpha_f)\alpha_m}{\alpha_f(1-\alpha_m)(y_f + T + Y_m) + (1-\alpha_f)\alpha_m T} = \frac{\partial u_f}{\partial r} \bigg|_H$$

Simplifying yields the following condition,

$$\left( \frac{\alpha_f\alpha_m}{1-\alpha_f\alpha_m} \right) (Y_f + Y_m) > T$$

**Proof of Proposition 2:**

If $f$ reveals $T$ the equilibrium allocations are:

$$s = (1-\alpha_m)Y_m - \alpha_m(Y_f + T) - t, \quad x_m = \alpha_m(Y_f + Y_m + T),$$

$$Q = \left[ \frac{(1-\alpha_f)(1-\alpha_m)}{p} (y_f + Y_m + T) \right], \quad x_f = \alpha_f(1-\alpha_m)(y_f + Y_m + T).$$

If $f$ hides $T$:

$$s = (1-\alpha_m)Y_m - \alpha_m(y_f), \quad x_m = \alpha_m(Y_f + Y_m),$$

$$Q = \left[ \frac{(1-\alpha_f)(1-\alpha_m)}{p} (y_f + Y_m) \right], \quad x_f = \alpha_f(1-\alpha_m)(y_f + Y_m) + T.$$
\[
\frac{\partial u_f}{\partial T} \bigg|_R = \frac{1}{Y_f + T + Y_m} < \frac{\alpha_f}{\alpha_f(1 - \alpha_m)(Y_f + T + Y_m)} = \frac{\partial u_f}{\partial T} \bigg|_{NR}
\]
Simplifying yields the threshold level of transfer needed to induce revelation:
\[
\frac{\alpha_f(1 - \alpha_m)(Y_f + Y_m)}{(1 - \alpha_f)} < T \quad \square
\]

**Proof of Proposition 3:**

If the transfer is revealed, the optimal allocations are:
\[
Q^{B*} = \left[ \bar{\mu}(1 - \alpha_f) + (1 - \bar{\mu})(1 - \alpha_m) \right] \frac{Y_f + Y_m + T}{p}
\]
\[
\bar{x}_f^{B*} = \bar{\mu} \alpha_f [Y_f + Y_m + T] \quad ; \quad \bar{x}_m^{B*} = (1 - \bar{\mu}) \alpha_m [Y_f + Y_m + T]
\]
If the transfer is hidden, the optimal allocations are:
\[
Q^{B^H*} = \left[ \mu(1 - \alpha_f) + (1 - \mu)(1 - \alpha_m) \right] \frac{Y_f + Y_m}{p}
\]
\[
\bar{x}_f^{B^H*} = \mu \alpha_f [Y_f + Y_m + T] \quad ; \quad \bar{x}_m^{B^H*} = (1 - \mu) \alpha_m [Y_f + Y_m]
\]

Spouse \( f \) hides iff
\[
\frac{\partial u_f}{\partial f} \bigg|_R = \frac{\partial u_f}{\partial f} \bigg|_{H}
\]
Solving for the threshold change in bargaining power:
\[
\frac{\partial \mu}{\partial T} < \left[ \frac{\bar{\mu} \left[ \bar{\mu}(1 - \alpha_f) + (1 - \bar{\mu})(1 - \alpha_m) \right]}{\bar{\mu}(\alpha_m - \alpha_f) + (1 - \alpha_m) \alpha_f} \right] \left[ \frac{\alpha_f}{\mu \alpha_f(Y_f + Y_m + T)} - \frac{1}{Y_f + T + Y_m} \right]
\]
Simplifying
\[
\frac{\alpha_f}{\mu \alpha_f(Y_f + Y_m + T)} - \frac{1}{Y_f + T + Y_m} = \frac{\alpha_f(1 - \mu)(Y_f + Y_m) - (1 - \alpha_f)T}{\mu \alpha_f(Y_f + Y_m + T)(Y_f + T + Y_m)} > 0 \quad \text{iff} \quad \frac{\alpha_f(1 - \mu)(Y_f + Y_m)}{(1 - \alpha_f)} > T
\]
and
\[
\frac{\bar{\mu}(1 - \bar{\mu})(1 - \alpha_m)}{\bar{\mu}(\alpha_m - \alpha_f) + (1 - \alpha_m) \alpha_f} > 0 \quad \text{so the sign of the threshold is strictly positive as long as } T \text{ does not exceed the threshold.} \quad \square
\]

**Proof of Proposition 4:**

From Propositions 1 and 2, and Corollary 1 we know:
\[
\frac{\alpha_f \alpha_m[Y_f + Y_m]}{(1 - \alpha_f)} > \frac{\alpha_f \alpha_m[Y_f + Y_m]}{(1 - \alpha_f \alpha_m)} > \frac{\alpha_f(1 - \mu)[Y_f + Y_m]}{(1 - \alpha_f)} > T
\]
It is clear that \( \frac{\alpha_f \alpha_m[Y_f + Y_m]}{(1 - \alpha_f \alpha_m)} > \frac{\alpha_f(1 - \mu)[Y_f + Y_m]}{(1 - \alpha_f)} \) as long as \( \alpha_m(1 - \alpha_f) > (1 - \mu) \). Therefore, as long as bargaining power of \( f \) is large, hiding will be less likely in the collective household than in the independent management case. \( \square \)
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References


