Gender Roles and Intra-Household Allocation:

Identifying Differences in the Incentives to Hide Money Across Spouses in Ghana

Carolina Castilla

Department of Economics, Colgate University

ccastilla@colgate.edu

Thomas Walker

The World Bank

twalker@worldbank.org

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PRELIMINARY AND INCOMPLETE

Carolina Castilla[1] and Thomas Walker[2]

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Abstract:

We present a simple model of intra-household allocation between spouses to show that when there is asymmetric information over monetary transfers between spouses, the incentives to hide income depend on the role spouses play within the household. We test the model with data from a field experiment in Ghana and an in-depth household survey. Ghana is an interesting place to test this since men and women hold separate economies and spending patterns differ by gender. The model is specified in accordance to the marital contract in Ghana, such that intra-household transfers occur between spouses. In other settings, this threat point may seem of little interest because the redistribution of resources between spouses would have no effect on allocations. However, when household bargaining evidences gender roles and strictly positive transfers occur between spouses, there can be incentives to hide private resources, and these incentives differ depending on the role each spouse plays within the marital contract. Results indicate that hiding occurs and that it differs by gender. Husband's allocate private cash transfers to alcohol consumption and gifts to his social network, while the wife lends the money out which makes it difficult for the husband to have access to the money. When the cash transfer is public, both spouses increase their gifts to their social network. Further evidence suggests this could be due to social pressure to share.

Key words: incomplete information, income hiding, non-cooperative family bargaining.

JEL Classification: D13, D82, J12.

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To contact the corresponding author: *Email*: ccastilla@colgate.edu. *Postal Address*: Department of Economics. Colgate University. 13 Oak Drive, Hamilton, NY 13346.
[2] The World Bank.

1. Introduction

> "The family is the basic building block in the edifice of institutions that govern social and economic interactions. How the family allocates resources across its members has important implications both for individual outcomes such as health, education and occupation choice as well as for public policy on issues such as property rights and income transfers" (Mani, 2010).

Although an extensive literature dating back to Becker examines the dynamics of resource allocation within the family, fundamental questions about the family unit remain unresolved. Are family members, with repeated interaction over a long time, able to eliminate the frictions we observe in contracting? Do spouses actually have access to better information about each other's income? And if they don't, do they exploit their private information? If spouses choose to exploit their information advantages by concealing money from each other, this may have consequences for resource allocation and welfare. Within a cooperative marital contract, spouses must allocate resources away from goods that can easily be monitored, which can result in underinvestment in household public goods.

In a development setting, such behavior may contribute to an intergenerational poverty trap. Since child human capital investments, such as education and nutrition, are easily monitored, spouses who conceal income may spend less on such investments. This limits their children's productivity later in life (Duflo, 2001; Rosenzweig, 1990). It might also have consequences for the strength of the observed relationship between female earnings and investment in children: women who conceal their income from their husbands may invest less in their children than those who do not.

The allocation of resources within the household has historically been viewed as either the result of a single household member (unitary or common preference model) or the result of a cooperative decision among the collective of household members (which model?). It is often argued that, because families involve long-term, repeated interactions and caring, households will realize there are opportunities for Pareto improvement and thus cooperation will evolve over time (see Browning et al., 2008, for a review of the literature on the subject). However, these opportunities may diminish if asymmetric information over money exists between spouses, that is, if it is the case that one spouse is able to conceal income without risk of detection. Recent empirical evidence has documented inefficient allocations (Udry, 1996) and non-cooperative behavior as a result of asymmetric information within the household (Chen (2009); de Laat (2009); Ashraf, (2009); Castilla (2011)).

Households living under the same roof can be subject to asymmetric information (Pahl (1983; 1990); Boozer et al. (2009); Bursztyn and Coffman, (2010); Castilla (2011)), and the literature on the response of household members to having informational advantages over own income is scarce. Ashraf (2009) conducted field experiments in the Philippines to examine the effect of the information environment on savings decisions among married couples. She finds that when husbands have private information over their own resources, they deposit the money into their private accounts. Because Ashraf's experiments end at the point when spouses choose to deposit the money in a certain account we cannot determine the effect of asymmetric information outside of the laboratory environment. Castilla (2011) finds that husbands hide farm income from their spouses in the form of gifts to extended family; however, the data used does not allow her to compare the likelihood of hiding when wives have information advantages.

In this paper we expand upon the findings of Castilla (2011) to examine the effect of asymmetric information over money on expenditure. In order to do this, we use data from a field experiment in Southern Ghana in which subjects participated in a lottery. Half of the prizes were given out in public (in front of the entire village) and the remaining half were distributed in private. Husbands and wives had the same probability of winning a prize, which allows us to compare spouses' responses to prize-winning by gender. Further, using baseline data collected before the experiments were conducted, and follow-up data collected afterwards, we can test the effect of asymmetric information on actual household expenditure[3].

Southern Ghana is an ideal setting for analyzing intrahousehold resource allocation because of the extent to which the standard marital contract deviates from the commonly assumed unitary model. In Ghanaian households men and women maintain separate economies, such that no spouse has control over all of the household's resources, and spending patterns differ by gender (Goldstein, 2004). Nonetheless, it is common for spouses to exchange resources formally through intra-household transfers called "chop money" (usually flowing from husband to wife), as well as irregular gifts and loans. It seems then that either the intra-household allocation of resources is non-cooperative (each spouse controls his/her own resources), or that the fall-back alternative when household members cannot reach a bargaining agreement (the threat point) corresponds to a non-cooperative equilibrium within marriage where the husband makes positive transfers to his wife. In the unitary model, or in a separate-spheres model where preferences are identical, transfers are of little interest because the redistribution of resources between spouses has no effect on consumption decisions. However, when household bargaining is non-cooperative, utility functions differ and there is asymmetric information, there can be

[3] We use data on individual spousal expenditure, as well as aggregate household expenditure on different items.

incentives to hide unobservable resources. These incentives differ depending on the role each spouse plays within the marital contract and on the patterns of intra-household transfers.

We present a simple model of intra-household allocation to show that when the quantity of resources available to the household is not perfectly observed by all household members, the incentives to hide income depend on the role spouses have within the resource management contract. We follow the assumption used in Lundberg and Pollak's (1993) separate spheres model that spouses do not commit to any binding agreements, and extend the framework in Castilla (2010). In Ghana, the marital contract obliges husbands to provide chop money to their wives to pay for food and household items (Ogbu, 1978). Wives, on the other hand, are allowed to choose how to spend the chop money. In equilibrium, the husband has no incentives to hide money because through his chop money allowance he can indirectly determine the household public good allocation. Conversely, when the wife has private information over her own money, she has an incentive to hide from her husband in order to keep him from reducing the chop money allowance. Two testable hypotheses fall out of the model: (1) hiding of money occurs when observable resources do not respond to changes in unobservable money, while unobservable resources do; (2) the spouse in charge of deciding the chop money allowance has no incentives to hide, while the spouse responsible for household public good provision does.

We test these predictions on the Ghanaian survey data, exploiting the fact that household income was experimentally and randomly perturbed using the lottery prizes. The model predicts that winning a prize will have differential effects on resource allocations depending on the gender of the winner, and the ease with which the prize is observed by his or her spouse. In line with the model's predictions, we find that when husbands win public prizes the additional income has no effect on chop money transfers, nor on observable household or private expenditures. However, husbands who win private cash prizes increase their expenditure on alcohol and gifts to others in their social network. In contrast, when wives win private cash prizes, they lend more to non-household members. The wife seems to use the fact that her social network does not know she received this additional money to invest in social capital, which also allows her to prevent the husband from accessing those additional resources. Winning a public prize increases the wife's gifts to her social network, indicating some degree of social pressure to share, particularly when the prize is cash. A wife's winning a private prize appears to have no effect on her observable expenditure, while winning a public prize increases her food expenditure. Interestingly, receiving a cash prize (by both husbands and wives) has a positive effect on food consumption out of own farms, independently of the ease by which the transfer is observed. This suggests that the value spouses get from consuming that food themselves is greater than what they would get in the market, and the additional liquidity allows them to make this substitution.

2. Intra-Household Decision-Making under Asymmetric Information

It is not the norm for men and women to pool resources in Ghanaian households (Chao, (1998); (Clark, 1999)). Women are often as economically active as men, and their income is neither a supplement, nor it is conceived as part of the family income (Vercruijsse et al., 1974). The responsibility for day-to-day maintenance of the family, however, seemed to be shared by both husbands and wives, while the majority maintains separate financial arrangements of spending, owning and saving (Oppong, 1974). Oppong observed that, as a result of the Akan matrilineal inheritance system, husbands and wives rarely own, manage or inherit property together.[4] She found that husbands were twice as likely to own property with their kin as with their wives, and only ten percent of households had joint accounts. Although these observations are dated, the 2009 survey data affirm that asset ownership and inheritance patterns remain distinctly separate between spouses. As observed by Duflo and Udry (2004) in Cote d'Ivoire, men and women tend to have separate income streams, often with a traditional gender-based division of responsibilities for different type of expenditures (Chao, 1998). Generally, men are expected to contribute either staple grains from their farms for household consumption, or "chop money" for food and pay for children's school fees (Chao, 1998). Women bear primary responsibility for childrearing, cooking, washing and collecting fuel, wood and water. Thus additional expenditures for children - such as clothes - are met by women, as are meal preparation and ingredients (Chao, 1998).

Reflecting the marital contract described above, we develop the following model. Consider a model with two family members, f and m, who each have preferences over consumption of a private (or personal) good, denoted x_i, $i \in \{f, m\}$, and one household public good, Q, whose quantity is chosen by f.[5] The household resource allocation decision is made in two stages. In the first stage household member m receives income, Y_m and household member f receives Y_f, which are both common knowledge to both spouses. Further, one spouse receives a lottery prize T which is not observed by the other household member. It is worth noting that household who receives the lottery prize can adjust effort, in which case his total income from all sources has the potential to remain constant.

[4] Most of the respondents were of Akan heritage, although a small number are immigrants with a different clan heritage which is not matrilineal (e.g. the Ewe).

[5] Since some Ghanaians continue to practice polygamy, there are a small number of households with more than one wife. We exclude these households from the sample as the intra-household resource management contract in this case is considerably different.

The prize winner household member has to decide whether to reveal the unobserved income to his/her spouse or to keep it for private consumption. For simplicity T is assumed to be observable with probability zero and it is also assumed that *the uninformed spouse* cannot observe *the informed spouse* private consumption choices, nor does she invest in monitoring income[6], though *the uninformed spouse* can perfectly infer the presence of additional income through the public good allocation, which is perfectly observable. In the second stage, each household member makes his consumption choices conditional on the amount of the lottery prize that is revealed. The family decision-making process is solved by backwards induction. First, the consumption choices conditional on the amount of resources that become known are described, and then the circumstances under which it is optimal for *m* or *f* to hide income are determined.

Both family members face the same price for private goods which is normalized to 1 (one can think about the private good as discretionary expenditure), and p is the price of the public good. If both household members pool their income, the joint budget constraint is:

$$x_f + x_m + pQ = Y_f + Y_m + T \qquad (1)$$

If each member decides to allocate the income at his/her disposal separately between private and household public goods, their individual budget constraints are:

$$x_i + pQ_i = Y_i + T_i \qquad \textit{for } i = f,m \qquad (2)$$

where $T_i > 0$ for the lottery winner spouse, and $T_i = 0$ for the other spouse. Preferences over own consumption are represented by a money metric egotistic utility function, U_i. Utility depends on the aggregate level of consumption of household public goods, Q, and private goods, x_i, and is assumed to be separable in both:

[6] This assumption is not trivial, but it can be justified given that in the field experiment care was taken to guarantee that in one of the treatments whether the spouse had won the lottery was kept private both from his spouse and from the rest of the village. The model can be extended to incorporate both, time allocation decisions and a cost of monitoring.

$$U_i = U(Q, x_i) = u(x_i) + v(Q) \qquad for\ i = f,m \tag{3}$$

The functions $u(\cdot)$ and $v(\cdot)$ satisfy the standard Inada conditions: $u' > 0$, $v' > 0$, $u'' < 0$, $v'' < 0$. Both spouses have the same functional form for simplicity. The characterization of goods as public or private depends on the nature of the good. 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 clothing provides utility only to the person who consumes it.

Separate Spheres Bargaining in Ghanaian Households

As mentioned earlier, in Ghanaian households men and women hold separate economies, such that no spouse has access to all of the household's resources, and spending patterns differ by gender[7]. Nonetheless, it is generally the case, and so it is observed in the data, for intra-household transfers to occur in the form of "chop money" (Udry and Goldstein, 1998), loans and farm produce, particularly from husbands to wives. It seems plausible to consider the possibility then that either the intra-household allocation of resources is non-cooperative (each spouse controls his/her own resources)[8]. In the unitary model, or in a separate-spheres model where preferences are identical, transfers are of little interest because the redistribution of resources between spouses has no effect on consumption decisions. However, when household bargaining is non-cooperative and strictly positive transfers occur between spouses, there can be incentives to hide unobservable resources.

[7] This does not conflict with the assumption on the same functional form of the utility function as each spouse can spend money on different private items.

[8] Or that the fall-back alternative when household members cannot reach a bargaining agreement (the threat point) corresponds to a non-cooperative equilibrium within marriage where the husband makes positive transfers to his wife

In this section, we examine the incentives to hide when household bargaining is non-cooperative; when there is gender specialization in the household, such that the husband is in charge of providing money, while the wife specializes in the provision of the public good. We draw from the Lundberg and Pollak (1993) separate spheres model. Consistent with observations of Ghanaian households, we assume that under the marital contract the husband must pay for children's school fees and provide chop money to his wife.[9] Thus, upon marriage the husband makes a binding commitment to pay for school fees (and these are assumed to be given). This assumption is not unrealistic given that the individuals in the sample live in very small villages and it is unlikely that they have many schooling choices. The chop money allowance, s, however, is chosen by the husband. The marital contract stipulates that he must provide for his wife (Ogbu, 1978), though it does not specify the amount. The wife, on the other hand, chooses the household public good allocation (Q). The public good can be thought of as child expenditures other than school fees, such as clothing and other schooling expenses, shared household goods, and common meals. We assume that spouses do not commit to any binding agreements regarding intra-household transfers and public goods expenditures. The non-cooperative game consists of 2 stages: in the first stage, one of the spouses has the opportunity to win a lottery. The lottery money (T) comes in the form of a cash transfer that may or may not be observable by the other spouse. In the second stage, the husband chooses the chop money allowance (s) he will give his wife (f) first; and then the wife decides the public good provision conditional on both T and s.

[9] Among the Akan, the wife can divorce in the case lack of economic support by her husband (Ogbu, 1978). Husbands are also expected to pay for school fees (Chao, 1998).

Separate Spheres Bargaining in Ghanaian Households: Husband wins Private Lottery Prize

We first consider the case when the husband (*m*) receives his regular income (Y_m) and also wins the lottery prize (T). In this stage, if the lottery prize is unobserved, the husband chooses whether to reveal the cash transfer (T) or to hide it (it is observed, then this stage is trivial). In the second stage, the non-cooperative bargaining game consists of two stages. First, he chooses the chop money allowance (s) he will give his wife (*f*); and then the wife decides the public good provision, Q, conditional on both T and s. The model is solved by backwards induction. In the benchmark case, i.e. when T is observed (or revealed), the wife (*f*) solves the following optimization problem,

$$\max_{Q\geq 0;\, x_f\geq 0} U_f = v(Q) + u(x_f) \quad s.t. \quad x_f \leq Y_f + s - pQ \tag{4}$$ [10]

Substituting in the budget constraint, the first-order condition for Q is

$$v'(Q) - pu'(Y_f + s - pQ) \leq 0 \tag{5}$$

Conducting comparative statics on the above condition yields,

$$\frac{\partial Q}{\partial s} = \frac{pu''(Y_f + s - pQ)}{v''(Q) + p^2 u''(Y_f + s - pQ)} > 0 \tag{6}$$

So, the chop money allowance is the husband's way to increase his household public good consumption, but the correspondence is not one-to-one because it depends on the wife's preferences. Note that, the public good allocation will be strictly positive, thus equation (5) holds with equality.

Taking spouse *f's* first-order condition as given, spouse *m* solves:

$$\max_{s\geq 0;\, x_m\geq 0; Q\geq 0} U_m = v(Q) + u(x_m)$$

[10] Technically, the utility function is given by: $U_i = v(Q,t) + u(x_i)$ but since the schooling fees (t) are assumed fixed, it does not affect the outcomes. One can also think about Y_m as being the husband's disposable income after paying for school fees.

$$s.t. \quad x_m \leq Y_m + T - s;\;\; v'(Q) - pu'\big(Y_f + s - pQ\big) = 0 \tag{7}$$

The Lagrangian is:

$$\mathcal{L} = v(Q) + u(Y_m + T - s) + \lambda\big[pu'\big(Y_f + s - pQ\big) - v'(Q)\big]$$

which yields the following Kuhn-Tucker first-order conditions,

$$\frac{\partial \mathcal{L}}{\partial Q} = v'(Q) - \lambda p^2 u''\big(Y_f + s - pQ\big) - \lambda v''(Q) \leq 0 \tag{8}$$

$$\frac{\partial \mathcal{L}}{\partial s} = -u'(Y_m + T - s) + \lambda p u''\big(Y_f + s - pQ\big) \leq 0 \tag{9}$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = pu'\big(Y_f + s - pQ\big) - v'(Q) = 0 \tag{10}$$

$$Q\left[\frac{\partial \mathcal{L}}{\partial Q}\right] = 0,\, s\left[\frac{\partial \mathcal{L}}{\partial s}\right] = 0;\, \lambda\left[\frac{\partial \mathcal{L}}{\partial \lambda}\right] = 0;\, Q \geq 0;\, s \geq 0$$

Solving the system of first-order conditions simultaneously yields the Subgame Perfect Nash equilibrium. There is a corner solution where the chop money allowance can be zero, as well as an interior solution. Proposition 1 specifies the conditions that must be met for an equilibrium with a strictly positive chop money allowance to exist.

Proposition 1: *Given $Y_m + T$, there exists a $\overline{Y_m}$ in the interval $\big(0, Y_f\big)$ such that if $Y_m + T \leq \overline{Y_m}$ a corner solution with $s = 0$ and $Q > 0$ is possible.*

Following Proposition 1, if $Y_m + T \leq \overline{Y_m} \in \big(0, Y_f\big)$, it is optimal for *m* to give a zero chop money allowance to *f*. Proposition 2 states the properties of the equilibrium with respect to changes of income for both cases, and provides the foundations as to why when household bargaining is non-cooperative there are no incentives for the husband to hide income.

Proposition 2: *When spouses behave non-cooperatively and all income is revealed:*

Case (i) If $Y_m + T \leq \overline{Y_m} \in (0, Y_f)$, $s = 0$ *and* $Q > 0$, *then an increase in* Y_f *results in* $\frac{\partial x_f}{\partial Y_f} > 0$; $\frac{\partial Q}{\partial Y_f} > 0$; $\frac{\partial s}{\partial Y_f} = \frac{\partial x_m}{\partial Y_f} = 0$, *while an increase in* Y_m *or* T *results in* $\frac{\partial x_m}{\partial Y_m} = \frac{\partial x_m}{\partial T} > 0$; $\frac{\partial s}{\partial Y_m} = \frac{\partial s}{\partial T} = 0$; $\frac{\partial Q}{\partial Y_m} = \frac{\partial Q}{\partial T} = \frac{\partial x_f}{\partial Y_m} = \frac{\partial x_f}{\partial T} = 0$.

Case (ii) If $Y_m + T > \overline{Y_m}$, $s, Q > 0$, *then an increase in* Y_f *results in* $\frac{\partial x_f}{\partial Y_f} > 0$; $\frac{\partial Q}{\partial Y_f} > 0$; $\frac{\partial x_m}{\partial Y_f} > 0$; $\frac{\partial s}{\partial Y_f} < 0$ *while an increase in* Y_m *or* T *results in* $\frac{\partial x_m}{\partial Y_m} = \frac{\partial x_m}{\partial T} > 0$; $\frac{\partial s}{\partial Y_m} = \frac{\partial s}{\partial T} > 0$; $\frac{\partial Q}{\partial Y_m} = \frac{\partial Q}{\partial T} > 0$; $\frac{\partial x_f}{\partial Y_m} = \frac{\partial x_f}{\partial T} > 0$.

If spouse *m* is not giving a positive housekeeping allowance to *f* (Case (i)), changes in husband's resources have no impact on *f's* allocations inframarginally. Now consider the case when *m* receives income that is unobservable to household member *f*. If the distribution of income is such that $Y_m + T \leq \overline{Y_m} \in (0, Y_f)$, hiding is indistinguishable from non-cooperative behavior under perfect information because in both cases a change in *m's* resources only impacts *m's* allocations[11]. This is intuitive because when all sources of cooperation and interaction fail between household members, the information asymmetries become irrelevant.

When $Y_m + T > \overline{Y_m}$, it is *m*'s best response to give a strictly positive chop money allowance to *f* in order to increase his household good consumption. In this case, an increase in *m's* resources increases his discretionary expenditure and his chop money allowance, and therefore the provision of the public good. However, it also increases *f's* private consumption.

[11] There exists another case that is not being examined in this paper, corresponding to when *T* is such that, if revealed, it makes the interior equilibrium possible. In that case, comparisons cannot be made on the margin because the baseline utility is not the same across cases.

Thus in this case there could be incentives to hide income. To decide whether to reveal or to hide, m compares the utility per unit change of T in both cases.

Proposition 3: *Given Y_f and Y_m when $Y_m + T > \overline{Y_m}$, the Subgame Perfect Nash Equilibrium of the game is to always reveal.*

Propositions 2 and 3 imply that when household bargaining is non-cooperative, i.e. when they manage their resources independently, the husband does not hide income in equilibrium. When allocations default to separate spheres and no intra-household transfers occur, information asymmetries over household income are irrelevant. If strictly positive transfers occur between household members, the husband reveals his unobservable income, and first best can be attained. This contrasts with the case where the wife receives income that is unobservable to her husband, where hiding is the equilibrium if the unobservable income does not exceed a certain threshold.

Separate Spheres Bargaining in Ghanaian Households: Wife wins Private Lottery Prize

Now we consider the case when the wife receives the cash prize (T) that is unobservable to spouse m and chooses whether to reveal the transfer or to hide it; in the second stage, spouse m chooses the housekeeping allowance (s) he will give spouse f; and then, spouse f decides the public good provision conditional on both T and s.

In particular, spouse f solves the following optimization problem,

$$\max_{Q\geq 0;\, x_f\geq 0} U_f = v(Q) + u(x_f) \quad s.t. \quad x_f \leq Y_f + T + s - pQ \tag{11}$$

The first-order condition for Q is

$$v'(Q) - pu'\left(Y_f + T + s - pQ\right) \leq 0 \tag{12}$$

Conducting comparative statics on the above condition yields,

$$\frac{\partial Q}{\partial s} = \frac{pu''\left(Y_f+T+s-pQ\right)}{v''(Q)+p^2u''\left(Y_f+T+s-pQ\right)} > 0 \tag{13}$$

So, the housekeeping allowance is the husband's way to increase his household good consumption, but the correspondence is not one-to-one. Note that, the public good allocation will be strictly positive, thus equation (12) holds with equality.

Taking spouse *f's* first-order condition as given, spouse *m* solves:[12]

$\max_{s\geq 0;\, x_m\geq 0; Q\geq 0} U_m = v(Q) + u(x_m)$

$$s.t. \quad x_m \leq Y_m - s;\;\; v'(Q) - pu'\left(Y_f + T + s - pQ\right) = 0 \tag{14}$$

The Lagrangian is:

$$\mathcal{L} = v(Q) + u(Y_m - s) + \lambda\left[pu'\left(Y_f + T + s - pQ\right) - v'(Q)\right]$$

which yields the following Kuhn-Tucker first-order conditions,

$$\frac{\partial \mathcal{L}}{\partial Q} = v'(Q) - \lambda p^2 u''\left(Y_f + T + s - pQ\right) - \lambda v''(Q) \leq 0 \tag{15}$$

$$\frac{\partial \mathcal{L}}{\partial s} = -u'(Y_m - s) + \lambda pu''\left(Y_f + T + s - pQ\right) \leq 0 \tag{16}$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = pu'\left(Y_f + T + s - pQ\right) - v'(Q) = 0 \tag{17}$$

$$Q\left[\frac{\partial \mathcal{L}}{\partial Q}\right] = 0,\, s\left[\frac{\partial \mathcal{L}}{\partial s}\right] = 0;\, \lambda\left[\frac{\partial \mathcal{L}}{\partial \lambda}\right] = 0;\, Q \geq 0;\, s \geq 0$$

Solving the system of first-order conditions simultaneously yields the Subgame Perfect Nash equilibrium. There is a corner solution where the housekeeping allowance can be non-positive,

[12] This is equivalent to setting the optimization problem in the following way:

$\max_{s\geq 0;\, x_m\geq 0; Q\geq 0} U_m = v\left(Q(s)\right) + u(x_m)\; s.t. \quad x_m \leq Y_m - s;\;\; Q(s) \geq 0$

And then using equation (15) in the FOC to substitute for $\frac{\partial Q}{\partial s}$.

as well as an interior solution. Proposition 5 specifies the conditions that must be met for an interior solution to exist.

<u>Proposition 4</u>: *Given Y_f, there exists a $\overline{Y_m}$ in the interval $(0, Y_f)$ such that the Subgame Perfect Nash equilibrium is a corner solution with $s = 0$ and $Q > 0$ if $Y_m \leq \overline{Y_m}$.*

Following Proposition 4, if $Y_m \leq \overline{Y_m} \in (0, Y_f)$, it is optimal for *m* to give a zero chop money allowance to *f*. As shown by Lundberg and Pollak (1993), this yields an inefficient outcome that could be improved upon by bargaining. Proposition 5 states the properties of the equilibria with respect to changes in *f's* income.

<u>Proposition 5:</u>

Case (i): If $Y_m \leq \overline{Y_m} \in (0, Y_f)$ thus $s = 0$, an increase in Y_f or T results in $\frac{\partial x_f}{\partial Y_f} = \frac{\partial x_f}{\partial T} > 0$; $\frac{\partial Q_f}{\partial Y_f} = \frac{\partial Q_f}{\partial T} > 0$; $\frac{\partial s}{\partial Y_f} = \frac{\partial s}{\partial T} = \frac{\partial x_m}{\partial Y_f} = \frac{\partial x_m}{\partial T} = 0$, *while an increase in Y_m results in* $\frac{\partial x_m}{\partial Y_m} > 0$; $\frac{\partial s}{\partial Y_m} = 0$; $\frac{\partial Q}{\partial Y_m} = \frac{\partial x_f}{\partial Y_m} = 0$.

Case (ii): If $Y_m > \overline{Y_m}$.thus $s, Q > 0$, an increase in Y_f or T results in $\frac{\partial x_f}{\partial Y_f} = \frac{\partial x_f}{\partial T} > 0$; $\frac{\partial Q_f}{\partial Y_f} = \frac{\partial Q_f}{\partial T} > 0$; $\frac{\partial x_m}{\partial Y_f} = \frac{\partial x_m}{\partial T} > 0$; $\frac{\partial s}{\partial Y_f} = \frac{\partial s}{\partial T} < 0$, *while an increase in Y_m results in* $\frac{\partial x_f}{\partial Y_m} > 0$; $\frac{\partial Q_f}{\partial Y_m} > 0$; $\frac{\partial x_m}{\partial Y_m} > 0$; $\frac{\partial s}{\partial Y_m} > 0$.

If spouse *m* is not making a positive chop money allowance to *f*, changes in Y_f have no impact on *m's* allocations. Now consider the case when *f* receives a transfer (*T*) that is unobservable to household member *m*. Spouse *f* then has to decide whether to allocate the monetary transfer (*T*) between private and household public 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 the distribution of income is such that $Y_m \leq \overline{Y_m} \in (0, Y_f)$, then there is no incentive to hide the transfer because a change in Y_f only impacts *f's* allocations.[13]

When *m* gives a strictly positive housekeeping allowance to his wife, an increase in Y_f increases both *f* and *m's* private consumption and *f's* contribution to the public good, though it is likely to decrease *m's* supplementary 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 public good consumption, or to hide it and spend it all on private consumption. If the conditions described in Proposition 6 are met, *f* will hide the transfer from *m*.

Proposition 6: *Given Y_f, Y_m when $Y_m > \overline{Y_m}$, there exists a threshold level of transfer ($\bar{T}$) such that for any $T < \bar{T}$ the Subgame Perfect Nash Equilibrium of the game is to hide the transfer.*

[13] 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.

As before, if the change in utility per unit change in the transfer is higher when f hides the transfer compared to when she reveals it, income-hiding is an equilibrium. The decision to hide depends not only on the relative change in marginal utility of private and public consumption for both household members, but on the size of the transfer as well, such that small transfers will be hidden. So far, we have shown that when spouses have independent accounts or when there is gender specialization, there is a threshold level of transfer such that income hiding is an equilibrium.

<u>Testable Hypothesis 1</u>:

Case (1): When spouse f cannot observe T, if x_m is not observed by spouse f, and Q and x_f are perfectly observable by spouse f, hiding occurs if $\frac{\partial x_m}{\partial T} \neq 0$, and $\frac{\partial Q}{\partial T} = \frac{\partial x_f}{\partial T} = 0$ and $\frac{\partial x_m}{\partial Y_m} \neq 0, \frac{\partial Q}{\partial Y_m} \neq 0, \frac{\partial x_f}{\partial Y_m} \neq 0$.

Case (2): When spouse m cannot observe T, if x_f is not observed by spouse m, and Q and x_m are perfectly observable by spouse m, hiding occurs if $\frac{\partial x_f}{\partial T} \neq 0$, and $\frac{\partial Q}{\partial T} = \frac{\partial x_m}{\partial T} = 0$ and $\frac{\partial x_m}{\partial Y_m} \neq 0, \frac{\partial Q}{\partial Y_m} \neq 0, \frac{\partial x_f}{\partial Y_m} \neq 0$.

<u>Testable Hypothesis 2</u>:

Following Propositions 3 and 6, the spouse in charge of deciding the chop money allowance, the husband in this case, has no incentives to hide when he has an information advantage. However, the wife (who is responsible for the household public good provision) does. Therefore, we expect to find hiding if the wife's prize is small enough, and no hiding among husbands.

The hypotheses derived from the model are tested through a field experiment conducted among households in 4 villages in Ghana. We collected data on spousal and household expenditure over 6 rounds and implemented a lottery experiment where spouses had the opportunity to win a prize that was either announced in public or in private. The details on the experimental design are presented in Section 3.

3. Survey and Experimental Design

The field experiments were conducted between March and October 2009 in conjunction with a year-long household survey in four communities in Akwapim South district of Ghana's Eastern Region. This district lies some 40 miles north of the nation's capital, Accra. Further details on the survey are provided in Walker (2011). The sample consists of approximately 70 households from each of the four communities. Slightly more than half of these 70 households were part of the initial 1997-98 sample, and the rest were recruited in January 2009 using stratified random sampling.[14] In the original sample, and in the 2009 re-sampling, households were selected only if headed by a resident married couple.[15] In some households from the 1997-98 sample, only one of the spouses remained. These 'single-headed households' account for between 7 and 15 of the households in each community. Thus the sample of individuals included in the experiment was around 150 individuals in each of the four communities (Table 1).

[14] New sample members were selected randomly from the subset of households in the community headed by a married couple. The sample was stratified by age of the head into three categories: 18-29, 30-64 and 65+, so that the shares of households whose head was in each of these age categories corresponded to the community's population shares.

[15] Some men in the sample have two or three wives, all of whom were included.

Table 1. Sample summary

	Village				
	1	**2**	**3**	**4**	**Total**
Husbands	70	67	69	68	274
Wives	77	71	73	68	289
Single males	4	3	1	4	12
Single females	7	5	6	11	29
Total	158	146	149	151	604

Each respondent was interviewed five times during 2009, once every two months between February and November. Each survey round took approximately three weeks to complete, with the two survey teams each alternating between two villages. The survey covered a wide range of subjects including personal income, farming and non-farm business activities, gifts, transfers and loans, and household consumption expenditures. Each round, both the husband and wife in each household were interviewed separately on all of these topics. The expenditure module obtained detailed information on the quantities and values purchased of a long list of items. Referring to the week prior to the interview, each spouse was asked about his or her own expenditures, those of their partner, and about expenditures for the household as a whole. In the gifts and transfers module, respondents were asked to report any gifts (cash or kind) given and received during the past two months, obtaining information on the counterparty's location and relationship to the respondent, and the nature and value of the gift. The survey also included a detailed survey of respondents' in-sample social networks.

The first round of the survey was designed as a baseline, therefore no lottery took place in that round. One week before each subsequent round the survey team visited each village to distribute prizes to selected respondents. There were twenty prizes allocated in each community, in each of the four lottery rounds, so that in all 320 prizes were given. Over the four lotteries, approximately 42 per cent of individuals and 62 per cent of households won at least one prize. Ten of the prizes were allocated publicly by lottery, and the other ten (identical in type) were allocated in private, by lucky dip. The values of the prizes varied, as described in Table 2. The prizes were of a substantial size. During 2009, mean monthly per capita expenditure averaged around GH¢65.[16]

Table 2. List of prizes distributed in each lottery and lucky dip

Cash	**Livestock**
GH¢10	One broiler chicken, worth GH¢10
GH¢20	Two broiler chickens, worth GH¢10 each
GH¢35	Small goat, worth GH¢35
GH¢50	Medium goat, worth GH¢50
GH¢70	Large goat, worth GH¢70

Note: On average during 2009, one Ghana cedi (GH¢) was worth approximately 70 US cents. Mean per capita consumption averaged around GH¢65 per month in the study communities.

The livestock prizes were purchased by the survey team in Accra on the morning of the lottery, and transported to the community. The chickens were of a type intended for eating, and were chosen because their price was essentially fixed at GH¢10 throughout the year. The goats were bought individually by the team directly from traders at the main market near Accra. On the first visit, the size and quality of goats available was established for the three price points (GH¢35, GH¢50 and GH¢70). On every subsequent visit, the team endeavored to obtain goats of

[16] One Ghana cedi (GH¢) was worth about 70 US cents in mid 2009.

similar size and quality, subject to market price and supply fluctuations.[17] Female goats were obtained when possible because of their utility for breeding.

The lotteries and lucky dips took place one week before the commencement of the survey interviews. Great care was taken to make clear to participants that the allocation of prizes was random, and that each respondent had an equal chance of winning in each round. A village meeting was held in the community, and all respondents were invited to attend. A small amount of free food and drink was provided as an incentive to come. Attendance at the meetings was generally around 100 people; roughly half of the respondents appeared for each meeting.[18] There were usually a number of non-respondents at these meetings as well, including many children. At each gathering, the respondents were thanked for their continued participation in the survey. The team explained that respondents had a chance to win one of 20 prizes that day, framing the prizes as a gratuity for their participation in the survey.[19,20] Winners for the ten public prizes were then drawn (without replacement) from a bucket containing the names of the survey respondents. A village member not in the sample was chosen by the villagers to do the draw, so as to emphasize that the outcomes were random. Each winner was announced, and asked to come forward to receive their prize. The prizes were announced and displayed clearly before being awarded. Respondents who were absent at the time of drawing were called to pick up their prize in person, if possible. Spouses or close family members were allowed to receive the public livestock prizes

[17] There was little price movement in the goat market throughout the year, though the price of chickens slowly appreciated, rising perhaps 20 per cent over 2009. The additional cost of the broiler chickens was absorbed to maintain consistency of the prizes across rounds. The quality of goats varied slightly between rounds in line with supply and climatic conditions, but a concerted effort was made to keep the quality close to constant within rounds.
[18] Around 125 of the 150 respondents in each community appeared for the private lucky dip, some of them arriving before or after the public meeting.
[19] Respondents signed an informed consent form at the start of the survey, explaining how they would be remunerated for their participation in the survey.
[20] In addition to the chance of winning a prize, every respondent was given a small amount of cash at the time of interview as partial payment for their participation in the survey.

(but not cash prizes) on the winner's behalf. Unclaimed prizes were delivered in person to the winner after the lottery.[21]

After the lottery prizes were distributed, the lucky dip began. Respondents were asked to identify themselves to an enumerator, who took their thumbprint or signature and issued them with a ticket displaying their name and identification number. The respondents then waited to enter a closed school room, one at a time, where another enumerator invited them to draw a bottle cap without replacement from a bag. Care was taken to shuffle the bottle caps after each draw, and to prevent respondents from seeing into the bag. If a respondent inadvertently drew more than one bottle cap, those caps were shuffled and the respondent was asked to blindly select one of them. There was one bottle cap for each of the *n* respondents in the community. Of these, *n*-10 were non-winning tokens (red colored), and 10 were winning tokens, marked distinctively to indicate one of the ten prizes listed in Table 2.[22] Those who drew winning tokens were informed immediately that they had won a prize, which was identified to them, and were told that they did not have to tell anyone else that they had won. The survey team made clear that they would not divulge the identities of the lucky dip prize winners. Cash prizes were given to the winners immediately. Livestock prizes were delivered one or two days later to the winner in person, or to another household member if they were absent.[23,24] At the conclusion of the day, tokens which had not been drawn were counted and the remaining prizes allocated randomly

[21] We have data on these cases, including the dates on which the prizes were claimed and the identity of the recipient (if not the winner).
[22] Respondents were shown a sheet relating the tokens to the prizes; this sheet was used to explain what prize (if any) the respondent had won based on the token they drew.
[23] If anyone received the prize on behalf of the winner, the survey team made clear who the animal was intended for. In the follow-up survey, each winner was interviewed privately about their prize, and established that all of them ultimately received their prizes.
[24] Clearly, there was no way of keeping the livestock prizes completely secret. It should be assumed that members of the winner's household were all aware of those prizes. However, the delivery of the lucky dip livestock prizes was kept as low-key as possible. Thus there is a strong difference in publicity between the lottery and lucky dip prizes, at least with respect to non-household members.

among the non-attending respondents using a computer. There were usually 25-30 non-attendees and less than three prizes remaining.

All of the winners collected or received their prizes within one month of the lottery, and in all but one case at least a week before the household survey interview. The interviews commenced one week after the lottery, deliberately delayed to allow winners to receive their prize and do something with it. The interviews took place in no specified order throughout the following three weeks, so that some winners were interviewed a week after winning, and others up to four weeks after winning.[25] Table 3 contains a summary of the balance of treatment information. The only statistically significant difference ex ante between the treatment groups is for gifts received, and it seems to be driven by an outlier.

[25] We have data on the dates of the lotteries and interviews, but thus far have not looked at them for this analysis.

Table 3. Balance of treatment for key round 1 variables (by prize type)

Variable	Non-winners	Public prize	Private prize
Demographic characteristics			
Male	0.484	0.448	0.475
	(0.500)	(0.499)	(0.501)
Years schooling	7.259	7.731	7.240
	(3.977)	(4.002)	(4.266)
Num. adults	3.141	3.122	3.271
	(1.594)	(1.564)	(1.835)
Num. kids	1.882	1.748	1.812
	(1.438)	(1.361)	(1.372)
Age of HH head	45.254	45.336	46.624
	(13.416)	(14.433)	(14.16)
SN size	91.35	92.233	91.194
	(39.947)	(40.075)	(38.409)
Friends given gift	31.367	30.552	32.201
	(28.837)	(28.846)	(30.575)
Coinsured	0.510	0.433*	0.475
	(0.501)	(0.497)	(0.501)
Coinsured (HH)	0.691	0.679	0.712
	(0.463)	(0.469)	(0.454)
Relatively rich	0.427	0.425	0.468
	(0.495)	(0.496)	(0.501)
Relatively rich (household)	0.527	0.493	0.532
	(0.5)	(0.502)	(0.501)
Relatively rich (alt. measure)	0.854	0.873	0.914
	(0.694)	(0.73)	(0.717)
Rel. rich HH (alt. measure)	0.986	0.985	0.993
	(0.688)	(0.715)	(0.717)

Variable	Non-winners	Public prize	Private prize	Non-winners	Public prize	Private prize
	Ex-ante variables (round 1)			**Ex-post variables (rounds 2-5)**		
Total expenditure	627.383	581.35	674.495	466.776	493.796	490.208
	(504.752)	(370.986)	(622.185)	(299.674)	(339.05)	(296.547)
Food expenditure	327.468	319.637	352.763	269.305	275.505	281.168
	(209.303)	(174.126)	(246.492)	(135.914)	(154.165)	(135.977)
Other expenditure	136.671	128.144	131.296	103.699	107.832	117.552**
	(105.962)	(96.204)	(106.083)	(83.369)	(88.317)	(83.839)
Asset expenditure	14.442	26.062	28.344	5.643	5.481	4.114
	(89.491)	(147.932)	(153.018)	(24.508)	(21.229)	(14.501)
Abnormal exp.	148.802	107.506*	162.092	88.13	104.978	87.375
	(338.216)	(182.476)	(441.616)	(187.31)	(201.062)	(171.277)
Farm expenses	17.906	15.917	19.176	17.387	33.648***	28.477**
	(52.361)	(56.338)	(67.05)	(54.177)	(122.119)	(123.197)
Log liquid assets	5.331	5.482	5.451	4.735	4.795	4.943*
	(1.48)	(1.41)	(1.462)	(1.566)	(1.51)	(1.636)
Log illiquid assets	6.610	6.640	6.618	6.749	6.770	6.803
	(0.986)	(0.904)	(1.047)	(0.778)	(0.675)	(0.816)
Gave transfer	0.507	0.560	0.46	0.381	0.44*	0.5***
	(0.501)	(0.498)	(0.5)	(0.486)	(0.498)	(0.502)
Amount given	16.438	14.451	28.027	9.336	7.898	10.63
	(36.648)	(24.224)	(131.189)	(23.798)	(16.676)	(28.373)
Received transfer	0.519	0.590*	0.532	0.462	0.520*	0.506
	(0.500)	(0.494)	(0.501)	(0.499)	(0.501)	(0.502)
Amount received	25.995	30.194	48.281***	23.082	19.360	28.966
	(42.709)	(46.301)	(123.214)	(52.548)	(28.139)	(60.313)
Gave transfer (within village)	0.350	0.328	0.302	0.271	0.327*	0.353**
	(0.478)	(0.471)	(0.461)	(0.445)	(0.471)	(0.479)
Amount given (within village)	9.382	5.175*	7.155	4.468	3.236	3.953
	(30.744)	(11.799)	(31.032)	(17.303)	(7.285)	(9.181)
Received transfer (within village)	0.246	0.306*	0.245	0.212	0.227	0.231
	(0.432)	(0.463)	(0.431)	(0.408)	(0.42)	(0.423)
Amount received (within village)	5.204	9.196**	24.132***	4.368	4.312	4.859
	(15.79)	(25.436)	(112.399)	(16.219)	(13.789)	(13.777)

4. Estimation and Empirical Results

The testable hypotheses in Section 2 indicate that hiding can be identified empirically if an unobservable cash prize has no effect on observable expenditure, while it has a significant effect on expenditure that is unobservable. In the experiment, we actually have random variation between private and public prizes, thus these hypotheses can be translated to match the experimental design as follows. Allow $x_{f,hr}^{g,Pr}$ to indicate expenditure on item g which is only observable to the wife (*f*), $x_{f,hr}^{g,Pu}$ to indicate expenditure on item g which is observable to both *f* and *m*; likewise for the husband, allow $x_{m,hr}^{g,Pr}$ to indicate expenditure on item g which is only observable to the husband (*m*), $x_{m,hr}^{g,Pu}$ to indicate expenditure on item g which is observable to both *f* and *m.* Then the hypotheses to be tested are:

<u>Testable Hypothesis 1</u>:

Case (1): Let T_{Pu} be the public prize and T_{Pr} be the private prize. If the wife wins a prize, $x_{m,hr}^{g,Pr}$ is not observed by spouse *f*, and $x_{m,hr}^{g,Pu}$, $x_{f,hr}^{g,Pr}$ and $x_{f,hr}^{g,Pu}$ are perfectly observable by spouse *f*, hiding occurs if $\frac{\partial x_{f,hr}^{g,Pr}}{\partial T_{Pu}} \neq 0$; $\frac{\partial x_{f,hr}^{g,Pu}}{\partial T_{Pu}} \neq 0$; $\frac{\partial x_{m,hr}^{g,Pu}}{\partial T_{Pu}} \neq 0$; $\frac{\partial x_{m,hr}^{g,Pr}}{\partial T_{Pu}} \neq 0$ and $\frac{\partial x_{f,hr}^{g,Pr}}{\partial T_{Pr}} = \frac{\partial x_{f,hr}^{g,Pu}}{\partial T_{Pr}} = \frac{\partial x_{m,hr}^{g,Pr}}{\partial T_{Pr}} = 0$; $\frac{\partial x_{f,hr}^{g,Pr}}{\partial T_{Pr}} \neq 0$.

Case (2): Let T_{Pu} be the public prize and T_{Pr} be the private prize. If the husband wins a prize, $x_{f,hr}^{g,Pr}$ is not observed by spouse *m*, and $x_{m,hr}^{g,Pu}$, $x_{m,hr}^{g,Pr}$ and $x_{f,hr}^{g,Pu}$ are perfectly observable by spouse m, hiding occurs if $\frac{\partial x_{f,hr}^{g,Pr}}{\partial T_{Pu}} \neq 0$; $\frac{\partial x_{f,hr}^{g,Pu}}{\partial T_{Pu}} \neq 0$; $\frac{\partial x_{m,hr}^{g,Pr}}{\partial T_{Pu}} \neq 0$; $\frac{\partial x_{m,hr}^{g,Pu}}{\partial T_{Pu}} \neq 0$ and $\frac{\partial x_{f,hr}^{g,Pr}}{\partial T_{Pr}} = \frac{\partial x_{f,hr}^{g,Pu}}{\partial T_{Pr}} = \frac{\partial x_{m,hr}^{g,Pu}}{\partial T_{Pr}} = 0$; $\frac{\partial x_{m,hr}^{g,Pr}}{\partial T_{Pr}} \neq 0$.

Testable Hypothesis 2:

We expect to find no differences in the effect of the husband winning a public or a private prize on the different expenditure categories, as he has no incentive to hide a private transfer. Conversely, we would expect to find an effect of winning a private prize on unobservable expenditures of the wife, while no differences in the expenditure patters when winning a public prize.

For both the husband and the wife, personal and clothing expenditures are considered, as well as the gifts granted to each social network, loans given and consumption of alcohol and/or tobacco which is only purchased by the husband. Clothing is easily observable, personal expenditure less so, while gifts, loans and alcohol consumption are harder to monitor. The gifts to each social network, as well as loans, are much harder to monitor because the money effectively leaves the household, and the recipients have an incentive to keep the gifts or loans private because otherwise, the giver would have to negotiate with his/her spouse over how the money is allocated. For household public goods we consider children schooling and clothing expenditures, as well as food and health spending and we assume these are observable to both spouses.

To test these hypotheses, we estimate reduced-form demand equations for expenditure on observable household goods such as children's clothing and schooling, household health, as well as goods attributable to either the husband or the wife. The wife's expenditures include clothing and personal items. We also consider expenditure in purchased food items and foods from own farms, which provide information about beliefs regarding availability of resources. The husband's expenditures include clothing, personal items and spending in alcohol and/or tobacco. Finally, we consider money allocated towards gifts to each spouses' social network and loans given and received. Because there exists the possibility of spending zero Cedis at any particular round on a given item, a Tobit fixed-effects model is used. The empirical specification is as follows.

$$x_{ihr}^{g,p} = \delta_1 TPr_{ir} + \delta_2 TPu_{ir} + \delta_3 Livestock_{ir} + \theta Y_h + \sum_{h=1}^{n} \alpha_n + \sum_{r=1}^{5} \sigma_r + \varepsilon_{ir}$$

Where $x_{ihr}^{g,p}$ is the expenditure in item g with degree of observability $p \in [Pr, Pu]$, by household member $i \in [f, m]$, in household h, in round r; $\sum_{h=1}^{n} \alpha_n$ corresponds to household fixed-effects; $\sum_{r=1}^{5} \sigma_r$ contains round fixed-effects; Y_h is household income; TPr_{ir} is an indicator variable of whether household member *i* received a private cash prize in round *r*; TPu_{ir} is an indicator variable of whether household member *i* received a public cash prize in round *r;* and $Livestock_{ir}$ is an indicator variable of whether household member *i* received a livestock prize in round r. Livestock prizes were given in public and private, however, they are easily observable to household members, thus we are not differencing these by degree of observability.

The results are presented in Table 4 for the effect of intent to treat effects of private and public cash prizes on household public goods which would be observable to both spouses, in Table 5 for the effect on attributable expenditures of each spouse, in Table 6 for the effect on gifts and loans, and finally in Table 7 for food expenditure. Expenditure on schooling, health and child clothing does not vary with cash prizes, independently of the ease with which these are observed. Health expenditure decreases when the wife wins a livestock prize. This could be due to increases of expenditure in food which is observed in Table 7.

Table 4. Treatment Effects of Asymmetric Information on Household Public Good Expenditure

	Total Schooling		Total Health		Total Child Clothing	
	Husband	Wife	Husband	Wife	Husband	Wife
Cash Prize Public	12.30	5.629	-0.433	3.894	-1.297	1.104
	(11.52)	(10.02)	(3.203)	(2.780)	(1.296)	(1.268)
Cash Prize Private	5.424	7.698	-0.874	1.108	2.046	0.170
	(11.18)	(10.02)	(2.944)	(2.589)	(1.278)	(1.272)
Livestock Prize	10.21	-10.54	0.768	-8.845**	1.123	-1.131
	(25.78)	(20.50)	(5.983)	(3.301)	(2.087)	(2.356)
HH Income	0.003	0.002	-0.000	-0.000	0.000	0.000
	(0.009)	(0.009)	(0.001)	(0.001)	(0.000)	(0.000)
N	1308	1308	1308	1308	1308	1308

The wife's expenditure in husband's clothing decreases when the wife wins a private prize, which indicates non-cooperative behavior as a result of asymmetric information. The wife's personal care expenditure increases when she wins a cash prize independently of the ease by which it is observed. This is a strong indicator of a feeling of entitlement and also that perhaps the husband does not monitor her personal expenses. One of the most interesting results are found when looking at the husband's alcohol and eating out expenditure. The husband's spending on alcohol increases when he wins a private prize. This result is robust to estimation strategy and the inclusion of controls. The livestock prize has no effect on attributable expenditure of either spouse.

Table 5. Treatment Effects of Asymmetric Information on Attributable Expenditure

	Husband's Attributable Expenditures					
	Adult Clothing		Personal Care		Alcohol/Eating Out	
	Husband	Wife	Husband	Wife	Husband	Wife
Cash Prize Public	0.268	1.337	-0.047	0.133	-1.622	-0.926
	(2.250)	(2.087)	(0.323)	(0.312)	(1.872)	(1.843)
Cash Prize Private	0.391	-4.443**	0.348	-0.068	3.136*	-0.262
	(2.279)	(2.116)	(0.305)	(0.316)	(1.786)	(1.829)
Livestock Prize	2.601	1.380	0.053	-0.198	2.462	-0.429
	(3.903)	(4.055)	(0.747)	(0.561)	(2.971)	(2.784)
	Wife's Attributable Expenditures					
	Adult Clothing		Personal Care			
	Husband	Wife	Husband	Wife		
Cash Prize Public	0.119	2.178	-0.673	0.736*		
	(1.527)	(1.579)	(0.441)	(0.379)		
Cash Prize Private	0.829	0.206	0.503	0.918**		
	(1.528)	(1.529)	(0.444)	(0.381)		
Livestock Prize	2.406	1.110	-0.755	-0.873		
	(3.282)	(2.634)	(0.847)	(0.626)		
N	1308	1308	1308	1308	1308	1308

There is evidence that spouses use money guards to conceal resources from each other to be able to make expenditures that they do not agree on, or in order to make transfers to their family (Collins et al., 2009). It also makes intuitive sense to allocate resources that are unobserved, if the spouse wishes to keep them private, in alternatives outside of the household as it makes monitoring more difficult. The husband's gifts to his social network increase when he receives a cash prize both when the cash prize is public or private. It would be of interest to disentangle the motives: whether when the prize is public the increase in gifts is due to social pressure to share, versus when prizes are private the gifts increase due to some other motive, hiding being one of them. In order examine this, we look at the wife's gifts. When a wife receives a public cash prize, gifts also increase, while gifts decrease when she receives a livestock prize. This provides some indication of social pressure. A livestock prize is less liquid than cash, and thus gifts increase when the prize is liquid and observable. The gifts received are not affected by whether either spouse received a prize, suggesting that perhaps gifts are not reciprocated. Interestingly, when the wife receives a private prize, the amount of money she lends out increases, with no significant change in the amount borrowed. As with the use of money guards, a compelling explanation for this finding is that wives want to put the money temporarily in a place where the husband cannot access it.

Table 6. Treatment Effects of Asymmetric Information on Gifts and Loans

	Gifts In		Gifts to Social Network		Money Lent	
	Husband	Wife	Husband	Wife	Husband	Wife
Cash Prize Public	-8.310	-2.292	6.906*	3.983**	-31.82	-2.132
	(12.75)	(3.946)	(3.961)	(1.677)	(27.95)	(9.512)
Cash Prize Private	-18.46	5.401	4.640 *	1.239	-2.977	21.24**
	(15.31)	(3.771)	(3.176)	(1.695)	(24.87)	(9.771)
Livestock Prize	24.39	-3.385	-7.368	-6.122*	-3.456	31.63
	(26.49)	(4.905)	(5.928)	(3.213)	(42.40)	(19.57)
HH Income	0.013*	-0.006**	-0.000	0.000	0.017	0.009
	(0.007)	(0.003)	(0.002)	(0.001)	(0.016)	(0.006)
N	834	834	834	834	378	394

Finally, we look at the effect of asymmetric information on both purchased food, as well as the food the household consumes from own farms. Food purchases of the husband decrease if he wins a public prize, and they also decrease when the wife wins a private cash prize. We can observe that the husband's food from farms usage by the household increases when either spouse wins a public prize, and the wife's food from farms expenditure increase when she wins a prize (public or private) but are unaffected by whether the husband wins a prize. This suggests that the value spouses get from consuming that food themselves is greater than what they would get in the market, and the additional liquidity allows them to make this substitution from own food to purchased food, and use the money elsewhere. However, there are asymmetries here: it seems as if husbands substitute farm food for food purchases and keep the cash, while the wives are more interested in increasing food consumption in general. Consistent with most of the literature, food purchases of the wife increase when she wins a public prize. On the other hand, asset purchases decrease when the wife wins a livestock prize, and they increase when she wins a private prize. Consistent with Ashraf (2009) findings, it indicates that she spending the cash prize in a less liquid investment such that it is harder to become undone.

Table 7. Treatment Effects of Asymmetric Information on Food

	Husband Food Purchases		Wife Food Purchases		Asset Purchases	
	Husband	Wife	Husband	Wife	Husband	Wife
Cash Prize Public	-8.714**	-3.482	-2.686	7.270*	-3.358	-1.269
	(4.013)	(4.343)	(4.273)	(4.083)	(2.927)	(2.462)
Cash Prize Private	-5.029	-7.684*	1.320	2.737	-0.999	5.500**
	(3.800)	(4.265)	(4.483)	(4.027)	(2.833)	(2.600)
Livestock Prize	17.81	-7.441	-3.672	1.144	-2.261	-9.513*
	(13.76)	(5.137)	(9.743)	(5.626)	(4.666)	(5.372)
HH Income	0.003	0.003	0.009	0.009	0.003*	0.003
	(0.003)	(0.003)	(0.007)	(0.007)	(0.001)	(0.001)
N	1308	1308	1308	1308	1308	1308
			Food from Farms			
	Husband Foods from Farms		Wife Foods from Farms		Food from Family Farms	
	Husband	Wife	Husband	Wife	Husband	Wife
Cash Prize Public	5.662**	5.073**	-1.099	4.200*	8.362*	10.15**
	(2.053)	(2.089)	(2.805)	(2.338)	(4.505)	(4.070)
Cash Prize Private	3.225	1.166	1.914	6.269**	8.964**	11.23**
	(1.964)	(2.114)	(2.784)	(2.352)	(4.402)	(4.234)
Livestock Prize	-1.843	3.779	0.464	-0.433	-4.885	11.06
	(3.570)	(4.218)	(5.008)	(4.151)	(7.284)	(8.456)
HH Income	-0.001	-0.000	0.000	-0.000	-0.003	-0.003
	(0.001)	(0.001)	(0.001)	(0.000)	(0.002)	(0.002)
N	1308	1308	1308	1308	1308	1308

5. Conclusions

We present a simple model of intra-household allocation to show that when the quantity of resources available to the household is not perfectly observed by all household members, the incentives to hide income depend on the role spouses have within the resource management contract. We draw from the Lundberg and Pollak (1993) separate spheres model in assuming that spouses do not commit to any binding agreements. The main focus is on the equilibrium where strictly positive intra-household transfers exist as this is what we observed among almost all households in the survey. Two testable hypotheses were derived from the model: (1) hiding of money occurs when observable resources do not respond to changes in unobservable money, while observable resources do; (2) the spouse in charge of deciding the chop money allowance has no incentives to hide, while the spouse responsible of the household public good provision does. We test the model through a field experiment in Ghana. The field experiments were conducted between March and October 2009 in conjunction with a year-long household survey in four communities in Akwapim South district of Ghana's Eastern Region. It consisted on four lotteries where all survey respondents were invited to participate. Participants were randomly allocated to one of two treatments: public or private prize. Half of the prizes were allocated publicly by lottery, and the other half were allocated in private, by lucky dip.

We find that winning an unanticipated monetary transfer has differential effects depending on the role spouses play within the household contract, as well as depending on the ease by which it can be observed. Whether the husband wins a public prize has no effect observable household or private expenditures. However, winning a private prize increases his expenditure on alcohol, as well as the gifts given to his social network. Contrastingly, winning a private prize by the wife increases the amount she lends out. It is likely that this reflects a storage decision, since loans to close friends and family (which are interest free) substitute for savings accounts. Winning a public prize also increases the wife's gifts to her social network, indicating some degree of social pressure to share, particularly when the prize is in cash. There are no differences in the effect of receiving a private prize on the wife's observable expenditure, while receiving a public prize increases food. Interestingly, receiving a cash prize (by both husbands and wives) has a positive effect on food consumption out of own farms, independently of the ease by which the transfer is observed. This suggests that the value spouses get from consuming that food themselves is greater than what they would get in the market, and the additional liquidity allows them to make this substitution.

Appendix I: Proofs

Husband has Information Advantage:

Proof of Proposition 1:

Let Q=0, then (5) implies:

$$v'(0) < pu'(Y_f + s) \quad \textit{(P1.1)}$$

But by assumption $v'(0) = \infty$, so (5) binds and Q>0.

Equation (9) implies that *s=0* for some Q>0 as long as:

$$\lambda pu''(Y_f - pQ) < u'(Y_m) \quad (P1.2)$$

Which only holds *iff* $\lambda < 0$. We have shown that (5) binds, therefore the constraint on *m's* problem binds as well, so $\lambda \neq 0$. Since Q>0, from (8) we know:

$$v'(Q) = \lambda[p^2 u''(Y_f - pQ) + v''(Q)] \quad \textit{(P1.3)}$$

given the concavity assumption, is only possible if $\lambda < 0$.
If $Y_m + T = 0$, (*P3.2*) holds because $u'(0) = \infty$.

$$\lambda pu''(Y_f - pQ) < u'(0) \quad \textit{(P1.4)}$$

If $Y_m + T = Y_f$, due to the concavity assumption we know that $u'(Y_f - pQ) > u'(Y_f)$, and from (5) and (8) we know that:

$$pu'(Y_f - pQ) = v'(Q) = \lambda[p^2 u''(Y_f - pQ) + v''(Q)] \quad \textit{(P1.5)}$$

So,

$$pu'(Y_f) < pu'(Y_f - pQ) = \lambda[p^2 u''(Y_f - pQ) + v''(Q)] \quad \textit{(P1.6)}$$

So, following from (9), and multiplying (*P3.4*) by *p* on both sides:

$$\lambda p^2 u''(Y_f - pQ) < pu'(Y_f) < \lambda[p^2 u''(Y_f - pQ) + v''(Q)] \quad \textit{(P1.7)}$$

when $\lambda v''(Q) \to 0$, *(P1.7)* will generally won't hold, though there exists the possibility of a small interval where *(P1.7)* holds.

Proof of Proposition 2:

Case (i) If $Y_m + T \leq \overline{Y_m} \in (0, Y_f)$, $s = 0$, such that the value of Q is obtained from (5)

$$v'(Q) - pu'(Y_f - pQ) \leq 0 \quad \textit{(P2.1)}$$

Differentiating *(P2.1)* and *f's* budget constraint with respect to Y_f *and* T yields the results stated in the proposition.

$$\frac{\partial Q}{\partial Y_f} = \frac{\partial Q}{\partial T} = \frac{pu''(x_f)}{v''(Q) + p^2 u''(x_f)} > 0 \quad \textit{(P2.2)}$$

$$\frac{\partial Q}{\partial Y_m} = 0 \quad \textit{(P2.3)}$$

$$\frac{\partial x_f}{\partial Y_f} = \frac{\partial x_f}{\partial T} = \frac{v''(Q)}{v''(Q) + p^2 u''(x_f)} > 0 \quad \textit{(P2.4)}$$

$$\frac{\partial x_f}{\partial Y_m} = 0 \quad \textit{(P2.5)}$$

$$\frac{\partial x_m}{\partial Y_f} = \frac{\partial x_m}{\partial T} = 0 \quad \textit{(P2.6)}$$

$$\frac{\partial x_m}{\partial Y_m} = 1 \quad \textit{(P2.7)}$$

Case (ii) If $Y_m + T > \overline{Y_m}$,. $s, Q > 0$.
Solving (8) and (9) for λ and substituting in, yields the following system for *s* and *Q:*

$$u'(Y_m + T - s)\left[p^2u''(Y_f + s - pQ) + v''(Q)\right] - pv'(Q)u''(Y_f + s - pQ) = 0 \qquad (P2.8)$$
$$pu'(Y_f + s - pQ) - v'(Q) = 0$$

Totally differentiating the system in (*P2.8*):

$$\begin{bmatrix} -p^3u'(x_m)u'''(x_f) + u'(x_m)v'''(Q) - pv''(Q)u''(x_f) + p^2v'(Q)u'''(x_f) & -p^2u''(x_m)u''(x_f) + p^2u'(x_m)u'''(x_f) - u''(x_m)v''(Q) - pv'(Q)u'''(x_f) \\ v''(Q) + p^2u''(x_f) & -pu''(x_f) \end{bmatrix}\begin{bmatrix} dQ \\ ds \end{bmatrix}$$

$$= \begin{bmatrix} pv'(Q)u'''(x_f) - p^2u'(x_m)u'''(x_f) & -p^2u''(x_m)u''(x_f) - u''(x_m)v''(Q) & -p^2u''(x_m)u''(x_f) - u''(x_m)v''(Q) \\ pu''(x_f) & 0 & 0 \end{bmatrix}\begin{bmatrix} dY_f \\ dY_m \\ dT \end{bmatrix}$$

Let *D* denote determinant of the Hessian which is equal to:

$$D = det\begin{bmatrix} -p^3u'(x_m)u'''(x_f) + u'(x_m)v'''(Q) - pv''(Q)u''(x_f) + p^2v'(Q)u'''(x_f) & -p^2u''(x_m)u''(x_f) + p^2u'(x_m)u'''(x_f) - u''(x_m)v''(Q) - pv'(Q)u'''(x_f) \\ v''(Q) + p^2u''(x_f) & -pu''(x_f) \end{bmatrix}$$
$$= u''(x_m)\left[p^2u''(x_f) + v''(Q)\right]^2 + p\lambda v''(Q)u'''(x_f)v''(Q) - pu'(x_m)u''(x_f)v'''(Q) + p^2v''(Q)u''(x_f)^2 < 0 \qquad (P2.9)$$

Recall from FOC's: $v'(Q) - pu'(x_m) = \lambda v''(Q)$

So, the comparative statics are,

$$\frac{\partial Q}{\partial Y_m} = \frac{\partial Q}{\partial T} = \frac{\partial Q}{\partial Y_f} = \frac{p^3u''(x_m)u''(x_f)^2 + pu''(x_m)u''(x_f)v''(Q)}{D} > 0 \qquad (P2.11)$$

$$\frac{\partial x_f}{\partial Y_f} = \frac{\partial x_f}{\partial Y_m} = \frac{\partial x_f}{\partial T} = \frac{u''(x_m)v''(Q)^2 + p^2u''(x_m)u''(x_f)v''(Q)}{D} > 0 \qquad (P2.12)$$

$$\frac{\partial s}{\partial Y_f} = \frac{pu'(x_m)u''(x_f)v'''(Q) - p\lambda v''(Q)u'''(x_f)v''(Q) - p^2v''(Q)u''(x_f)^2}{D} < 0 \qquad if$$
$$pu'(x_m)u''(x_f)v'''(Q) > p\lambda v''(Q)u'''(x_f)v''(Q) + p^2v''(Q)u''(x_f)^2$$
(P2.13)

$$\frac{\partial s}{\partial Y_m} = \frac{\partial s}{\partial T} = \frac{u''(x_m)\left[p^2u''(x_f) + v''(Q)\right]^2}{D} > 0 \qquad (P2.15)$$

$$\frac{\partial x_m}{\partial Y_m} = \frac{\partial x_m}{\partial T} = \frac{\partial x_m}{\partial Y_f} = \frac{-pu'(x_m)u''(x_f)v'''(Q) + p\lambda v''(Q)u'''(x_f)v''(Q) + p^2v''(Q)u''(x_f)^2}{D} > 0 \qquad (P2.16)$$

<u>*Proof of Proposition 3:*</u>
Assumptions:

(i) Spouse *f* can observe T with probability zero.
(ii) Spouse *m's* private consumption, or discretionary expenditure, is not monitored by *f.*

If *m* chooses to reveal T and $Y_m > \overline{Y_m}$ the change in utility per unit change in T is given by:

$$\left.\frac{\partial U_f}{\partial T}\right|_R = \frac{\partial v}{\partial Q}\frac{\partial Q}{\partial T} + \frac{\partial u}{\partial x_f}\frac{\partial x_f}{\partial T} \qquad (P3.1)$$
$$= \frac{v'(Q^R)}{D}\left[p^3u''(x_m^R)u''(x_f^R)^2 + pu''(x_m^R)u''(x_f^R)v''(Q^R)\right] + \frac{u'(x_m^R)}{D}\left[-pu'(x_m^R)u''(x_f^R)v'''(Q^R) + p\lambda v''(Q^R)u'''(x_f^R)v''(Q^R) + p^2v''(Q^R)u''(x_f^R)^2\right]$$

Substituting in *f's* FOC $pu'(x_f^R) = v'(Q^R) = \lambda\left[p^2u''(x_f^R) + v''(Q^R)\right]$, and $u'(x_m^R) = \lambda pu''(x_f^R)$

$\left.\frac{\partial U_f}{\partial T}\right|_R = \frac{u'(x_m^R)}{D}\left[u''(x_m^R)\left[p^2u''\left(x_f^R\right) + v''(Q^R)\right]^2 - pu'(x_m^R)u''\left(x_f^R\right)v'''(Q^R) + p\lambda v''(Q^R)u'''\left(x_f^R\right)v''(Q^R) + p^2v''(Q^R)u''\left(x_f^R\right)^2\right] = u'(x_m^R)$

since $D = u''(x_m^R)\left[p^2u''\left(x_f^R\right) + v''(Q^R)\right]^2 - pu'(x_m^R)u''\left(x_f^R\right)v'''(Q^R) + p\lambda v''(Q^R)u'''\left(x_f^R\right)v''(Q^R) + p^2v''(Q^R)u''\left(x_f^R\right)^2$

If *m* decides to hide then *m* spends all the unobservable income on private consumption. Thus, the change in utility per unit change in the transfer is give by:

$$\left.\frac{\partial U_m}{\partial T}\right|_H = u'(x_m^H) \qquad \textit{(P3.2)}$$

where x_m^H is the allocation when T is hidden, and x_m^R is the allocation when T is revealed. Note that $x_m^H > x_m^R$.

Spouse *m* hides money from *f* if and only if

$$\left.\frac{\partial U_m}{\partial T}\right|_R = u'(x_m^R) < u'(x_m^H) = \left.\frac{\partial U_m}{\partial T}\right|_H \qquad \textit{(P3.3)}$$

Which is never true due to the concavity assumption. Thus in a non-cooperative outcome, even when the husband makes positive transfers to his wife, he never hides.

<u>Wife has Information Advantage:</u>

<u>Proof of Proposition 4:</u>

First, it is important to show that (12) binds. Let Q=0, then (14) implies:

$$v'(0) < pu'\left(Y_f + s\right) \qquad \textit{(P4.1)}$$

But by assumption $v'(0) = \infty$, so (12) binds and Q>0.

Equation (16) implies that *s=0* for some Q>0 as long as:

$$\lambda pu''\left(Y_f - pQ\right) < u'(Y_m) \qquad (\textit{P4.2})$$

Which only holds *iff* $\lambda < 0$. We have shown that (12) binds, therefore the constraint on *m's* problem binds as well, so $\lambda \neq 0$. Since Q>0, from (15) we know:

$$v'(Q) = \lambda\left[p^2u''\left(Y_f - pQ\right) + v''(Q)\right] \qquad \textit{(P4.3)}$$

Which, given the concavity assumption, is only possible if $\lambda < 0$.

If $Y_m = 0$, (*P4.2*) holds because $u'(0) = \infty$.

$$\lambda pu''\left(Y_f - pQ\right) < u'(0) \qquad \textit{(P4.4)}$$

If $Y_m = Y_f$, due to the concavity assumption we know that $u''\left(Y_f - pQ\right) > u'\left(Y_f\right)$, and from (12) and (15) we know that:

$$pu'\left(Y_f - pQ\right) = v'(Q) = \lambda\left[p^2u''\left(Y_f - pQ\right) + v''(Q)\right] \qquad \textit{(P4.5)}$$

So,

$$pu'\left(Y_f\right) < pu'\left(Y_f - pQ\right) = \lambda\left[p^2u''\left(Y_f - pQ\right) + v''(Q)\right] \qquad \textit{(P4.6)}$$

So, following from (16), and multiplying (*P4.4*) by *p* on both sides:

$$\lambda p^2u''\left(Y_f - pQ\right) < pu'\left(Y_f\right) < \lambda\left[p^2u''\left(Y_f - pQ\right) + v''(Q)\right] \qquad \textit{(P4.7)}$$

As long as $\lambda v''(Q) \to 0$, *(P4.7)* will not hold. When $\lambda v''(Q) \neq 0$, it will generally not hold, even though for a small interval, it is possible that *(P4.7)* holds.

Proof of Proposition 5:

It suffices to derive the comparative statics only for a change in Y_f which is also the comparative statistic of interest for the propositions that follow.

Case (i): If $Y_m \leq \overline{Y_m} \in (0, Y_f)$ thus $s = 0$, so the value of Q is obtained from (12)

$$v'(Q) - pu'(Y_f - pQ) \leq 0 \qquad \textit{(P5.1)}$$

Differentiating *(P5.1)* and *f's* budget constraint with respect to Y_f yields the results stated in the proposition. Note that neither x_m nor s change with Y_f. In particular,

$$\frac{\partial Q}{\partial Y_f} = \frac{pu''(x_f)}{v''(Q)+p^2u''(x_f)} > 0 \qquad \textit{(P5.2)}$$

$$\frac{\partial x_f}{\partial Y_f} = \frac{v''(Q)}{v''(Q)+p^2u''(x_f)} > 0 \qquad \textit{(P5.3)}$$

Case (ii): If $Y_m > \overline{Y_m}$.thus $s, Q > 0$.

Solving (15) and (16) for λ and substituting in, yields the following system for s and Q*:*

$$u'(Y_m - s)\left[p^2u''(Y_f + s - pQ) + v''(Q)\right] - pv'(Q)u''(Y_f + s - pQ) = 0 \quad \textit{(P5.4)}$$

$$pu'(Y_f + s - pQ) - v'(Q) = 0$$

Totally differentiating the system in (*P5.4*):

$$\begin{bmatrix} -p^3u'(x_m)u'''(x_f) + u'(x_m)v'''(Q) - pv''(Q)u''(x_f) + p^2v'(Q)u'''(x_f) & -p^2u''(x_m)u''(x_f) + p^2u'(x_m)u'''(x_f) - u''(x_m)v''(Q) - pv'(Q)u'''(x_f) \\ v''(Q) + p^2u''(x_f) & -pu''(x_f) \end{bmatrix}\begin{bmatrix} dQ \\ ds \end{bmatrix}$$

$$= \begin{bmatrix} pv'(Q)u'''(x_f) - p^2u'(x_m)u'''(x_f) & -p^2u''(x_m)u''(x_f) - u''(x_m)v''(Q) \\ pu''(x_f) & 0 \end{bmatrix}\begin{bmatrix} dY_f \\ dY_m \end{bmatrix}$$

Let D denote determinant of the Hessian which is equal to:

$$D = det\begin{bmatrix} -p^3u'(x_m)u'''(x_f) + u'(x_m)v'''(Q) - pv''(Q)u''(x_f) + p^2v'(Q)u'''(x_f) & -p^2u''(x_m)u''(x_f) + p^2u'(x_m)u'''(x_f) - u''(x_m)v''(Q) - pv'(Q)u'''(x_f) \\ v''(Q) + p^2u''(x_f) & -pu''(x_f) \end{bmatrix}$$

$$= u''(x_m)\left[p^2u''(x_f) + v''(Q)\right]^2 + p\lambda v''(Q)u'''(x_f)v''(Q) - pu'(x_m)u''(x_f)v'''(Q) + p^2v''(Q)u''(x_f)^2 < 0 \qquad \textit{(P5.5)}$$

So, the comparative statics are,

$$\frac{\partial Q}{\partial Y_f} = \frac{p^3u''(x_m)u''(x_f)^2 + pu''(x_m)u''(x_f)v''(Q)}{D} > 0 \qquad \textit{(P5.6)}$$

$$\frac{\partial Q}{\partial Y_m} = \frac{p^3u''(x_m)u''(x_f)^2 + pu''(x_m)u''(x_f)v''(Q)}{D} > 0 \qquad \textit{(P5.7)}$$

$$\frac{\partial x_f}{\partial Y_f} = \frac{u''(x_m)v''(Q)^2 + p^2u''(x_m)u''(x_f)v''(Q)}{D} > 0 \qquad \textit{(P5.8)}$$

$$\frac{\partial s}{\partial Y_f} = \frac{pu'(x_m)u''(x_f)v'''(Q) - p\lambda v''(Q)u'''(x_f)v''(Q) - p^2v''(Q)u''(x_f)^2}{D} < 0 \qquad \textit{if}$$

$$pu'(x_m)u''(x_f)v'''(Q) > p\lambda v''(Q)u'''(x_f)v''(Q) + p^2v''(Q)u''(x_f)^2 \qquad \textit{(P5.9)}$$

$$\frac{\partial x_m}{\partial Y_f} = \frac{pu'(x_m)u''(x_f)v'''(Q) - p\lambda v''(Q)u'''(x_f)v''(Q) - p^2v''(Q)u''(x_f)^2}{D} > 0 \qquad \textit{(P5.10)}$$

$$\frac{\partial s}{\partial Y_m} = \frac{u''(x_m)\left[p^2u''(x_f) + v''(Q)\right]^2}{D} > 0 \qquad \textit{(P5.11)}$$

$$\frac{\partial x_m}{\partial Y_m} = \frac{-pu'(x_m)u''(x_f)v'''(Q) + p\lambda v''(Q)u'''(x_f)v''(Q) + p^2v''(Q)u''(x_f)^2}{D} > 0 \qquad \textit{(P5.12)}$$

Recall from FOC's: $v'(Q) - pu'(x_m) = \lambda v''(Q)$

Proof of Proposition 6:

If f chooses to reveal the transfer and $Y_m > \overline{Y_m}$ the demands are obtained from solving the following system of equations:

$$u'(Y_m - s)\left[p^2 u''\left(Y_f + s - pQ\right) + v''(Q)\right] - pv'(Q)u''\left(Y_f + s - pQ\right) = 0 \quad (P6.1)$$
$$pu'\left(Y_f + s - pQ\right) - v'(Q) = 0$$

Thus, if *f* receives a transfer *T* and decides to reveal it, the change in Q, s, x_f, x_m per unit change in *T* are equivalent to those corresponding to changes in Y_f described in proposition 5.
The change in utility per unit change in the transfer is given by:

$$\left.\frac{\partial U_f}{\partial T}\right|_R = \frac{\partial v}{\partial Q}\frac{\partial Q}{\partial T} + \frac{\partial u}{\partial x_f}\frac{\partial x_f}{\partial T} \quad (P6.2)$$
$$= \frac{v'(Q)}{D}\left[p^3 u''(x_m)u''\left(x_f\right)^2 + pu''(x_m)u''\left(x_f\right)v''(Q)\right] + \frac{u'(\widetilde{x_f})}{D}\left[u''(x_m)v''(Q)^2 + p^2 u''(x_m)u''\left(x_f\right)v''(Q)\right]$$

Substituting in *f's* FOC $pu'\left(\widetilde{x_f}\right) = v'(Q)$,

$$\left.\frac{\partial U_f}{\partial T}\right|_R = \frac{u'\left(\widetilde{x_f}\right)}{D}\left[p^4 u''(x_m)u''\left(x_f\right)^2 + p^2 u''(x_m)u''\left(x_f\right)v''(Q) + u''(x_m)v''(Q)^2 + p^2 u''(x_m)u''\left(x_f\right)v''(Q)\right]$$

If f decides to hide the transfer then *f* spends all the transfer on private consumption and the household good allocation doesn't change compared to before the transfer, nor do *m's* allocations. So it must be that $u\left(x_f\right) < u\left(\widetilde{x_f}\right) < u\left(\overline{x_f}\right)$ *where* $\overline{x_f} = x_f + T$ where x_f is the pre-transfer private consumption optimal allocation and $\widetilde{x_f}$ is the post-transfer private consumption optimal allocation if the transfer is revealed. Thus, the change in utility per unit change in the transfer is give by:

$$\left.\frac{\partial U_f}{\partial T}\right|_{NR} = u'\left(\overline{x_f}\right) \quad (P6.3)$$

Spouse *f* hides money from *m* if and only if

$$\left.\frac{\partial U_f}{\partial T}\right|_R = \frac{u'(\widetilde{x_f})}{D}\left[p^4 u''(x_m)u''\left(x_f\right)^2 + p^2 u''(x_m)u''\left(x_f\right)v''(Q) + u''(x_m)v''(Q)^2 + p^2 u''(x_m)u''\left(x_f\right)v''(Q)\right] <$$
$$u'\left(\overline{x_f}\right) = \left.\frac{\partial U_f}{\partial T}\right|_{NR} \quad (P6.4)$$

Multiplying through by *D*<0,

$$u'\left(\widetilde{x_f}\right)\left[p^4 u''(x_m)u''\left(x_f\right)^2 + 2p^2 u''(x_m)u''\left(x_f\right)v''(Q) + u''(x_m)v''(Q)^2\right] > u'\left(\overline{x_f}\right)\left[u''(x_m)\left[p^2 u''\left(x_f\right) + v''(Q)\right]^2 + pv''(Q)u'''\left(x_f\right)\left[v'(Q) - pu'(x_m)\right] - pu'(x_m)u''\left(x_f\right)v'''(Q) + p^2 v''(Q)u''\left(x_f\right)^2\right]$$

Which simplifies to,

$$\left[u'\left(\widetilde{x_f}\right) - u'\left(\overline{x_f}\right)\right]u''(x_m)\left[p^2 u''\left(x_f\right) + v''(Q)\right]^2 < u'\left(\overline{x_f}\right)\left[pv''(Q)u'''\left(x_f\right)\left[v'(Q) - pu'(x_m)\right] + p^2 v''(Q)u''\left(x_f\right)^2 - pu'(x_m)u''\left(x_f\right)v'''(Q)\right] \quad (P6.6)$$

Recall from *(P5.9)* that,

$$\frac{\partial s}{\partial Y_f} < 0 \quad if \quad pu'(x_m)u''\left(x_f\right)v'''(Q) > pv''(Q)u'''\left(x_f\right)\left[v'(Q) - pu'(x_m)\right] + p^2 v''(Q)u''\left(x_f\right)^2$$

So, when $\frac{\partial s}{\partial Y_f} > 0$ (*P6.6*) doesn't hold because left-hand-side is negative and right-hand-side is positive, so f never hides the transfer. However, when $\frac{\partial s}{\partial Y_f} < 0$ both sides of the equation are negative, and the decision to reveal depends on relative preferences and the size of the transfer.

Consider the extreme case where *f* doesn't hide and allocates all of the transfer towards the household public good, such that $T = pQ$. As the transfer increases ($T \to \infty$), $\lim_{T\to\infty} u'\left(\widetilde{x_f}\right) = \lim_{T\to\infty} u'\left(Y_f + T + s - pQ\right) = \lim_{T\to\infty} u'\left(Y_f + T + s - T\right) = u'\left(Y_f + s\right)$. If she does hide, then her only option is to allocate it towards private consumption to avoid detection, thus $\lim_{T\to\infty} u'\left(\overline{x_f}\right) = \lim_{T\to\infty} u'\left(x_f + T\right) = u'(\infty) \to 0$. The right-hand side of (*P6.6*) is negative and the left-hand side tends to zero, so in this case the equilibrium would be not to hide.

Now consider the other extreme case where the transfer tends to zero. If f reveals the transfer: $\lim_{T\to 0} u'(\widetilde{x_f}) = \lim_{T\to 0} u'\left(Y_f + T + s - pQ_f\right) = u'(x_f)$, if she hides it $\lim_{T\to 0} u'(\overline{x_f}) = \lim_{T\to 0} u'(x_f + T) = u'(x_f)$, so (*P6.6*) simplifies to $0 > u'(x_f)$, which always holds. Thus there exists a threshold level of transfer ($\bar{T}$) such that for any $T < \bar{T}$ the Subgame Perfect Nash Equilibrium is to hide.

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