Are Households Pareto Efficient? A Test Based on Multiple Job Holding

Jacob Penglase* Ömer F. Sözbir†

July 2025

Abstract

The collective household model requires that household decisions result in Pareto efficient outcomes. While this assumption is falsifiable, these tests are often difficult to implement due to data limitations or insufficient statistical power. We identify a novel setting—multiple job holding—where these issues are less of an obstacle. Using data from Bangladesh, we estimate the leisure demand of households where members are engaged in multiple occupations and use the parameter estimates to test the collective model. We are unable to reject Pareto efficiency, but do find evidence against the unitary model. The results support the use of the collective model as a framework to study the inner workings of the household.

JEL Codes: D1, J12, J22, Q12.
Keywords: collective model, Pareto efficiency, multiple job holding, moonlighting, labor supply.

*San Diego State University, Department of Economics, 5500 Campanile Drive, San Diego CA, 92182 (e-mail: jpenglase@sdsu.edu).
†Koç University, Department of Economics, Rumelifeneri Yolu, Sarıyer, İstanbul, Türkiye, 34450 (e-mail: osozbir@ku.edu.tr). Corresponding Author.

We thank Rossella Calvi and two anonymous referees for helpful suggestions. All errors are our own. Declarations of interest: none.

1 Introduction

Until recently, economists have predominantly modeled the household as a single decision-making unit. This so-called “unitary" framework assumes that household demands satisfy the Slutsky conditions, so that household preferences can be represented by a standard utility function.[1] However, many empirical studies have shown that household demands are not consistent with the unitary model. In particular, Slutsky symmetry is often rejected in the data (Blundell et al., 1993; Hoderlein and Mihaleva, 2008; Haag et al., 2009). Moreover, the “income pooling" implication of the unitary model, which requires relative incomes across spouses be immaterial to household decision making, is consistently rejected (Thomas, 1990; Lundberg et al., 1997; Attanasio and Lechene, 2002; Ward-Batts, 2008). In line with this empirical evidence, economists have developed several alternative models of household behavior that relax the restrictive assumptions of the unitary framework.

One such alternative is the collective model of Chiappori (1988, 1992) and Apps and Rees (1988). The collective model treats the household as a group of individuals with their own distinct preferences, and assumes that household decisions are Pareto efficient. Unlike the unitary framework, the collective model recognizes that prices, wages, and relative incomes matter in the bargaining process, and factors that shift power within the household can affect household behavior. The flexibility of the model has enabled economists to better examine the design of policies and programs that have the potential to affect the inner-workings of the household, such as laws governing marriage, cash transfer programs (e.g., the importance of who in the household receives the transfer), and the relative merits of joint versus individual taxation (Lise and Seitz, 2011; Attanasio and Lechene, 2014; Voena, 2015). The ability of the collective model to examine these topics has resulted in its widespread use as a framework for analyzing the inner-workings of the household. Additionally, the model has been recently used to estimate intra-household inequality and poverty in developing countries (Dunbar et al., 2013; Calvi, 2020; Penglase, 2021; Bargain et al., 2022; Lechene et al., 2022).

Another important factor in its growing popularity is that the collective model is falsifiable. Despite Pareto efficiency being a mild assumption, the collective model generates several testable implications (Browning and Chiappori, 1998; Chiappori and Ekeland, 2006; Bourguignon et al., 2009). However, these tests (which we discuss shortly) are often difficult to implement due to data limitations or insufficient statistical power. In this paper, we provide a novel setting to test collective rationality that overcomes these obstacles.

There are two main methods for testing the static collective model.[2] The first relies on *distribution factors*, which are variables that do not affect preferences or the household budget constraint, but do affect the allocation of resources through intra-household bargaining. Examples of distribution factors include transfers targeted a specific household member, sex ratios, or divorce laws that favor a particular spouse. The general idea behind these tests is that distribution factors can only enter the model in a limited way, which then imposes restrictions on how consumption and labor supply respond to variation in these variables. Specifically, distribution factors cannot have an effect on the set of feasible Pareto

[1] See Browning et al. (2006) for detailed discussions on the definition of the unitary model.

[2] An alternative strand of research uses revealed preference methods to study household behavior. Studies in this literature that have tested the collective model include Cherchye et al. (2007) and Cherchye et al. (2011). For a review of dynamic collective models, see Chiappori and Mazzocco (2017). Our focus in this paper is on the static collective model, which the majority of empirical applications are based on.

efficient allocations, but rather only the location of the final allocation on the Pareto frontier. A growing body of research has employed distribution factors to test collective rationality, and the results are largely positive as the model is rarely rejected (Chiappori et al., 2002; Bobonis, 2009; Attanasio and Lechene, 2014). Nonetheless, Dauphin et al. (2018) have noted the potential weakness of these tests. The central problem relates to finding satisfactory distribution factors; they have to simultaneously be important enough to the household's decision-making process to affect demand, but also must be valid distribution factors (i.e., excluded from individual preferences and the budget constraint).[3] This data challenge is one we wish to avoid. Moreover, previous studies that utilize distribution factors to test Pareto efficiency in the context of the same conditional cash transfer program, namely Progresa in Mexico, find different results (Bobonis, 2009; Attanasio and Lechene, 2014; Angelucci and Garlick, 2016; De Rock et al., 2022). Considering the theoretical issues and the mixed evidence from these empirical studies, using distribution factors to test Pareto efficiency in household decisions might not be the most convincing approach. The present study contributes to this Pareto efficiency debate by using a novel setting where distribution factors are not necessary, unlike in the case of the aforementioned studies.

Our analysis is based on the second, less commonly used test of collective rationality pertaining to the Slutsky matrix (Browning and Chiappori, 1998; Chiappori and Ekeland, 2006). The collective model requires that household demands satisfy a symmetry and rank condition on the Slutsky matrix. The central obstacle to this test is that it requires price variation and at least five consumption goods.[4] These two data requirements are often overly burdensome. The challenge when using consumption data is having enough price variation, which mostly rules out the use of cross-sectional data. With labor supply, the (to this point) insurmountable obstacle is having five goods, as the labor supply of husband and wife, together with a Hicksian consumption comprise just three goods for the household. Indeed, Browning and Chiappori (1998) note the infeasibility of testing the collective model with typical labor supply data:

> *"Since there is no cross-section variation in prices for goods, we can only define a single composite commodity, consumption, and then analyze the three "good" system for male and female labor supply and consumption. The cross-section variation in wages gives the (relative) "price" variation that we have exploited in this paper. ... however, we see that without further restrictions, the collective setting does not have any implications for price responses in a three-good model. Any Slutsky response in a three-good model are consistent with the collective setting."*

That is, the standard three-good labor supply setting for couples is sufficient to test the unitary model, but not the collective model's requirement of Pareto efficiency. Nonetheless, there is a considerable amount of price variation in wages, even with only cross-sectional data, which makes it attractive to use in testing collective rationality.

[3] Many empirical tests of the collective model based on distribution factors do not satisfy the underlying theoretical restrictions provided by Bourguignon et al. (2009) and Dauphin et al. (2018). Specifically, if there are two valid distribution factors, each household demand has to either respond to both distribution factors or none of them. This requirement is especially burdensome when the tests are based on disaggregated demand systems.

[4] More generally, given the homogeneity and adding-up, for N decision-maker households, $2N+1$ goods are required to test the collective model using price variation. See Section 4 for details.

Our main innovation is to identify a labor supply setting where there are five goods: multiple job holding (or moonlighting). We model the labor supply decisions of individuals who are engaged in multiple jobs at different wages. Thus, in a couple where each spouse is employed in two occupations, there will be five goods: two quantities of hours worked for each spouse, and a composite consumption good. Therefore, we will be able to test the collective model just by using labor supply data. This setting allows us to avoid the pitfalls of existing tests, as we do not need to identify valid distribution factors. Moreover, the labor supply setting has significant cross-sectional variation in prices. Therefore, unlike previous tests that rely on detailed household consumption data, we do not need long time series of datasets to generate sufficient price variation.[5] Insufficient price variation causes large standard errors and failing to reject the tests regarding model restrictions. Therefore, using substantial individual-level price variation, this study gives a robust test of the collective model.

The downside of our test is that it is limited to a select population, since we must restrict the sample to couples where both spouses are employed in at least two occupations. In high-income countries, this is a constraining restriction. For example, in the United States, only 7.8 percent of employed individuals work in multiple jobs (Bailey and Spletzer, 2021). However, multiple job holding is widespread in low-income countries. As a result, we conduct our tests in rural Bangladesh where 43.4% percent of men and 30.9% of women engage in multiple occupations (see Figure 1 in Section 3). The need to focus on multiple job holders makes the scope of our analysis somewhat limited. Nonetheless, having a robust test for a smaller population complements (arguably) less robust tests that can be conducted more broadly.

The results of the study do not provide evidence against the collective model for nuclear families. However, we do find strong evidence against the unitary model. Our results are robust to selection into multiple job holding, which is important as the sample selection is the main limitation of the study. Moreover, the results are robust to selecting a subset of households without children, dropping a subset of households where spouses engage in more than two jobs, clustering standard errors at the village level, instrumenting possibly endogenous hourly earnings, and using alternative definitions of available time for market work. Therefore, we conclude that Pareto efficiency is not a very strong assumption in nuclear families in rural Bangladesh.

Our study has two contributions.[6] First, we provide a new setting, multiple job holding, to test the collective model using price variation. We, therefore, add to work that has tested the symmetry and rank condition on the Slutsky matrix (Browning and Chiappori, 1998; Kapan, 2009; Dauphin et al., 2011). Second, with our empirical application in rural Bangladesh, we contribute to the literature on modeling household decisions in developing countries. The collective model is increasingly used to understand intra-household inequality and poverty in these contexts. However, there is also considerable evidence in the literature against the Pareto efficiency assumption for developing-country households (Udry, 1996; Dercon and Krishnan, 2000; Duflo and Udry, 2004; Robinson, 2012). Therefore, tests of the collective model are essential. With this regard, our study contributes to the literature on intra-household inequality and poverty by providing a modeling guidance for household decisions in the developing world.

The rest of the paper is organized as follows. In Section 2 we provide an overview of the literature.

[5] Also note that detailed household consumption data might be more prone to measurement error compared to simple labor supply data on hours and earnings.

[6] In addition to the main contributions, we add to research on multiple job holding in developing countries. The study of multiple job holding is becoming increasingly important as alternative forms of work become more common in developed countries, as well (Katz and Krueger, 2019).

In Section 3 we provide background information on multiple job holding in rural Bangladesh. In Section 4 we discuss the collective model and how it can be tested. We then discuss the application of the test in Section 5, describe our data in Section 6, and provide the results in Section 7. Section 8 concludes. The supplementary results are provided in the Appendix.

2 Literature Review

A large body of research has conducted tests that provide evidence against the unitary model rather than evidence in support of the collective model. These tests either demonstrate that distribution factors affect household choices or they show that the Slutsky matrix is not symmetric (see Browning et al. (2014) for a summary of tests of the unitary model). Of more interest to this paper are tests on the restrictions of the collective model rather than those of the unitary alternative. Again, one can delineate between tests involving distribution factors from those that examine the form of the Slutsky matrix. We discuss the theory behind these tests in more detail in Section 4, and focus here instead on summarizing applications of these tests and their results.

There are mainly two ways in which distribution factors can be used to test the static collective model. The first way involves the *proportionality property*, which requires that the ratio of the marginal effects of the distribution factors on demand must be proportional across all goods (Browning and Chiappori, 1998; Bourguignon et al., 2009). The idea behind this test is that the Pareto weights can affect demand in only a one-dimensional way, which restricts demand responses to variation in the distribution factors. This test has been employed notably by Bourguignon et al. (1993) and Chiappori et al. (2002), and the results in each study fail to reject the collective model. In Bangladesh, both Bargain et al. (2022) and Brown et al. (2021) conduct the proportionality test and also find evidence in support of the collective model. Importantly, we use the same data as Brown et al. (2021), though we use different sample restrictions; therefore, our results are not directly comparable.

An alternative approach that also relies on distribution factors is the *z-conditional demand* test. The theoretical basis for this test again relies on the idea that distribution factors can only affect demand in a one-dimensional way. The demand for a particular good, once conditioning on the demand for a single other good and the substituting out a particular distribution factor, is independent of all other distribution factors (Bourguignon et al., 2009). Applications of this test include Bobonis (2009) and Attanasio and Lechene (2014). Both studies use the random assignment of a cash transfer program in Mexico (Progresa) that was provided to women as a distribution factor. Bobonis (2009) additionally uses rainfall shocks, while Attanasio and Lechene (2014) uses family network size. The results of both studies support the collective model. However, recent work by Dauphin et al. (2018) has cast doubt on these results as their tests do not satisfy the so-called *all or nothing* condition, which requires that each demand function be affected by all or none of the distribution factors. Indeed, this condition is often not satisfied. More recently, Angelucci and Garlick (2016) and De Rock et al. (2022) test the collective model using the z-conditional demand test, focusing on the same conditional cash transfer program. Angelucci and Garlick (2016) find that only a set of households (older couples) are efficient, while others (younger couples) are not. De Rock et al. (2022) show that household decisions are compatible with the collective model at the beginning of the program, but not later on.

Our study is more related to research that has examined the symmetry and rank condition on the Slutsky matrix. Unlike the aforementioned studies, this approach does not rely on distribution factors. To our knowledge, the only studies that have employed this test are Browning and Chiappori (1998), Kapan (2009), Dauphin et al. (2011), and Sözbir (2024).[7] Using seven waves of the Canadian Family Expenditure Survey, Browning and Chiappori (1998) find that price responses are consistent with the collective model for couples, while the unitary model is not rejected for singles. Canada provides an ideal setting for their analysis because there is both inter-temporal and spatial variation in prices. Dauphin et al. (2011) provide a similar test in the United Kingdom using twelve waves of the UK Family Expenditure Survey, and fail to reject the collective model.[8] Both of these studies rely on long time series of cross-sectional datasets for price variation. This data requirement is especially burdensome for developing countries where household datasets are in general collected less frequently and span shorter time periods. Again, this highlights the need to identify a setting with only cross-sectional price variation as we do in our analysis. Interestingly, Kapan (2009) relies only a single year to provide a test of the symmetry and rank condition on the Slutsky matrix for households in Turkey. However, he uses twelve waves of monthly household expenditure data during a year in which a financial crisis resulted in substantial inflation, generating enough price variation. Unlike these studies, we do not rely on detailed household consumption and time series price variation, as our test is based on substantial individual-level variation in wages. This allows us to provide a robust price-based test to Pareto efficiency in household decisions.

Not all studies fail to reject Pareto efficiency. Seminal work by Udry (1996) examines productive efficiency across male and female agricultural plots in rural Burkina Faso. He finds that households are not optimally allocating labor and fertilizer across plots, which violates efficiency. Besides having different model assumptions and empirical contexts, the aim of Udry (1996) and our study is different. Given the separability of preferences from production decisions, he tests whether households make efficient agricultural production decisions. That is, he tests productive efficiency in agricultural households. Our notion of efficiency is different and more similar to consumption efficiency in Browning and Chiappori (1998) or Dauphin et al. (2011), with a particular focus on leisure instead of detailed consumption. We test whether moonlighting spouses make efficient (joint) consumption and labor supply decisions, relying on cross-sectional variation in their wage rates.

Recently, Lewbel and Pendakur (2022) propose a collective household model with consumption inefficiency and in a companion paper, Lewbel and Pendakur (2024), apply the model to data. Note that within the collective household literature, these studies mainly contribute to the strand of research that estimates resource allocation within the household (Browning et al., 2013; Dunbar et al., 2013). In contrast, our paper contributes to the research that investigates intra-household decision-making and tests efficiency (Browning and Chiappori, 1998; Dauphin et al., 2011). As a result, the underlying theoretical assumptions and empirical strategies of our study differs from Lewbel and Pendakur (2024). We allow for a more general model as we do not estimate intra-household resource shares, and use a novel setting to test Pareto efficiency using price variation. Despite these differences, the empirical results of Lewbel and Pendakur (2024) are somewhat in line with our study, as they do not find substantial inefficiency. Note

[7]The study by Sözbir (2024) tests the intra-household decision-making power of children in the same context. We refer to this study in the following sections regarding data and empirical applications.

[8]In particular, their test results provide evidence in favor of a collective model with three decision-makers for nuclear families with working children.

that other work in the literature provide evidence of inefficient behavior within the household by identifying instances of income hiding (Ashraf, 2009), imperfect information between spouses (Ashraf et al., 2014), and the use of domestic violence in household bargaining (Bloch and Rao, 2002; Calvi and Keskar, 2023). These deviations from efficient behavior all occur in developing countries, which suggests that the validity of the collective model in this context is still an open question that merits further research.

Finally, our study relates to work on multiple job holding (or moonlighting). The seminal paper by Shishko and Rostker (1976) incorporates multiple job holding into a standard labor supply model with hours constraint. Empirical work in this literature has identified several other reasons than hours constraint for multiple job holding, including job mobility (Paxson and Sicherman, 1996), job insecurity (Bell et al., 1997), preference for heterogeneous work (Conway and Kimmel, 1998; Kimmel and Smith Conway, 2001), self-insurance (or income diversification) (Guariglia and Kim, 2004), financial pressure (Wu et al., 2009), and loss aversion (Hlouskova et al., 2017). Focusing on moonlighting men in the UK, Choe et al. (2018) model moonlighting decisions, allowing for both hours constraint and preference for heterogenous work. Finally, Krishnan (1990) studies the intra-household aspects of multiple job holding by modeling the husband's decision to moonlight jointly with the wife's decision to work. Note that unlike all these studies, we do not aim to explain or model the extensive margin of multiple job holding decisions. Instead, we focus on multiple job holders and use their intensive margin decisions to provide a novel, labor supply-based test to the collective model. Therefore, with regard to its aim, our study mostly diverges from this multiple job holding literature.

3 Multiple Job Holding in Rural Bangladesh

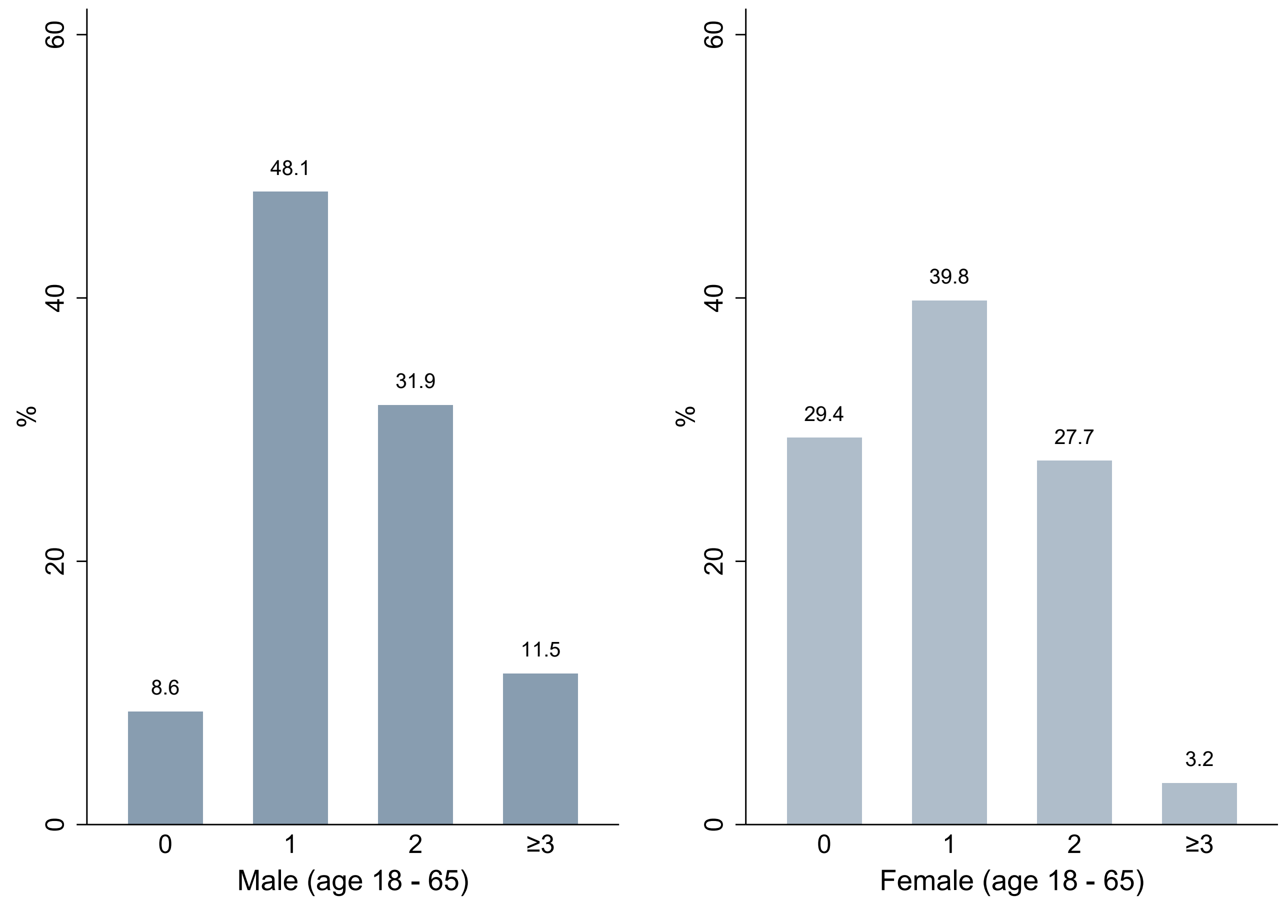
A distinct feature of employment in rural Bangladesh is the prevalence of multiple job holding. That is, a significant proportion of the population engage in more than one economic activity. These activities are mostly in agriculture, and they can be either self or wage employment.[9] Unlike in developed countries where jobs can be categorized as full-time or part-time with specific hours constraints, in rural Bangladesh we observe a wide range of hours. Moreover, the reasons for multiple job holding are likely to be different in this context than urban settings in developed countries. Although our data does not provide information regarding the reasons of taking a second job, income diversification is likely to be an important motivation for multiple job holding in rural parts of low-income countries (Reardon, 1997; Barrett et al., 2001). In this section, we document the employment patterns regarding multiple job holding in rural Bangladesh based on all observations in the Bangladesh Integrated Household Survey (BIHS). We then apply our test focusing on a particular subset of these households. We describe the details of the BIHS and our sample selection in Section 6.

Figure 1 shows the prevalence of multiple job holding in rural Bangladesh.[10] Around 43.4% of adult men and 30.9% of adult women engage in more than one occupation. This frequency contrasts sharply with developed countries, and suggests multiple job holding is quite typical in our context. These numbers

[9] Note that employment is very broadly defined here; any positive hours of work in an income generating activity is considered as a job. For example, raising poultry is considered as a job while unpaid family work or household chores are not.

[10] For this figure, only the set of households that is representative of the country in the BIHS are included, while those sampled for the Feed the Future are excluded. When all observations are used (i.e., including the Feed the Future sample), the multiple job holding rates are almost identical (see Figure A1 in Appendix C). Tables A1-A3 in Appendix B are based on all observations, as well.

Figure 1: Multiple Job Holding in Rural Bangladesh



Notes: Bangladesh Integrated Household Survey (2011/12, 2015, 2018/19). Number of jobs held, for all adults aged 18-65. Representative of rural Bangladesh; excluding the Feed the Future sample.

for rural Bangladesh are comparable with a previous study by Unni (1996), which documents that more than 50% of working adults hold more than one job in rural Gujarat, India. Importantly, these numbers correspond to simultaneous multiple job holding as the survey we use in our analysis collects employment information for individuals during the previous week. Therefore, if there is seasonality in employment activities, the pervasiveness multiple job holding may even be understated in the data.

Tables A1 and A2 in Appendix B show the most common occupations for adult men and women in each survey round of the BIHS, respectively.[11] For men, raising livestock is the most common occupation. Moreover, the percentage of men who raise livestock increased from 19.20% in 2011/12 to 24.76% in 2018/19. Working on one's own farm and agricultural day labor are the second and third most common occupations for men, respectively. Share cropper/tenant, trader (medium or small), and rickshaw/van pulling are the next most common economic activities for men in rural Bangladesh.

For women, raising poultry and livestock are by far the most common occupations. Around half of the women are engaged in raising poultry, while more than 30% of women raise livestock. Other economic activities, such as handicrafts, agricultural day labor, other wage labor, tailor, or working one's own farm, are done by less than 2% of working women in rural Bangladesh.

Finally, to see the spatial heterogeneity in these economic activities we provide the most common occupations (combined for men and women) separately for each seven divisions of Bangladesh in Table A3 of the Appendix. Livestock and poultry raising are the most common economic activities in every part of the country. Except for Chittagong, working on one's own farm is the third most common occupation

[11]Note that these occupations are not only for multiple job holders, but all individuals observed in the BIHS.

in all regions. The geography of the divisions inevitably affects the economic activities. For example, raising fish is the seventh most common activity in Khulha, which is a region by the Indian Ocean, while we do not observe this activity in the landlocked region of Sylhet. However, overall, we do not observe significant spatial heterogeneity across the rural parts of Bangladesh in terms of economic activities.

For our main results, we use the labor supply decisions of multiple job holders in rural Bangladesh to test Pareto efficiency in household decisions. One particular issue pertaining to the economic activities we see in this context is that many of them can be categorized as self-employment. On the one hand, this situation makes our tests more robust as individuals can more flexibly make labor supply decisions compared to the case with salary jobs with strict constraints on hours. On the other hand, these jobs might require fixed costs (or investments) and non-labor inputs initially. For example, in the case of livestock raising, households buy animals, which are then raised by household members. Moreover, marginal earnings can be a decreasing function of hours worked. Therefore, such self-employment-type economic activities can be more accurately modeled as agricultural production (or household enterprise in other examples) where investments on the assets, time inputs, and profits generated are explicitly considered.[12] We do not take this approach; instead, we look at the short-term labor supply (or leisure) preferences of household members considering the average earnings from this activity as the value of time (i.e., wage/price), and assuming away the long-term decisions regarding non-labor inputs or fixed costs for these occupations. Individuals supply different hours of labor for these occupations and have different hourly earnings from each. The main innovation of our paper is to use the short-term (weekly) labor supply decisions of multiple job holders to test Pareto efficiency, which cannot be tested using labor supply preferences in general (Browning and Chiappori, 1998).

4 Model

We set out a collective model following Browning and Chiappori (1998) and Chiappori and Ekeland (2006). The key modification of the model is that we incorporate multiple job holding into the household's problem. Our goal is to derive the pseudo-Slutsky matrix resulting from the household's problem, as that will generate restrictions on household behavior that we will test in Section 5.

We model households that consist of N members, indexed by $i = 1, ..., N$.[13] Let c_i denote the vector of private consumption of member i, with $c = (c_1, \ldots, c_N)$. Let $\tilde{c}$ denote the vector of public consumption in the household.[14] The price vectors associated with the private and public goods are given by p and $\tilde{p}$, respectively. Each member can be employed in multiple jobs. The labor supply of individual i in job k is given by h_{ik} for $k = 1, \ldots, K$, and the vector $h_i = (h_{i1}, \ldots, h_{iK})$ describes his or her employment.[15] So, if the individual has a single job, then $h_{ik'} = 0$ for $k' > 1$. The wage rate of person i at job k

[12]Another concern might be about the dynamics. As the issue of skill accumulation is pivotal for labor market outcomes, dynamic labor supply models are predominantly used in the literature. However, in our context, skill accumulation might not be the most important concern, as in the case of urban or developed country contexts, since most of the occupations we observe are low-skill, agricultural occupations.

[13]We provide the theoretical idea behind our test for the most general case, i.e., for arbitrary number of decision-makers in the household. In our empirical application we focus on nuclear households with two decision-makers, husband (m) and wife (f), with or without children aged at most 11. These children are not very likely to be decision-makers (in the sense of the collective model) considering the legal framework about their employment (Sözbir, 2024). See Section 6 for details about our sample selection. See Appendix A.1 for a simpler theoretical model that matches our empirical application.

[14]Consumption of any commodity can be partly private and partly public as in Browning et al. (2013).

[15]Our study is not the only one that generalizes the simple collective labor supply model to allow for different types of working hours for an individual; Cosaert et al. (2023) partition total working hours as regular and irregular, with possibly different wage rates for each.

is given by w_{ik}, and the vector $w_i = (w_{i1}, \dots, w_{iK})$ shows hourly earnings of person i in each job.[16] Each individual has preferences over the private consumption and labor supply of all members, as well as the household public consumption. This allows for altruism, as well as externalities or any other preference interaction.[17] Let $h = (h_1, \dots, h_N)$ and $c = (c_1, \dots, c_N)$. The utility function of member i is given by $u_i(-h, c, \tilde{c})$, which is assumed to be strictly increasing in $-h_i$ (or decreasing in h_i) and c_i, strongly concave and twice differentiable in all arguments.[18,19] Denote the vector of all prices and wages household members face by $\pi = (p, \tilde{p}, w_1, \dots, w_N)$. Finally, let y denote the household's non-labor income.

Under Pareto efficiency, the household maximizes a weighted sum of individual utilities,

$$\max_{h_1,\dots,h_N,c_1,\dots,c_N,\tilde{c}} \sum_{i=1}^{N} \lambda_i(\pi, y, z)\, u_i(-h, c, \tilde{c}), \tag{1}$$

where the scalar function $\lambda_i \geq 0$ is the Pareto weight for household member i, with $\sum_{i=1}^{N} \lambda_i = 1$. Pareto weights are functions of prices, non-labor income, and distribution factors z. The household solves the above problem subject to a budget constraint:

$$\tilde{p}'\tilde{c} + \sum_{i=1}^{N} p' c_i = \sum_{i=1}^{N} w_i' h_i + y, \tag{2}$$

and each member's time constraint:

$$\sum_{k=1}^{K} h_{ik} + l_i = T_d, \quad \text{for } i = 1, \dots, N, \tag{3}$$

where d is the type (adult male, adult female, child, etc.) of individual i. Note that T_d's are fixed constants (i.e., not choice variables) that are the same for all individuals of any type. We allow different types of household members to have different total available time for market work, T_d.[20] In the empirical application, T_d's will be different for the husband (T_m) and the wife (T_f), which will then be partitioned into available time for primary (T_{m1} and T_{f1}) and secondary (T_{m2} and T_{f2}) jobs. Note that we do not make any hours restriction on the labor supply for a particular job h_{ik}; we choose constants for available times to be greater than all the working hours observed in our data for the corresponding job (see Section 5 for details). This aligns with our context of rural Bangladesh, where hours constraints are less likely to drive multiple job holding compared to non-agricultural jobs in urban settings, particularly in developed countries.

Let $f(\pi, y, \lambda(\pi, y, z))$ denote the vector of Marshallian demand functions (or labor supplies) resulting from the household's problem (1)-(3). Each demand depends on prices, non-labor income, and the Pareto

[16]For single job holders, $w_{ik'}$ for $k' > 1$ can be thought as missing, zero, or the potential hourly earnings in the secondary jobs. Note that we do not model the extensive margin decision in our empirical application; we simply write the theoretical model here in the most general way.

[17]Note that individual preferences or intra-household resource shares cannot be identified with these general preferences; for these results, one needs to assume egoistic or Beckerian-type caring preferences. Since our aim is not to identify the resource shares, we keep the model as general as possible.

[18]Minus labor supply notation is particularly useful for the Slutsky matrix when considered together with other private and public consumption goods. Also we will be estimating the leisure demand of households in our empirical application.

[19]Note that $u_i(-h, c, \tilde{c})$ is not necessarily increasing in $-h_j$ or c_j for $j \neq i$, and thus, selfishness or negative consumption externalities may exist between household members.

[20]Note that this is more general than constraining total available time to be the same for different types of household members, as usually done in the literature (Lise and Seitz, 2011).

weights. Let $\eta(\pi, u, \lambda)$ denote the vector of Hicksian demand functions resulting from the household's dual problem. Similar to the Marshallian demands, η is a function of the Pareto weights which will have implications for the structure of the Slutsky matrix. Using standard duality results, we have that,

$$f(\pi, E(\pi, u), \lambda) = \eta(\pi, u, \lambda),$$

where $E(\pi, u)$ is the non-labor income necessary to reach household utility u. Differentiating with respect to any price in π results in the canonical Slutsky equation:

$$\frac{\partial f_j}{\partial \pi_{j'}} + \frac{\partial f_j}{\partial y} f_{j'} = \frac{\partial \eta_j}{\partial \pi_{j'}},$$

for any goods j and j'. In matrix notation,

$$f_\pi + f_y f' = \eta_\pi,$$

where f_π is the Jacobian matrix of partial derivatives of f with respect to π, f_y is a vector of partial derivatives of f with respect to y, f' is the transpose of f, and η_π is the Jacobian matrix of partial derivatives of η with respect to π. The above relationship holds when both utility and the Pareto weights are fixed, which corresponds to the standard unitary case. In the collective setting, the Pareto weights vary with prices; therefore, the usual Slutsky conditions do not hold.

The vector of structural demand functions $f(\pi, y, \lambda(\pi, y, z))$, which shows the independent variations of household demand with prices, non-labor income, and Pareto weights, is not observable as we cannot observe the Pareto weights. Instead, what we can observe is the changes in demand with prices, non-labor income, and distribution factors. Therefore, the vector of observable demand functions given by $\xi(\pi, y, z)$ are defined as:

$$\xi(\pi, y, z) = f(\pi, y, \lambda(\pi, y, z)). \tag{4}$$

Following Browning and Chiappori (1998), we define the pseudo-Slutsky matrix S for the observable demands $\xi(\pi, y, z)$ as:

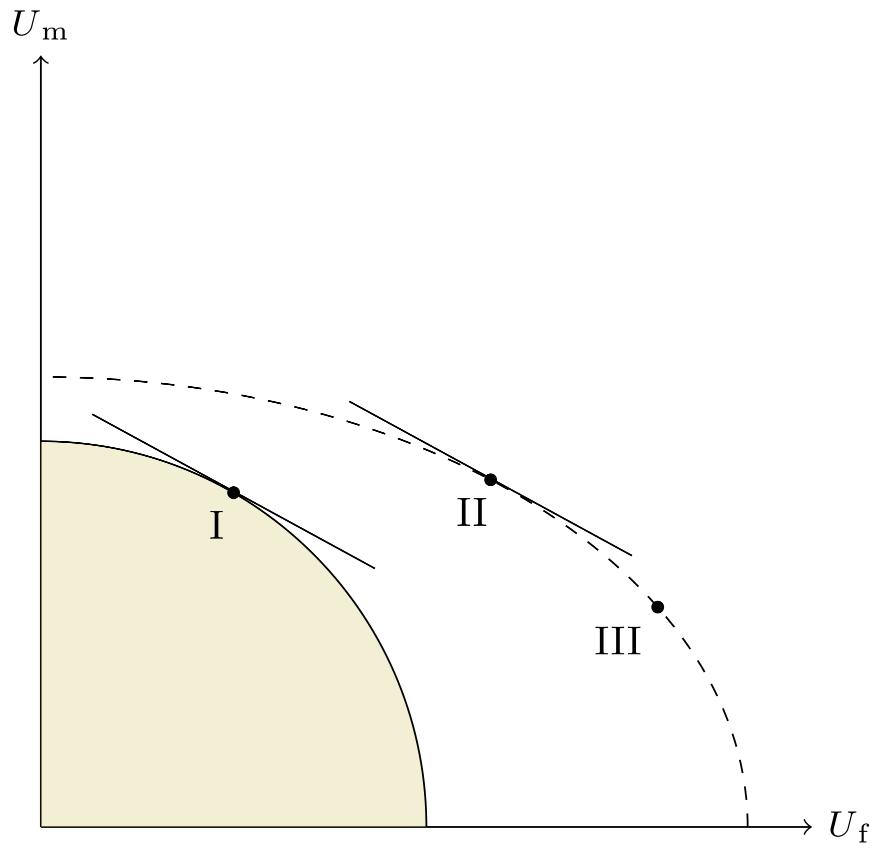
$$S(\pi, y, z) = \xi_\pi + \xi_y \xi', \tag{5}$$

where ξ_π is the Jacobian matrix of partial derivatives of ξ with respect to π, and ξ_y is a vector of partial derivatives of ξ with respect to y. Then using Equation (4) and rearranging, we can write the pseudo-Slutsky matrix as,

$$\begin{aligned}
S(\pi, y, z) &= \xi_\pi + \xi_y \xi' \\
&= f_\pi + f_\lambda \lambda'_\pi + (f_y + f_\lambda \lambda_y) f' \\
&= f_\pi + f_y f' + f_\lambda (\lambda'_\pi + \lambda_y f)' \\
&= \Sigma(\pi, y, z) + R(\pi, y, z),
\end{aligned}$$

where $\Sigma(\pi, y, z) = f_\pi + f_y f'$ is a symmetric, negative definite matrix and $R(\pi, y, z) = f_\lambda(\lambda'_\pi + \lambda_y f)'$ is a matrix of rank no more than $N-1$. In words, when the price of good j' changes, its effect on the demand for good j can be decomposed into two effects. First, holding utility and the Pareto weights constant,

Figure 2: Price Changes and Household Outcomes



Notes: Utility possibility set for couples under two different prices. The y-axis shows the husband's utility, while the x-axis shows the same for the wife. The shaded region gives the set of feasible utility levels under some initial price vector, and point I shows a possible initial allocation. The dashed line gives the Pareto frontier after a change in the price vector. A resulting allocation at point II would be consistent with the unitary model, while an additional change to point III would be consistent with the collective model.

there will be a reallocation of consumption given by Σ. Second, and specific to the collective model, the price change will induce a change in the Pareto weights, which comprise R.

The matrix $R(\pi, y, z)$ being at most rank $N-1$ has important implications for the tests we conduct. The reason behind this restriction is that any effect of prices on the Pareto weights will be at most $N-1$ dimensional as there are $N-1$ free Pareto weights (since they add up to one). With two decision-makers there is a single Pareto weight, and thus a one-dimensional movement along the Pareto frontier when prices change. In this case, the pseudo-Slutsky matrix is a sum of a symmetric, negative definite matrix, and an additional matrix of rank one (the $SR1$ property in Browning and Chiappori (1998)). Any price change will first induce a change in the Pareto frontier. This change is given by the Slutsky matrix Σ. Second, the price change will then result in a movement along the new Pareto frontier. This change is given by the matrix R. Therefore, the rank of R is informative about the decision-making process in the household. If $\text{rank}(R) = 0$, then the pseudo-Slutsky matrix $S(\pi, y, z)$ is symmetric and negative definite, which means that the household decisions are compatible with the unitary model. If, on the other hand, $\text{rank}(R) = n$, for $n \neq 0$, then the household behavior is compatible with the collective model with $n+1$ decision-makers (with non-zero Pareto weights).

To explain the intuition behind this point, Figure 2 graphically illustrates the impact of price changes on household allocations for couples ($N = 2$). The shaded area shows the utility possibility set under an initial price vector π and non-labor income y. The boundary of this area shows the Pareto optimal allocations for the household. Suppose the set of distribution factors, z, are such that the household chooses the allocation given at point I.[21] Suppose prices change to π', altering the set of feasible allocations for the

[21] Note that z has no impact on the set of feasible allocations; it only affects the final allocation on the Pareto frontier.

household. Under new prices, the Pareto frontier is shown with the dashed curve. If the Pareto weights are unaffected to price changes (as in the unitary model), the final allocation will be at point II, where the tangent line to point I will be parallel to the line tangent to point II. The movement from point I to II is captured by Σ. If instead, changes in prices also alter the Pareto weights (as in the collective model), then in addition to changes in feasible allocations, there will also be a movement along the Pareto frontier, where the total effect is captured by S. Under the collective setting, a possible final allocation is shown with point III.[22] Note that the utility of a member can be less than his/her initial utility due to changes in bargaining positions.[23] In both cases (unitary and collective), efficiency requires that the outcomes are on the frontier. However, price changes might result in inefficient household allocations, as well. If the final allocation is somewhere inside the (dashed) frontier, then there will be room for Pareto improvement. Therefore, the way household demands change with prices (or wages in the labor supply setting) allows us to test the restrictions of the unitary model, which predicts λ to be unaffected, as well as the collective model, which postulates Pareto efficiency only.

While the rank of $R(\pi, y, z)$ is informative about the decision-making process in the household, we cannot observe the matrix R as we cannot observe the changes in the vector of Pareto weights as a result of price changes. Instead, what we could observe is $S(\pi, y, z)$. Following Browning and Chiappori (1998) we define a matrix,

$$M(\pi, y, z) = S(\pi, y, z) - S(\pi, y, z)', \tag{6}$$

which is observable, with rank at most $2(N-1)$. Note that $M(\pi, y, z)$ is a real, anti-symmetric (skew-symmetric) matrix, therefore its rank has to be even.[24] Our empirical test of the collective model using price variations is based on this matrix, $M(\pi, y, z)$. If its rank is zero, i.e., $S(\pi, y, z)$ is symmetric, we cannot reject the unitary model. In the case of a collective model with two decision-makers, the rank(M) can be at most two. Therefore, for couples, if we reject both cases, i.e., rank$(M) = 0$ and rank$(M) = 2$, then we reject collective rationality, i.e., Pareto efficiency of the household. Thus, the validity of the Pareto efficiency assumption, and either of the household models will be based on determining the rank of the matrix M.

Finally, to be able to test rank$(M) = 2$, we need to observe at least five goods.[25] To see this, suppose that we had only four goods. Then, the rank of M can be zero, two, or four. However, adding-up and homogeneity implies that $M\pi = 0$, i.e., M cannot be full rank. This means that the rank of M is either zero or two; therefore, the collective model assumptions are always satisfied and cannot be tested.[26] The main novelty of our study is to find a setting (multiple job holding) where Pareto efficiency can be tested with labor supply data, which is not possible in standard labor supply settings due to this particular data requirement (five goods). We do not rely on either detailed, product-level consumption data, or aggregated consumption data with price variation. Instead, we consider a single Hicksian composite good, and use labor supply and variation in individual-level wages for our test. Moreover, we do not need

[22] Note that without further restrictions we cannot know whether a person's intra-household bargaining, the share of household resources, or the individual consumption would increase or decrease with a particular price (or wage) change. Importantly, we do not need to know this to implement our test. If Pareto weights change with prices, then the unitary model is rejected.

[23] Note also that not all points on the Pareto frontier are realistic outcomes for the household. Spouses might have reservation utilities, below which they would choose to be single.

[24] A matrix is anti-symmetric if $M' = -M$.

[25] As discussed in the Introduction, for the rank$(M) = 0$ test, i.e., the Slutsky symmetry, once the usual adding-up and homogeneity conditions are imposed, observing only three goods suffices.

[26] See Proposition 4 of Browning and Chiappori (1998) for a formal proof of this result.

to observe any distribution factors. We provide more details regarding the implementation of this test in the following section.

5 Empirical Specification and Estimation

We restrict our attention to households with a husband (m) and wife (f), and thus omit households with extended family members or older children (i.e., two decision-makers, $N = 2$).[27] While most individuals in our sample have exactly two jobs, some have three and even four occupations. For those individuals, we pool the non-primary jobs into a single occupation so that $K = 2$, where $k = 1$ for the primary job and $k = 2$ for the secondary job.[28] We then apply our test using the requisite five goods to test the collective rationality of couples. In Section A.1 of the Appendix, we simplify the general theoretical model outlined in Section 4 to match our empirical application with two decision-makers and two jobs.

The multiple job holding setting is not standard for a demand system estimation. As a result, we provide additional details regarding how we implement the estimation and conduct the test. We first describe how we construct budget shares. We then describe the demand system that we use in the estimation. Finally, we describe how we test the rank of the matrix described in Equation (6).

Budget Share Construction We have five goods (and therefore five budget shares) in our empirical application: two leisure goods for each spouse (one for each job), and a composite consumption good. Leisure goods are defined as the difference between total available time and hours worked for each job. Total available times are given constants (not choice variables), and we choose them to be type-specific, i.e., different for men and women. Specifically, let T_{dk} denote the maximum possible hours an individual of type $d = m, f$ can work at job $k = 1, 2$, where $T_{m1} + T_{m2} = T_m$ and $T_{f1} + T_{f2} = T_f$. Then, the leisure of household member i of type d associated with job k is defined as $l_{ik} = T_{dk} - h_{ik}$, where h_{ik} denotes the working hours and $l_{i1} + l_{i2} = l_i$ in equation (3). As we discuss below, we choose T_{dk}'s in a way that individuals are not hours constrained; they freely choose h_{1i} and h_{2i}, and therefore l_{i1} and l_{i2}.

Before detailing the construction of budget shares, there are two things to note. First, from an empirical point of view, leisure goods are akin to negative working hours, as total available times are fixed and the same for every individual of any type. Therefore, the estimation is based on the same individual-level and cross-sectional variation in hours worked, or alternatively time freed up for leisure. The reason why we need to use leisure instead of labor supply pertains to the construction of budget shares. In theory, working hours can be directly used; in that case, the corresponding budget shares could be negative (i.e., not within 0-1 range) while the denominator becomes the non-labor income.[29] However, from an empirical point of view, a particular difficulty of this approach arises when non-labor income is zero or negative (Stern, 1986), precluding the use of flexible functional forms like the one used in this study. Therefore, similar to Kooreman and Kapteyn (1986) in the case of modeling household labor supply or Choe et al. (2018) in the case of modeling moonlighting, we work with leisure. Second, as each job

[27] Multiple job holding is not common among children, even for those who can be legally employed. Our test can be easily applied to extended households, given each decision-maker member engages in multiple jobs.

[28] See Section 6 for details regarding how we construct wages for the secondary occupation for individuals with more than two jobs. Our results are robust to selecting a subsample of households where spouses have exactly two jobs.

[29] In the case of the simple consumption-leisure model, the budget constraint would be $C = wh + y$ or $C - wh = y$; therefore, the budget shares would be $\omega_1 = -wh/y$ and $\omega_2 = C/y$.

generates possibly different hourly earnings (as well as non-pecuniary benefits and costs for the utility), the corresponding leisure parts due to not working full possible time are priced differently. The prices of these leisure goods are the wages for the corresponding jobs. Our approach has similarity with previous studies in the collective household literature that differentiates private from joint leisure (Browning et al., 2021; Cosaert et al., 2023). In these studies, total leisure is partitioned (using detailed time-use data) as private and public, and each part is (possibly) valued differently by the household. The unique feature of our setting is that the prices of the leisure parts are simply wages for the corresponding jobs.

We normalize the price of the composite good to one. The vector of prices faced by the household then contains five elements: $\pi = (w_{m1}, w_{m2}, w_{f1}, w_{f2}, 1)$, where, e.g., w_{m2} denotes the husband's wage in his second job. Full income (the denominator for the budget shares) is determined by these wages, as well as the time endowments in each occupation and household non-labor income. Similar to Choe et al. (2018), we calculate T_{dk} as the maximum weekly hours of work observed in our sample for individual type $d = m, f$ in job $k = 1, 2$ plus one, which ensures that leisure budget shares are non-negative.[30] The resulting vector of available times in our sample is $(T_{m1}, T_{m2}, T_{f1}, T_{f2}) = (85, 43, 55, 22)$.[31] Given this choice and our focus on moonlighting couples, hours constraints are not binding. More precisely, each of these four limits is binding only for a single observation that corresponds to the maximum observed hours for each gender and for each job. Therefore, we have $l_{ik} > 0$ for each $i = m, f$ and $k = 1, 2$. The household's budget constraint is given by:

$$C + w_{m1}l_{m1} + w_{m2}l_{m2} + w_{f1}l_{f1} + w_{f2}l_{f2} = w_{m1}T_{m1} + w_{m2}T_{m2} + w_{f1}T_{f1} + w_{f2}T_{f2} + y \tag{7}$$

where the left-hand side is the total household expenditure (including leisure expenditure) and the right-hand side is the full potential income of the household. Each $w_{ik}l_{ik}$ corresponds to leisure expenditure of the household associated with person i and job k. We compute non-labor income as the difference between total household consumption and labor income. This expenditure-based approach to calculate non-labor income reduces measurement error (Blundell et al., 2007; Lise and Seitz, 2011). We then construct the budget shares as follows:

$$\omega_1 = \frac{w_{m1}l_{m1}}{g}, \ \omega_2 = \frac{w_{m2}l_{m2}}{g}, \ \omega_3 = \frac{w_{f1}l_{f1}}{g}, \ \omega_4 = \frac{w_{f2}l_{f2}}{g}, \ \omega_5 = \frac{C}{g},$$

where the denominator $g = w_{m1}T_{m1} + w_{m2}T_{m2} + w_{f1}T_{f1} + w_{f2}T_{f2} + y$ is the right-hand side of Equation (7), i.e., full potential income. Then, for example, ω_2 corresponds to the budget share for husband's secondary job. Note the similarity of household leisure demand in this moonlighting setting with the disaggregated household consumption demand. In the present case, instead of consumption, the leisure demand is disaggregated.

Demand System To estimate the leisure demand of households, we use the Quadratic Almost Ideal Demand System (QUAIDS) of Banks et al. (1997). This functional form allows flexible relative price effects and has been used in previous price-based tests of collective rationality (Browning and Chiappori,

[30] Choe et al. (2018) use T's for jobs that are either constrained or unconstrained in terms of hours. Our model assumes away hours constraints.

[31] As robustness checks, we consider three alternative definitions of these total available times; the main results do not change. See Section 7.3 for details.

1998; Dauphin et al., 2011). Our preliminary analyses show that leisure Engel curves are non-linear in log total (potential) income, and therefore a quadratic logarithmic model like QUAIDS is needed.[32] Although preferable, non-parametric alternatives are not feasible given our sample size.

Let ω and π be the vector of budget shares and prices (or wages), respectively. The system of demand functions is then given by,

$$\omega = \alpha + \Gamma \ln(\pi) + \beta[\ln(g) - a(\pi)] + \zeta \frac{[\ln(g) - a(\pi)]^2}{b(\pi)} + \epsilon, \tag{8}$$

where,

$$a(\pi) = \alpha_0 + \alpha' \ln(\pi) + \frac{1}{2} \ln(\pi)' \Gamma \ln(\pi), \quad b(\pi) = \exp(\beta' \ln(\pi)). \tag{9}$$

To impose the adding up constraint, we omit the Hicksian consumption good from the estimation. Homogeneity is imposed as the price of the Hickisan consumption good is normalized to one. Thus, ω and π are 4×1 vectors of the budget shares and wages respectively and Γ is a 4×4 matrix of parameters. Similar to previous studies (Banks et al., 1997; Cherchye et al., 2015), we model the parameter α as a linear function of observed household characteristics (preference factors), including the husband's age, household size, and an indicator for the household residing in the Dhaka division. Our sample is quite homogeneous, so we include a limited number of preference factors.[33] We then estimate the non-linear system provided in Equation (8) by iterative feasible generalized non-linear least squares, allowing errors to be correlated across equations (non-linear seemingly unrelated regression model). Finally, although the parameter α_0 is formally identified, it is not well-determined. Following previous studies (Deaton and Muellbauer, 1980; Banks et al., 1997; Browning and Chiappori, 1998), we choose a constant less than the minimum observed $\ln(g)$ in our data. We also experiment with alternatives constants; the main results do not change.

The pseudo-Slutsky matrix given in Equation (5) in the theoretical model can be written in terms of budget shares and log wages as,

$$S = g \operatorname{diag}(\pi)^{-1}[\tilde{S} - \operatorname{diag}(\omega) + \omega\omega'] \operatorname{diag}(\pi)^{-1}, \tag{10}$$

where $\operatorname{diag}(\cdot)$ creates a diagonal matrix given a vector and $\tilde{S}$ is given by,

$$\tilde{S} = \omega_{\ln(\pi)} + \omega_{\ln(g)} \omega' \tag{11}$$

where $\omega_{\ln(\pi)}$ is the Jacobian matrix of partial derivatives of the budget shares with respect to log wages, and $\omega_{\ln(g)}$ is the gradient of the budget shares with respect to $\ln(g)$.[34] Since S and $\tilde{S}$ have the same symmetry and rank properties (Sözbir, 2024), we use $\tilde{S}$ as previously done by Browning and Chiappori

[32] Previously, the linear (in log expenditure) version of this demand system, AIDS by Deaton and Muellbauer (1980), is used to estimate the leisure demand of households (Ray, 1982; Kooreman and Kapteyn, 1986). Focusing on individuals separately, Choe et al. (2018) use Linear Expenditure System based on Stone-Geary preferences to model the labor supply decisions of moonlighters.

[33] Considering our sample size and the non-linearity of the model, including a large number of observable characteristics is computationally difficult as well.

[34] See Sözbir (2024) for details.

(1998) and Dauphin et al. (2011). From Equations (8) and (9), the matrix $\tilde{S}$ for QUAIDS is then,

$$\tilde{S} = \Gamma - \frac{1}{2}(\beta + 2\frac{\tilde{g}}{b(\pi)}\zeta)\ln(\pi)'(\Gamma - \Gamma') + \tilde{g}[\beta\beta' + \frac{\tilde{g}}{b(\pi)}(\zeta\beta' + \beta\zeta') + 2\Big(\frac{\tilde{g}}{b(\pi)}\Big)^2\zeta\zeta'] \tag{12}$$

where $\tilde{g} = \ln(g) - a(\pi)$. We provide the details of the derivation of Equation (12), as well as the corresponding matrices S and M in Appendix A.2. As demonstrated in Browning and Chiappori (1998), a particular convenience for QUAIDS is that the rank of $\Gamma - \Gamma'$ can be used to infer the rank of $M = S - S'$.[35] Therefore, we implement our rank tests for the matrix $\Gamma - \Gamma'$.

Rank Test Recall that the restriction imposed by the collective model is that the rank of the antisymmetric matrix $M = S - S'$ is at most two for two-member households. Therefore, there are two cases to consider. If rank$(M) = 0$, then we cannot rule out the unitary model. This case corresponds to testing whether the matrix Γ is symmetric, which is testing the equality of $4(4-1)/2 = 6$ linear constraints. If instead the rank of M were two, then we conclude that the collective model is not rejected. Following Browning and Chiappori (1998), we test the case rank$(M) = 2$ as follows. Let γ_{ik} denote the $(i,k)^{th}$ element of $\Gamma - \Gamma'$.[36] Assume without loss of generality that $\gamma_{12} \neq 0$ (we test this assumption). Then $\Gamma - \Gamma'$ has rank two if,

$$\gamma_{34} = \frac{\gamma_{13}\gamma_{24} - \gamma_{14}\gamma_{23}}{\gamma_{12}}. \tag{13}$$

We use Wald test to test the symmetry of Γ and the non-linear equality given by Equation (13). The rejection of both the symmetry of Γ and the Equation (13) implies the rejection of the collective rationality, as the rank of M can exceed two in that case.[37]

Finally, we assume that wages are exogenous for our main results. We argue that hours and wages are less likely to suffer from measurement error compared to detailed household consumption and prices of consumption-good groups considered in demand systems, which is the typical alternative to our approach. Additionally, infrequent purchases of some consumption goods raises doubts about the exogeneity of total expenditure; as a result, total expenditure is typically instrumented by income or wealth in previous (detailed) consumption-based studies (Dauphin et al., 2011; Dunbar et al., 2013). This is not a particular concern for our study as we consider leisure expenditure and a single Hicksian consumption good. In the collective labor supply literature, wages are typically assumed to be exogenous (Couprie, 2007; Lise and Seitz, 2011; Cosaert et al., 2023). However, making the same assumption in our context is somewhat more restrictive as most of the occupations we observe can be categorized as self-employment, and thus more prone to endogeneity or measurement error. As a robustness check, we use a leave-one-out instrument for each wage, considering the average earnings for the same occupations in the village or larger geographic units. It is worth noting that the validity of this leave-one-out instrument is uncertain, and to our knowledge, no previous study has employed it for estimating hourly earnings.[38] That is why we con-

[35] The maximum possible rank of M is informative about the intra-household decision-making, and without further restrictions, rank$(M) \leq$ rank$(\Gamma - \Gamma')$. If rank$(M) \leq$ rank$(\Gamma - \Gamma')$, failing to reject the hypothesis rank$(\Gamma - \Gamma') = 0$ implies rank$(M) = 0$, and failing to reject rank$(\Gamma - \Gamma') = 2$ implies rank$(M) = 2$. See Sözbir (2024) for more discussions about this result.

[36] We use $\Gamma_{i,k}$ for the $(i,k)^{th}$ element of Γ.

[37] Note that our rank test results are robust to all possible order of budget shares (Sözbir, 2024).

[38] Finding separate instruments for each of the four wages (two for each spouse) is challenging. Note that prices are typically assumed to be exogenous in studies estimating consumption-based disaggregated demand systems, as finding valid instruments for each price is very difficult.

sider this instrumental variable strategy as a robustness check, and we assume the exogeneity of wages for the main results. The estimates with or without using these instruments lead to the same conclusion regarding intra-household decision-making (see Section 7.3).

6 Data

We use data from three waves of the Bangladesh Integrated Household Survey (BIHS) which were conducted in 2011/12, 2015, and 2018/19. The survey was designed to analyze intra-household dynamics and thus has been previously used to study nutrional inequality (D'Souza and Tandon, 2019), consumption inequality (Brown et al., 2021; Botosaru et al., 2023; Lechene et al., 2022), consumption inefficiency (Lewbel and Pendakur, 2024), and economies of scale in consumption (Calvi et al., 2023).[39]

We rely primarily on the labor supply and expenditure modules in our analysis. The labor supply module includes information on the activities of all individuals (age six and above) in the household over the previous week. This data includes the type of occupation, hours worked in that occupation, and the income (both cash and in-kind) for each activity.[40] We calculate hourly wages by dividing income by hours worked in each occupation. When income is missing, we rely on occupation-specific village-level averages.[41] As discussed in Section 3, a distinct feature of employment in Bangladesh is the prevalence of multiple job holding. The BIHS provides hours and income information for all occupations of each individual. We distinguish between primary and secondary occupations by whichever job the individual devoted more hours to in the previous week. Since some indiviudals work more than two occupations, we pool hours worked in jobs two and higher into a single occupation. Wages for this job are then a weighted average of the wages in each individual occupation, where the weights are the hours worked.[42] Note that under this categorization of jobs (primary vs. secondary) that is based on working hours, the wage rate in the secondary job can be higher than in the primary job. Finally, we infer non-labor income using the labor supply data in conjunction with the expenditure module. The expenditure module includes weekly expenditures on individual food items, monthly expenditures on non-durable goods, and a yearly recall of semi-durable consumption goods. We compute non-labor income as the difference between expenditure and labor income of the household.

As previously discussed, our tests apply to only a subset of households. We limit our sample to households with two married adults with children below 12. This age cutoff is imposed considering the legal framework relating to the employment of children in Bangladesh.[43] As children aged 12 and above can legally work and earn income, they might have bargaining power within the household, regardless of their actual work status. This would then require us to model these children as decision-makers with non-zero

[39]The BIHS was designed by the International Food Policy Research Institute (IFPRI) with data collected by DATA Limited, both of whom have extensive experience in complex surveys. Reflecting the survey's high quality, its data has been used in several well-published studies, many of which conducted sensitivity analyses on measurement error with positive results.

[40]Earnings information in the BIHS is mostly in line with the agricultural wage rates provided in the Bangladesh Monthly Statistical Bulletin by Bangladesh Bureau of Statistics.

[41]If the wage information for an activity is not available in a village, we use increasingly larger clusters, i.e., village, upazila and district.

[42]Our results are robust to selecting a subsample of households where spouses have exactly two jobs. See Section 7.3 for details.

[43]The principles regarding children's employment in Bangladesh are provided by the Bangladesh Labour Act 2006, and the amendment in 2013. In line with the Minimum Age Convention of the International Labour Organization (ILO, C138), children aged 12 and above can be employed in non-hazardous, light work up to 42 hours a week. Also, note that we observe very few employed children below age 12 in the BIHS, and a noticeable increase in employment rate at age 12.

Table 1: Descriptive Statistics

	Mean	**Median**	**Std. Dev.**
Husband:			
Primary wage	38.57	30.28	31.25
Secondary wage	56.95	37.31	66.96
Primary hours	37.72	36.00	17.03
Secondary hours	12.89	11.00	8.80
Wife:			
Primary wage	27.21	16.67	31.05
Secondary wage	16.04	8.50	20.37
Primary hours	11.49	7.00	8.29
Secondary hours	6.18	7.00	3.54
Preference factors:			
Age of husband	40.80	37.00	12.27
Number of children	1.50	1.00	1.03
$\mathbb{1}$(Dhaka)	0.29	0.00	0.46
Household:			
Consumption (C)	2468.05	2168.39	1306.38
Total expenditure (with leisure)	7704.89	6521.09	4328.71
Observations		1,114	

Note: Bangladesh Integrated Household Survey (2011/12, 2015, 2018/19). The table reports some descriptive statistics of the sample used in estimation. The distinction between the primary and secondary occupation is determined by which activity comprises a larger share of the individual's weekly time. All monetary values are measured in Bangladeshi Takas. Household expenditure and working hours are weekly.

Pareto weights.[44] We then drop couples where either spouse works fewer than two jobs. As previously discussed, this would be a limiting restriction in a developed country, but less so in Bangladesh where work in multiple activities is common. To analyze how different our sample is from those households that are not included due to multiple job holding restriction, we conduct a difference-in-means test based on six household characteristics. The results are given in Table A4 in the Appendix. We do not find any significant difference between these two groups of households in terms of household expenditure and the ages of spouses. The differences in the number of children and education of spouses are significant but not sizable. Nonetheless, we address this selection issue further using a Heckman selection specification which we discuss in Section 7.3. Finally, we omit any household with missing data for any preference factors given in Table 1. This results in a final sample of 1,114 households.

We provide descriptive statistics in Table 1. Because of our sample restrictions, households are relatively small with 1.5 children on average. Around thirty percent of households live in the Dhaka division. Husbands spend more time in market work (38 hours in the primary job and 13 hours in the secondary job per week) than their wives (11 hours in the primary job and 6 hours in the secondary job per week).[45] Moreover, husbands earn a higher wage for both their primary and secondary occupations.

Variation in earnings (wages) is the source of identification and constitutes the basis of our test. Figure A2 in Appendix C shows the distribution of wages for husbands and wives, in their primary and secondary

[44]This restriction on the household composition is common in the collective labor supply literature (see Sözbir (2024) for further discussions). Also note that all the results in this study is robust when a subsample of households without children is considered (see Section 7.3).

[45]See Figure A3 in Appendix C for the distribution of primary and secondary hours in our sample.

occupations, separately in each survey round. The main takeaway from this figure is that the variation we rely on is cross-sectional. That is, the price-adjusted (over time) wage distribution in each round almost exactly matches.[46] This is a distinct feature and important contribution of this study, as previous studies mainly rely on time variation and require observing long time series of cross-sections.

7 Empirical Results

7.1 Demand System Estimates

Before discussing the results of the rank tests which assess the validity of the collective model, we begin in Table 2 by presenting the parameter estimates of our demand system given by Equations (8) and (9). Columns 1 and 2 correspond to the leisure demand equations for the husband's first and second jobs, respectively. Columns 3 and 4 present the analogous equations for the wife.

We find the parameter estimates for ζ, which correspond to the quadratic term, are significant for all budget shares. This suggests that the Engel curves are nonlinear in log full income, and therefore, a specification like QUAIDS is needed. The signs of the coefficient estimates for β and ζ are the same for the primary jobs of both spouses; our estimates of β is significant and positive, while estimates of ζ are significant and negative. With regard to the secondary jobs, we find our estimate of β to be negative and significant for the husband, while insignificant for the wife. The estimate of ζ is positive only for husband's secondary job.

Our three preference factors are husband's age, number of children, and an indicator for living in the Dhaka division. These demographic controls affect the system in a non-linear way through the parameter α. The results show that the coefficient estimates for the husband's age and number of children are significant only for the budget share corresponding to husband's primary job. We would expect the number of children to affect the wife's leisure. The insignificant estimates for this preference factor for budget shares corresponding to the wife's labor supply might be due to the homogeneity of our sample. Again, note that average number of children in nuclear families in our sample is less than two. We find significant estimates regarding the coefficients corresponding to the Dhaka indicator in the husband's primary and the wife's secondary jobs.

As discussed in Section 5, we are especially interested in the estimate of the Γ matrix, which is given by the first four rows and columns of Table 2. All diagonal elements $\Gamma_{i,i}$, for $i = 1, \dots, 4$, are estimated to be positive and significant. The signs of the coefficient estimates corresponding to non-diagonal elements vary. Among twelve non-diagonal elements, eight of them are precisely estimated while we have insignificant estimates for $\Gamma_{2,1}, \Gamma_{2,3}, \Gamma_{3,4}$, and $\Gamma_{4,2}$, where $\Gamma_{i,k}$ corresponds to budget share i and log wage k.[47] To save space we do not report income or price elasticities. Our main interest is to test the rank of the non-symmetric component of the Pseudo-Slutsky matrix, and the estimates of the Γ matrix is sufficient for our purpose.

[46] Only for wife's primary job, the location (mean) of the distribution seems to shift in the third round.

[47] Note that as the demand system is non-linear in Γ (also in α), it is difficult to interpret these parameters. In particular, $\Gamma_{i,k}$ shows the marginal effect of log wage k on budget share i when deflated full income, $\ln g - a(\pi)$, is held constant. However, when wages change, deflated full income changes, as well.

Table 2: Estimation Results: Demand System and Rank Tests

Panel A: Demand System	Husband's primary job ω_1 (1)	Husband's secondary job ω_2 (2)	Wife's primary job ω_3 (3)	Wife's secondary job ω_4 (4)
Husband's primary wage	14.34	-0.89	-4.70	-0.85
	(0.66)	(0.60)	(0.43)	(0.22)
Husband's secondary wage	-5.09	11.41	-2.49	0.32
	(0.84)	(0.96)	(0.58)	(0.25)
Wife's primary wage	-4.44	-0.38	8.69	-0.30
	(0.34)	(0.34)	(0.26)	(0.10)
Wife's secondary wage	-1.33	-0.84	-0.28	3.11
	(0.27)	(0.22)	(0.18)	(0.14)
α (intercept)	-20.34	36.35	1.14	1.00
	(3.49)	(2.91)	(2.06)	(1.10)
α (husband's age)	0.06	0.01	-0.01	-0.01
	(0.02)	(0.02)	(0.02)	(0.01)
α (number of children)	-1.53	-0.38	-0.12	-0.05
	(0.27)	(0.25)	(0.23)	(0.09)
α (Dhaka)	-1.11	-0.67	0.23	0.60
	(0.55)	(0.52)	(0.42)	(0.22)
β	7.90	-15.25	4.05	0.23
	(1.73)	(0.83)	(0.77)	(0.46)
ζ	-0.36	0.86	-0.16	-0.06
	(0.11)	(0.11)	(0.04)	(0.02)

Panel B: Rank Tests	Rank = 0	Rank = 2
χ^2	33.91	0.39
p-value	(0.00)	(0.53)

Note: Bangladesh Integrated Household Survey (2011/12, 2015, 2018/19). Panel A shows the coefficient estimates and standard errors (in parentheses) of the demand system; all values are multiplied by 100. Panel B shows the rank test results for the matrix M. If $rank(M) = 0$, that would indicate a failure to reject the unitary model. If $rank(M) = 2$, that would indicate a failure to reject the collective model.

7.2 Rank Tests

In Panel B of Table 2 we provide our main results pertaining to the rank tests. Recall the implication of the collective model is that the anti-symmetric matrix $M = S - S'$ is of at most rank two. Moreover, if the household were unitary, the rank would be zero. Therefore, rejecting both cases would give evidence against Pareto efficiency assumption. As explained in Section 5, a particular convenience for QUAIDS specification is that the rank of $M = S - S'$ can be inferred from the rank of $\Gamma - \Gamma'$. Therefore, we test the rank of $\Gamma - \Gamma'$.

First, we test whether rank$(\Gamma - \Gamma') = 0$, i.e., the case of unitary model, which is equivalent to testing whether Γ is symmetric. We find strong evidence against the unitary model as the χ^2 statistic is 33.91, with a p-value of less than 0.01. This result is not surprising and consistent with the overwhelming majority of past studies that have tested the unitary model. Moving to our test of the collective model, we are unable to reject that rank$(\Gamma - \Gamma') = 2$, as the χ^2 statistic is very low at 0.39, with a p-value 0.53.[48] From this we

[48]Note that we first check our assumption underlying the rank$(\Gamma - \Gamma') = 2$ case, which is $\gamma_{12} \neq 0$. This is equivalent to testing $\Gamma_{1,2} = \Gamma_{2,1}$, and we reject the equality of $\Gamma_{1,2}$ and $\Gamma_{2,1}$ (with p-value less than 0.01).

conclude that Pareto efficiency is not an overly strong assumption in our context.

These results are consistent with other studies that examine Bangladeshi households. Brown et al. (2021) test the collective model using the proportionality test, and their results, conducted on a less restrictive sample, are in line with our findings. However, note that our test is based on a more general model as we do not make assumptions of egoistic preferences or separability of household consumption and leisure. Also we do not rely on distribution factors. Therefore, our test complements previous tests of the collective model, which are based on more restrictive assumptions but less restrictive sample selection criteria.

7.3 Robustness Checks

Our failure to reject the collective rationality is specific to the subset of households where both the husband and wife work multiple jobs. Our focus on this sample results in a selection issue, which we deal with using the usual Heckman (1979) procedure. Specifically, we use all households with two married adults and children below 12, and select our estimation sample that satisfies the multiple job holding criterion based on the variables in Table A4. Then, we include the predicted inverse Mills' ratio from the selection equation to the demand system provided in Equations (8) and (9). Demand system estimation results are provided in Table A5. The coefficient estimate for the predicted inverse Mills' Ratio is significant for the husband's secondary and the wife's primary job, while insignificant for the other equations. The first row under Panel A of the Table 3 shows the rank test results. Again, we reject the unitary model, but fail to reject the collective model.

We examine whether our results are robust when we consider a subsample of households without children. Note that in the context of Bangladesh, childless couples correspond to a very small proportion of the households. That is why we focus on nuclear households with children (or without) aged less than 12. As discussed in Section 6, these children are unlikely to be decision-makers in the sense of the collective model considering the legal framework regarding their employment. However, one might still argue that the rejection of the rank$(M) = 2$ case implies decision-making power of children (below 12) in our sample instead of the rejection of Pareto efficiency (Dauphin et al., 2011; Sözbir, 2024). To address this issue, we select a subsample of 206 nuclear households without children, and apply the same rank test procedure.[49] Table A6 provide the demand system estimation results; the rank test results are given in the second row under Panel A of Table 3. Similar to the main results, we strongly reject the unitary model but fail to reject the collective model.[50]

As we explained in Section 6, when individuals have more than two jobs, we pool together their secondary jobs. It might be useful to check whether the results continue to hold if we select a subsample of households where spouses have exactly two jobs (658 households). This analysis might alleviate the concerns about using hour-based weighted average for the secondary job wage, as well. Table A7 in the Appendix provide the demand system estimation results; the rank test results are given in the third row

[49] We also experiment with a subsample of households where there is no child above six. The rank test results are similar to the main case.

[50] Note that one of the main contributions of our study is to provide a statistically powerful test to collective rationality by relying on individual-level prices (wages). This is reflected in rank tests results as we strongly reject the unitary model in every case, and the p-values for the rank$(\Gamma - \Gamma') = 2$ test are not close to one. Therefore, the statistical power is not a concern for our test. However, for this robustness check with childless couples, the p-value for the rank$(\Gamma - \Gamma') = 2$ test is 0.87. This is potentially due to the small sample size, and the statistical power might be a concern for this particular robustness check.

Table 3: Robustness Checks: Rank Tests

	Rank = 0 (1)	Rank = 2 (2)
Panel A: Sample, inference, specification		
Selection-corrected	31.40	0.47
	(0.00)	(0.49)
Childless Couples	18.51	0.03
	(0.01)	(0.87)
Exactly two jobs	15.91	1.62
	(0.01)	(0.20)
Clustered Standard Errors	25.97	0.39
	(0.00)	(0.53)
Leave-one-out wages (IV)	61.76	0.08
	(0.00)	(0.78)
Panel B: Total available time		
$T'_{dk} = T_{dk} + 10$ for $d = m, f$ and $k = 1, 2$	34.70	0.74
	(0.00)	(0.39)
$T''_{d1} = 168 - T''_{d2}$ and $T''_{d2} = T_{d2}$ for $d = m, f$	77.13	0.80
	(0.00)	(0.37)
$T'''_{d1} = 100$ and $T'''_{d2} = 68$ for $d = m, f$	71.57	1.23
	(0.00)	(0.27)

Note: Bangladesh Integrated Household Survey (2011/12, 2015, 2018/19). Rank test results for the robustness checks. *Panel A*: (1) selection into the main sample is taken into account, (2) a sub-sample of household without children or (3) a sub-sample of households where spouses have exactly two jobs are selected, (4) standard errors are clustered at the village level, and (5) leave-one-out instruments are used for wages. *Panel B*: three alternatives for T_{dk}'s for $d = m, f$ and $k = 1, 2$. If $rank(M) = 0$, that would indicate a failure to reject the unitary model. If $rank(M) = 2$, that would indicate a failure to reject the collective model.

under Panel A of Table 3. Similar to the main results, we reject the unitary model but fail to reject Pareto efficiency.

We check whether our results are robust to clustering standard errors. The price variation in our study (wages) is at the individual-level, and thus in our main specification we chose to use robust standard errors without any clustering. However, there might be village-level unobserved effects on wages. Also note that when income information is missing for an individual for a particular job, we use average earnings for the same job in the village (or increasingly larger clusters). Additionally, the primary sampling unit of the BIHS is village. Considering these points, we test whether our results continue to hold when standard errors are clustered at the village level. The results of the demand system are given in Table A8; the fourth row under Panel A of the Table 3 shows the rank test results. Similar to the main results, we strongly reject the unitary model but fail to reject the collective model.

As we discussed in Section 5, our main results are based on the assumption that wages are exogenous. As a robustness check, we use leave-one-out instruments for wages. Specifically, for a particular person and occupation, this instrument takes the regional (village) average wage for that occupation, excluding the individual of interest. Therefore, instruments are individual-specific, just like wages. We apply the same idea when instrumenting the full potential income, i.e., we construct the instrument for household-level g by using leave-one-out wages of household members instead of actual wages. For this robustness check, we estimate the system by Iterated Linear Least Squares (ILLS) proposed by Blundell and Robin (1999), where the endogeneity in wages is tackled with an augmented regression technique.[51] The results of the demand system are given in Table A9; the fifth (last) row under Panel A of the Table 3 shows the rank test results. Similar to the main results, we strongly reject the unitary model but fail to reject the collective model.

In addition to these robustness checks regarding the sample, specification, and inference, we check whether our results continue to hold under different definitions of total available times. To reiterate, we choose T_{dk} to be one plus the maximum observed working hours by (household member) type $d \in \{m, f\}$ for the job $k = 1, 2$, similar to Choe et al. (2018). However, this choice is arbitrary. To see how the results would change if we defined T_{dk}'s differently, we estimate household demand and perform the rank tests with three alternative choices. First, we simply add 10 hours to the original T_{dk} for each member type and job; available times in this case are denoted by T'_{dk} for $d \in \{m, f\}$ and $k = 1, 2$.[52] Second, for each type, we define available time for the primary job to be 168 minus the original available time for the secondary job. That is, $T''_{d1} = 168 - T''_{d2}$ and $T''_{d2} = T_{d2}$. Finally, we simply fix available times as $T'''_{d1} = 100$ and $T'''_{d2} = 68$. Note that the last two alternatives ensure that the total available times add up to 168.[53] The results of these three robustness checks concerning total available times are provided in Panel B of Table 3; the corresponding demand system estimates are given in Tables A10-A12. In all these alternatives, we strongly reject the unitary model but fail to reject Pareto efficiency, similar to the main results.

Overall, these robustness checks reinforce our conclusion that Pareto efficiency is not an overly strong assumption for households in rural Bangladesh. Tackling the sample selection issue by considering a two-step selection approach, dropping households with children to ensure that there are exactly two members, choosing households where spouses have exactly two jobs, clustering standard errors at the village level, using leave-one-out instruments for wages, and defining total available times differently do not change our conclusion.

8 Conclusion

The collective household model, which postulates Pareto efficiency in household decisions, has recently become the workhorse model in the family economics literature. This model has been used to estimate the individual-level poverty using household-level data, as well the intra-household effects of various policies. However, the Pareto efficiency assumption has been questioned, especially when applied to developing country households. This study provides a labor supply-based test of Pareto efficiency in household decisions that overcomes several limitations of the previous tests in the literature. Our test is based on cross-sectional price variation in wages, and is especially relevant for developing countries.

Testing the collective household model using price variation requires observing at least five goods.

[51] We use the program by Lecocq and Robin (2015). In earlier versions of this study, we used GMM for this robustness check and obtained the same conclusion for the rank test. The computational advantage of the ILLS method is great compared to other non-linear techniques, including the one we use for our main results. As a further check, we also estimate our main specification without using instruments with ILLS. Again, we strongly reject the unitary model but fail to reject collective rationality.

[52] Note that even for men, these alternatives available hours do not exceed 168 as 85+43+10+10 = 148.

[53] In addition to these three robustness checks, we also consider increasing available time only for the primary or secondary job by 10 hours. Again, we reject the unitary model but fail to reject the collective model.

This requirement seemingly rules out the use of labor supply decisions of household members together with a Hicksian consumption good to test the collective model (Browning and Chiappori, 1998). However, in this study we identify a novel setting—multiple job holding—to overcome this obstacle. When couples are engaged in multiple occupations, they supply labor at different wage rates in their primary and secondary jobs. This results in five goods for the household: two labor supplies for each member and a Hicksian consumption good. Then, individual-specific wage rates provide sufficient price variation to test the model. Moreover, there is no need to use detailed household consumption, which is generally plagued with measurement error.

We apply this theoretical idea in rural Bangladesh where multiple job holding is prevalent. We test the collective model on a sample of nuclear households where both couples hold two or more jobs. Unlike much of the existing literature, our test does not require distribution factors. This is important considering the theoretical issues, as well as the seemingly contradictory empirical evidence of the tests using distribution factors. Moreover, unlike previous price-based tests, which rely on region- (or country) level prices and long time series of data to generate sufficient price variation, we utilize individual-specific prices that exhibit substantial cross-sectional variation. This allows us to estimate the response of household demand to prices precisely, and provide a robust test to Pareto efficiency.

The results show that household decisions are compatible with the collective model, while we find strong evidence against the unitary model. Therefore, we cannot rule out the Pareto efficiency assumption for Bangladeshi households. Our results are based on a flexible specification for household demand and are robust to selection into multiple job holding, different household compositions, endogeneity in wages, clustering standard errors at the regional level, and different assumptions regarding the available time for market work. The findings are in line with previous tests in this context that rely on more restrictive model assumptions (e.g., egoistic preferences, or separability of leisure from consumption), detailed consumption data, and distribution factors. The main limitation of our study is that it pertains to a select sample of married couples who work multiple occupations. Nonetheless, our study provides a robust test of Pareto efficiency for a small population and complements previous tests that can be conducted more broadly, but are based on more stringent data requirements and model assumptions.

References

ANGELUCCI, M. AND R. GARLICK (2016): "Heterogeneity in the Efficiency of Intrahousehold Resource Allocation: Empirical Evidence and Implications for Investment in Children," Working Paper. [3], [5]

APPS, P. F. AND R. REES (1988): "Taxation and the Household," *Journal of Public Economics*, 35, 355–369. [2]

ASHRAF, N. (2009): "Spousal Control and Intra-household Decision Making: An Experimental Study in the Philippines," *American Economic Review*, 99, 1245–1277. [7]

ASHRAF, N., E. FIELD, AND J. LEE (2014): "Household Bargaining and Excess Fertility: An Experimental Study in Zambia," *American Economic Review*, 104, 2210–2237. [7]

ATTANASIO, O. AND V. LECHENE (2002): "Tests of Income Pooling in Household Decisions," *Review of Economic Dynamics*, 5, 720–748. [2]

ATTANASIO, O. P. AND V. LECHENE (2014): "Efficient Responses to Targeted Cash Transfers," *Journal of Political Economy*, 122, 178–222. [2], [3], [5]

BAILEY, K. A. AND J. R. SPLETZER (2021): "A New Measure of Multiple Jobholding in the US Economy," *Labour Economics*, 71, 102009. [4]

BANKS, J., R. BLUNDELL, AND A. LEWBEL (1997): "Quadratic Engel Curves and Consumer Demand," *Review of Economics and Statistics*, 79, 527–539. [15], [16]

BARGAIN, O., G. LACROIX, AND L. TIBERTI (2022): "Intrahousehold Resource Allocation and Individual Poverty: Assessing Collective Model Predictions Using Direct Evidence on Sharing," *Economic Journal*, 132, 865–905. [2], [5]

BARRETT, C., T. REARDON, AND P. WEBB (2001): "Nonfarm Income Diversification and Household Livelihood Strategies in Rural Africa: Concepts, Dynamics, and Policy Implications," *Food Policy*, 26, 315–331. [7]

BELL, D., R. A. HART, AND R. E. WRIGHT (1997): "Multiple Job Holding as a 'Hedge' Against Unemployment," Tech. rep., CEPR Discussion Papers. [7]

BLOCH, F. AND V. RAO (2002): "Terror as a Bargaining Instrument: A Case Study of Dowry Violence in Rural India," *American Economic Review*, 92, 1029–1043. [7]

BLUNDELL, R., P.-A. CHIAPPORI, T. MAGNAC, AND C. MEGHIR (2007): "Collective Labour Supply: Heterogeneity and Non-participation," *Review of Economic Studies*, 74, 417–445. [15]

BLUNDELL, R., P. PASHARDES, AND G. WEBER (1993): "What Do We Learn About Consumer Demand Patterns from Micro Data?" *American Economic Review*, 83, 570–597. [2]

BLUNDELL, R. AND J. M. ROBIN (1999): "Estimation in Large and Disaggregated Demand Systems: An Estimator for Conditionally Linear Systems," *Journal of Applied Econometrics*, 14, 209–232. [24]

BOBONIS, G. J. (2009): "Is the Allocation of Resources within the Household Efficient? New Evidence from a Randomized Experiment," *Journal of Political Economy*, 117, 453–503. [3], [5]

BOTOSARU, I., C. MURIS, AND K. PENDAKUR (2023): "Identification of Time-varying Transformation Models with Fixed Effects, with an Application to Unobserved Heterogeneity in Resource Shares," *Journal of Econometrics*, 232, 576–597. [18]

BOURGUIGNON, F., M. BROWNING, AND P.-A. CHIAPPORI (2009): "Efficient Intra-household Allocations and Distribution Factors: Implications and Identification," *Review of Economic Studies*, 76, 503–528. [2], [3], [5]

BOURGUIGNON, F., M. BROWNING, P.-A. CHIAPPORI, AND V. LECHENE (1993): “Intra Household Allocation of Consumption: A Model and Some Evidence from French Data,” *Annales d’Economie et de Statistique*, 29, 137–156. [5]

BROWN, C., R. CALVI, AND J. PENGLASE (2021): “Sharing the Pie: An Analysis of Undernutrition and Individual Consumption in Bangladesh,” *Journal of Public Economics*, 200, 104460. [5], [18], [22]

BROWNING, M. AND P. CHIAPPORI (1998): “Efficient Intra-household Allocations: A General Characterization and Empirical Tests,” *Econometrica*, 66, 1241–1278. [2], [3], [4], [5], [6], [9], [11], [12], [13], [15], [16], [17], [25]

BROWNING, M., P.-A. CHIAPPORI, AND V. LECHENE (2006): “Collective and Unitary Models: A Clarification,” *Review of Economics of the Household*, 4, 5–14. [2]

BROWNING, M., P.-A. CHIAPPORI, AND A. LEWBEL (2013): “Estimating Consumption Economies of Scale, Adult Equivalence Scales, and Household Bargaining Power,” *Review of Economic Studies*, 80, 1267–1303. [6], [9], [32]

BROWNING, M., P.-A. CHIAPPORI, AND Y. WEISS (2014): *Economics of the Family*, Cambridge University Press. [5]

BROWNING, M., O. DONNI, AND M. GØRTZ (2021): “Do You Have Time to Take a Walk Together? Private and Joint Time Within the Household,” *Economic Journal*, 131, 1051–1080. [15]

CALVI, R. (2020): “Why are Older Women Missing in India? The Age Profile of Bargaining Power and Poverty,” *Journal of Political Economy*, 128, 2453–2501. [2]

CALVI, R. AND A. KESKAR (2023): “’Til Dowry Do Us Part: Bargaining and Violence in Indian Families,” *Review of Economics and Statistics*, 1–45. [7]

CALVI, R., J. PENGLASE, D. TOMMASI, AND A. WOLF (2023): “The More the Poorer? Resource Sharing and Scale Economies in Large Families,” *Journal of Development Economics*, 160, 102986. [18]

CHERCHYE, L., B. DE ROCK, A. LEWBEL, AND F. VERMEULEN (2015): “Sharing Rule Identification for General Collective Consumption Models,” *Econometrica*, 83, 2001–2041. [16]

CHERCHYE, L., B. DE ROCK, AND F. VERMEULEN (2007): “The Collective Model of Household Consumption: A Nonparametric Characterization,” *Econometrica*, 75, 553–574. [2]

——— (2011): “The Revealed Preference Approach to Collective Consumption Behaviour: Testing and Sharing Rule Recovery,” *Review of Economic Studies*, 78, 176–198. [2]

CHIAPPORI, P.-A. (1988): “Rational Household Labor Supply,” *Econometrica*, 56, 63–90. [2]

——— (1992): “Collective Labor Supply and Welfare,” *Journal of Political Economy*, 100, 437–467. [2]

CHIAPPORI, P.-A. AND I. EKELAND (2006): “The Micro Economics of Group Behavior: General Characterization,” *Journal of Economic Theory*, 130, 1–26. [2], [3], [9]

CHIAPPORI, P.-A., B. FORTIN, AND G. LACROIX (2002): “Marriage Market, Divorce Legislation, and Household Labor Supply,” *Journal of Political Economy*, 110, 37–72. [3], [5]

CHIAPPORI, P.-A. AND M. MAZZOCCO (2017): “Static and Intertemporal Household Decisions,” *Journal of Economic Literature*, 55, 985–1045. [2]

CHOE, C., R. L. OAXACA, AND F. RENNA (2018): “Constrained vs Unconstrained Labor Supply: The Economics of Dual Job Holding,” *Journal of Population Economics*, 31, 1279–1319. [7], [14], [15], [16], [24] CONWAY, K. S. AND J. KIMMEL (1998): "Male Labor Supply Estimates and the Decision to Moonlight," *Labour Economics*, 5, 135–166. [7]

COSAERT, S., A. THELOUDIS, AND B. VERHEYDEN (2023): "Togetherness in the Household," *American Economic Journal: Microeconomics*, 15, 529–579. [9], [15], [17]

COUPRIE, H. (2007): "Time Allocation Within the Family: Welfare Implications of Life in a Couple," *Economic Journal*, 117, 287–305. [17]

DAUPHIN, A., A.-R. EL LAHGA, B. FORTIN, AND G. LACROIX (2011): "Are Children Decision-makers within the Household?" *Economic Journal*, 121, 871–903. [4], [6], [16], [17], [22]

DAUPHIN, A., B. FORTIN, AND G. LACROIX (2018): "Is Consumption Efficiency within Households Falsifiable?" *Review of Economics of the Household*, 16, 737–766. [3], [5]

DE ROCK, B., T. POTOMS, AND D. TOMMASI (2022): "Household Responses to Cash Transfers," *Economic Development and Cultural Change*, 70, 625–652. [3], [5]

DEATON, A. AND J. MUELLBAUER (1980): "An Almost Ideal Demand System," *American Economic Review*, 70, 312–326. [16]

DERCON, S. AND P. KRISHNAN (2000): "In Sickness and in Health: Risk Sharing within Households in Rural Ethiopia," *Journal of Political Economy*, 108, 688–727. [4]

D'SOUZA, A. AND S. TANDON (2019): "Intrahousehold Nutritional Inequities in Rural Bangladesh," *Economic Development and Cultural Change*, 67, 625–657. [18]

DUFLO, E. AND C. R. UDRY (2004): "Intrahousehold Resource Allocation in Cote d'Ivoire: Social Norms, Separate Accounts and Consumption Choices," Working Paper. [4]

DUNBAR, G. R., A. LEWBEL, AND K. PENDAKUR (2013): "Children's Resources in Collective Households: Identification, Estimation, and an Application to Child Poverty in Malawi," *American Economic Review*, 103, 438–71. [2], [6], [17]

GUARIGLIA, A. AND B.-Y. KIM (2004): "Earnings Uncertainty, Precautionary Saving, and Moonlighting in Russia," *Journal of Population Economics*, 17, 289–310. [7]

HAAG, B. R., S. HODERLEIN, AND K. PENDAKUR (2009): "Testing and Imposing Slutsky Symmetry in Nonparametric Demand Systems," *Journal of Econometrics*, 153, 33–50. [2]

HECKMAN, J. J. (1979): "Sample Selection Bias as a Specification Error," *Econometrica*, 47, 153–161. [22]

HLOUSKOVA, J., P. TSIGARIS, A. CAPLANOVA, AND R. SIVAK (2017): "A Behavioral Portfolio Approach to Multiple Job Holdings," *Review of Economics of the Household*, 15, 669–689. [7]

HODERLEIN, S. AND S. MIHALEVA (2008): "Increasing the Price Variation in a Repeated Cross Section," *Journal of Econometrics*, 147, 316–325. [2]

KAPAN, T. (2009): "Collective Households and "Unitary" Households, and the Role of Outside Options: Evidence from Turkey," PhD Dissertation, Columbia University. [4], [6]

KATZ, L. F. AND A. B. KRUEGER (2019): "The Rise and Nature of Alternative Work Arrangements in the United States, 1995–2015," *ILR review*, 72, 382–416. [4]

KIMMEL, J. AND K. SMITH CONWAY (2001): "Who Moonlights and Why? Evidence from the SIPP," *Industrial Relations: A Journal of Economy and Society*, 40, 89–120. [7]

KOOREMAN, P. AND A. KAPTEYN (1986): "Estimation of Rationed and Unrationed Household Labour Supply Functions Using Flexible Functional Forms," *Economic Journal*, 96, 398–412. [14], [16] KRISHNAN, P. (1990): "The Economics of Moonlighting: A Double Self-selection Model," *Review of Economics and Statistics*, 72, 361–367. [7]

LECHENE, V., K. PENDAKUR, AND A. WOLF (2022): "Ordinary Least Squares Estimation of the Intrahousehold Distribution of Expenditure," *Journal of Political Economy*, 130, 681–731. [2], [18]

LECOCQ, S. AND J.-M. ROBIN (2015): "Estimating Almost-ideal Demand Systems with Endogenous Regressors," *The Stata Journal*, 15, 554–573. [24]

LEWBEL, A. AND K. PENDAKUR (2022): "Inefficient Collective Households: Cooperation and Consumption," *Economic Journal*, 132, 1882–1893. [6]

——— (2024): "Estimating a Model of Inefficient Cooperation and Consumption in Collective Households," *Review of Economics of the Household*, 22, 1–43. [6], [18]

LISE, J. AND S. SEITZ (2011): "Consumption Inequality and Intra-household Allocations," *Review of Economic Studies*, 78, 328–355. [2], [10], [15], [17]

LUNDBERG, S. J., R. A. POLLAK, AND T. J. WALES (1997): "Do Husbands and Wives Pool Their Resources? Evidence from the United Kingdom Child Benefit," *Journal of Human Resources*, 32, 463–480. [2]

PAXSON, C. H. AND N. SICHERMAN (1996): "The Dynamics of Dual Job Holding and Job Mobility," *Journal of Labor Economics*, 14, 357–393. [7]

PENGLASE, J. (2021): "Consumption Inequality Among Children: Evidence from Child Fostering in Malawi," *Economic Journal*, 131, 1000–1025. [2]

RAY, R. (1982): "Estimating Utility Consistent Labour Supply Functions: Some Results on Pooled Budget Data," *Economics Letters*, 9, 389–395. [16]

REARDON, T. (1997): "Using Evidence of Household Income Diversification to Inform Study of the Rural Nonfarm Labor Market in Africa," *World Development*, 25, 735–747. [7]

ROBINSON, J. (2012): "Limited Insurance within the Household: Evidence from a Field Experiment in Kenya," *American Economic Journal: Applied Economics*, 4, 140–64. [4]

SHISHKO, R. AND B. ROSTKER (1976): "The Economics of Multiple Job Holding," *American Economic Review*, 66, 298–308. [7]

SÖZBIR, O. F. (2024): "Children's Say in the Household," Working Paper. [6], [9], [16], [17], [19], [22]

STERN, N. (1986): "On the Specification of Labour Supply Functions," 143–189, in: Blundell, Richard and Walker, Ian, (eds.) Unemployment, Search and Labour Supply. Cambridge University Press, Cambridge, UK. [14]

THOMAS, D. (1990): "Intra-household Resource Allocation: An Inferential Approach," *Journal of Human Resources*, 25, 635–664. [2]

UDRY, C. (1996): "Gender, Agricultural Production, and the Theory of the Household," *Journal of Political Economy*, 104, 1010–1046. [4], [6]

UNNI, J. (1996): "Occupational Choice and Multiple Job Holding in Rural Gujarat," *Indian Economic Review*, 31, 157–183. [8]

VOENA, A. (2015): "Yours, Mine, and Ours: Do Divorce Laws Affect the Intertemporal Behavior of Married Couples?" *American Economic Review*, 105, 2295–2332. [2]

WARD-BATTS, J. (2008): "Out of the Wallet and into the Purse: Using Micro Data to Test Income Pooling," *Journal of Human Resources*, 43, 325–351. [2]

WU, Z., M. BAIMBRIDGE, AND Y. ZHU (2009): "Multiple Job Holding in the United Kingdom: Evidence from the British Household Panel Survey," *Applied Economics*, 41, 2751–2766. [7]

A Additional Details

A.1 A Simpler Model

In this section, we outline a simple version of the general model provided in Section 4, which matches our context and empirical application discussed in Section 5.

Consider a nuclear family with or without children age less than 12. The spouses are the decision-makers. Let h_{m1} and h_{m2} denote the working hours of the husband in his primary and secondary jobs, respectively. The corresponding wage rates are w_{m1} and w_{m2}. Similarly, h_{f1} and h_{f2} denote the working hours of the moonlighting wife, with the corresponding wage rates w_{f1} and w_{f2}. The household consumes a Hicksian consumption good C with price normalized to one. Let $h = (h_{m1}, h_{m2}, h_{f1}, h_{f2})$. The preferences of the husband and wife are denoted with the utility functions $u_m(-h, C)$ and $u_f(-h, C)$. Let $\pi = (w_{m1}, w_{m2}, w_{f1}, w_{f2})$ denote the vector of prices (wages), y denote the non-labor income of the household, and z denote the set of distribution factors. Note again that our test does not rely on distribution factors.

Let $\lambda_m(\pi, y, z)$ and $\lambda_f(\pi, y, z)$ denote the Pareto weights for the husband and wife, respectively, which are scalar functions such that $\lambda_m(\pi, y, z) + \lambda_f(\pi, y, z) = 1$. Assume that the household decisions lead to Pareto efficient outcomes. Then the household maximizes,

$$\lambda_m(\pi, y, z)\, u_m(-h, C) + \lambda_f(\pi, y, z)\, u_f(-h, C),$$

subject to the budget constraint,

$$C = w_{m1}h_{m1} + w_{m2}h_{m2} + w_{f1}h_{f1} + w_{f2}h_{f2} + y,$$

and the time constraint of each member,

$$\begin{aligned} h_{m1} + h_{m2} + l_m &= T_m, \\ h_{f1} + h_{f2} + l_f &= T_f. \end{aligned}$$

Note that unlike labor supply or leisure variables, T_m and T_f are not choice variables; they are fixed constants, which are possibly different for men and women (the reason for the subscripts). We choose (non-binding) available times for market work for the primary and secondary jobs T_{d1} and T_{d2} such that $T_{d1} + T_{d2} = T_d$ for $d = m, f$ and there is no observation with $h_{d1} \geq T_{d1}$ or $h_{d2} \geq T_{d2}$ (we consider alternative choices for T_d and its partitions T_{d1} and T_{d2}). Then, we write total leisure as the sum of freed-up times from two jobs, where we define l_{d1} and l_{d2} similar to working hours for the husband,

$$\begin{aligned} h_{m1} + h_{m2} + l_m &= T_m, \\ h_{m1} + h_{m2} + l_m &= T_{m1} + T_{m2}, \\ l_m &= (T_{m1} - h_{m1}) + (T_{m2} - h_{m2}), \\ l_m &= l_{m1} + l_{m2}, \end{aligned}$$

and for the wife,

$$\begin{aligned} h_{f1} + h_{f2} + l_f &= T_f, \\ h_{f1} + h_{f2} + l_f &= T_{f1} + T_{f2}, \\ l_f &= (T_{f1} - h_{f1}) + (T_{f2} - h_{f2}), \\ l_f &= l_{f1} + l_{f2}. \end{aligned}$$

Note that $l_{f1} = (T_{f1} - h_{f1})$ increases by the same amount that h_{f1} decreases; in this case, the forgone earnings would be w_{f1} per hour. Therefore, the prices of the leisure parts l_{m1}, l_{m2}, l_{f1}, and l_{f2} are the corresponding hourly wage rates w_{m1}, w_{m2}, w_{f1}, and w_{f2}. Then, the household budget constraint can be written as,

$$C + w_{m1}l_{m1} + w_{m2}l_{m2} + w_{f1}l_{f1} + w_{f2}l_{f2} = w_{m1}T_{m1} + w_{m2}T_{m2} + w_{f1}T_{f1} + w_{f2}T_{f2} + y,$$

or equivalently,

$$C - w_{m1}(T_{m1} - l_{m1}) - w_{m2}(T_{m2} - l_{m2}) - w_{f1}(T_{f1} - l_{f1}) - w_{f2}(T_{f2} - l_{f2}) = y,$$

Once adding-up is imposed (i.e., dropping the equation for C), the observed household leisure demand $(l_{m1}, l_{m2}, l_{f1}, l_{f2})$ is a vector of size four. Then the pseudo-Slutsky matrix is,

$$S = \begin{bmatrix} \frac{\partial l_{m1}}{\partial w_{m1}} - (T_{m1} - l_{m1})\frac{\partial l_{m1}}{\partial y} & \frac{\partial l_{m1}}{\partial w_{m2}} - (T_{m2} - l_{m2})\frac{\partial l_{m1}}{\partial y} & \frac{\partial l_{m1}}{\partial w_{f1}} - (T_{f1} - l_{f1})\frac{\partial l_{m1}}{\partial y} & \frac{\partial l_{m1}}{\partial w_{f2}} - (T_{f2} - l_{f2})\frac{\partial l_{m1}}{\partial y} \\ \frac{\partial l_{m2}}{\partial w_{m1}} - (T_{m1} - l_{m1})\frac{\partial l_{m2}}{\partial y} & \frac{\partial l_{m2}}{\partial w_{m2}} - (T_{m2} - l_{m2})\frac{\partial l_{m2}}{\partial y} & \frac{\partial l_{m2}}{\partial w_{f1}} - (T_{f1} - l_{f1})\frac{\partial l_{m2}}{\partial y} & \frac{\partial l_{m2}}{\partial w_{f2}} - (T_{f2} - l_{f2})\frac{\partial l_{m2}}{\partial y} \\ \frac{\partial l_{f1}}{\partial w_{m1}} - (T_{m1} - l_{m1})\frac{\partial l_{f1}}{\partial y} & \frac{\partial l_{f1}}{\partial w_{m2}} - (T_{m2} - l_{m2})\frac{\partial l_{f1}}{\partial y} & \frac{\partial l_{f1}}{\partial w_{f1}} - (T_{f1} - l_{f1})\frac{\partial l_{f1}}{\partial y} & \frac{\partial l_{f1}}{\partial w_{f2}} - (T_{f2} - l_{f2})\frac{\partial l_{f1}}{\partial y} \\ \frac{\partial l_{f2}}{\partial w_{m1}} - (T_{m1} - l_{m1})\frac{\partial l_{f2}}{\partial y} & \frac{\partial l_{f2}}{\partial w_{m2}} - (T_{m2} - l_{m2})\frac{\partial l_{f2}}{\partial y} & \frac{\partial l_{f2}}{\partial w_{f1}} - (T_{f1} - l_{f1})\frac{\partial l_{f2}}{\partial y} & \frac{\partial l_{f2}}{\partial w_{f2}} - (T_{f2} - l_{f2})\frac{\partial l_{f2}}{\partial y} \end{bmatrix}.$$

A similar derivation can also be found in Browning et al. (2013) (page 152) for the single job holding case. The household decisions are in line with the unitary model if S is symmetric. After constructing the matrix $M = S - S'$, the collective model will be rejected if rank$(M) > 2$.

A.2 Additional Details for QUAIDS

In this section, we provide the derivation of the pseudo-Slutsky matrix S and the anti-symmetric matrix M for QUAIDS. First, note that the gradient of budget shares with respect to $ln(g)$ is,

$$\omega_{ln(g)} = \beta + 2b(\pi)^{-1}\tilde{g}\zeta,$$

where $\tilde{g} = ln(g) - a(\pi)$. The partial derivative of the price index $a(\pi)$ with respect to log prices is $\alpha' + \frac{1}{2}ln(\pi)'(\Gamma + \Gamma')$. And the partial derivative of the price index $b(\pi)$ with respect to log prices is $\beta' exp[\beta' ln(\pi)] = b(\pi)\beta'$. Using these, one can write the Jacobian matrix of partial derivatives of the budget shares with respect to log prices as,

$$\omega_{ln(\pi)} = \Gamma - \beta\Big[\alpha' + \frac{1}{2}ln(\pi)'(\Gamma + \Gamma')\Big] - b(\pi)^{-2}\zeta\Big[2b(\pi)\tilde{g}[\alpha' + \frac{1}{2}ln(\pi)'(\Gamma + \Gamma')] + b(\pi)\tilde{g}^2\beta'\Big],$$
$$= \Gamma - \Big[\beta + 2b(\pi)^{-1}\tilde{g}\zeta\Big]\Big[\alpha' + \frac{1}{2}ln(\pi)'(\Gamma + \Gamma')\Big] - b(\pi)^{-1}\tilde{g}^2\zeta\beta'.$$

Then, using $\omega_{ln(\pi)}$ and $\omega_{ln(g)}$, the pseudo-Slutsky matrix can be written as,

$$S = g\,\mathrm{diag}(\pi)^{-1}\Big[\Gamma - [\beta + 2b(\pi)^{-1}\tilde{g}\zeta][\alpha' + \frac{1}{2}ln(\pi)'(\Gamma + \Gamma')] - b(\pi)^{-1}\tilde{g}^2\zeta\beta'$$
$$+ [\beta + 2b(\pi)^{-1}\tilde{g}\zeta]\omega' - \mathrm{diag}(\omega) + \omega\omega'\Big]\mathrm{diag}(\pi)^{-1},$$
$$= g\,\mathrm{diag}(\pi)^{-1}\Big[\Gamma - [\beta + 2b(\pi)^{-1}\tilde{g}\zeta][\alpha' + \frac{1}{2}ln(\pi)'(\Gamma + \Gamma')] - b(\pi)^{-1}\tilde{g}^2\zeta\beta'$$
$$+ [\beta + 2b(\pi)^{-1}\tilde{g}\zeta][\alpha' + ln(\pi)'\Gamma' + \tilde{g}\beta' + b(\pi)^{-1}\tilde{g}^2\zeta'] - \mathrm{diag}(\omega) + \omega\omega'\Big]\mathrm{diag}(\pi)^{-1},$$
$$= g\,\mathrm{diag}(\pi)^{-1}\Big[\Gamma - \frac{1}{2}[\beta + 2b(\pi)^{-1}\tilde{g}\zeta]ln(\pi)'(\Gamma - \Gamma') - b(\pi)^{-1}\tilde{g}^2\zeta\beta'$$
$$+ \tilde{g}\beta\beta' + b(\pi)^{-1}\tilde{g}^2\beta\zeta' + 2b(\pi)^{-1}\tilde{g}^2\zeta\beta' + 2b(\pi)^{-2}\tilde{g}^3\zeta\zeta' - \mathrm{diag}(\omega) + \omega\omega'\Big]\mathrm{diag}(\pi)^{-1},$$
$$= g\,\mathrm{diag}(\pi)^{-1}\Big[\Gamma - \frac{1}{2}[\beta + 2b(\pi)^{-1}\tilde{g}\zeta]ln(\pi)'(\Gamma - \Gamma')$$
$$+ \tilde{g}\beta\beta' + b(\pi)^{-1}\tilde{g}^2(\beta\zeta' + \zeta\beta') + 2b(\pi)^{-2}\tilde{g}^3\zeta\zeta' - \mathrm{diag}(\omega) + \omega\omega'\Big]\mathrm{diag}(\pi)^{-1},$$
$$= g\,\mathrm{diag}(\pi)^{-1}\Big[\Gamma - \frac{1}{2}[\beta + 2b(\pi)^{-1}\tilde{g}\zeta]ln(\pi)'(\Gamma - \Gamma')$$
$$+ \tilde{g}[\beta\beta' + b(\pi)^{-1}\tilde{g}(\beta\zeta' + \zeta\beta') + 2b(\pi)^{-2}\tilde{g}^2\zeta\zeta'] - \mathrm{diag}(\omega) + \omega\omega'\Big]\mathrm{diag}(\pi)^{-1}.$$

The transpose of S can be written as,

$$S' = g\,\mathrm{diag}(\pi)^{-1}\Big[\Gamma' + \frac{1}{2}(\Gamma - \Gamma')\ln(\pi)[\beta' + 2b(\pi)^{-1}\tilde{g}\zeta']$$
$$+ \tilde{g}[\beta\beta' + b(\pi)^{-1}\tilde{g}(\beta\zeta' + \zeta\beta') + 2b(\pi)^{-2}\tilde{g}^2\zeta\zeta'] - \mathrm{diag}(\omega) + \omega\omega'\Big]\mathrm{diag}(\pi)^{-1}.$$

Then, the anti-symmetric matrix $M = S - S'$ is,

$$M = g\,\mathrm{diag}(\pi)^{-1}\Big[\Gamma - \Gamma' - \frac{1}{2}[\beta + 2b(\pi)^{-1}\tilde{g}\zeta]ln(\pi)'(\Gamma - \Gamma')$$
$$- \frac{1}{2}(\Gamma - \Gamma')\ln(\pi)[\beta' + 2b(\pi)^{-1}\tilde{g}\zeta']\Big]\mathrm{diag}(\pi)^{-1}.$$

B Additional Tables

Table A1: Most Common Occupations Among Men

Occupation	Percent		
	2011/12	**2015**	**2018/19**
Raising livestock	19.20	21.47	24.76
Working own farm (crop)	19.07	17.23	15.03
Agricultural day labor	12.29	10.10	7.86
Share cropper/tenant	9.95	10.16	9.61
Medium trader (shop or small store)	5.46	6.45	6.57
Small trader (roadside stand or stall)	4.41	4.00	4.01
Rickshaw/van pulling	3.57	2.99	2.84
Other wage labor	2.88	3.69	3.38
Other self employed	2.22	1.64	1.17
Driver of motor vehicle	1.74	2.50	2.90
Mason	1.66	1.80	2.47
Service (private sector)	1.42	2.09	2.98
Raising fish / fish pond	1.34	1.18	1.12
Other salaried worker	1.26	1.13	1.33
Large trader (large shop or whole sale)	1.22	1.17	1.22
Earth work (other)	1.20	1.52	1.40
Carpenter	1.18	1.12	1.20
Fisherman (using non owned/not leased water body)	1.08	0.82	0.68
Fish Trader	0.79	0.48	0.30
Tailor/seamstress	0.66	0.69	0.62

Note: Bangladesh Integrated Household Survey. The most common occupations, focusing on men aged 18-65, separately for each round of the BIHS.

Table A2: Most Common Occupations Among Women

	Percent		
Occupation	**2011/12**	**2015**	**2018/19**
Raising poultry	49.64	52.25	50.83
Raising livestock	36.52	33.07	34.22
Handicrafts	1.45	1.54	1.28
Agricultural day labor	1.33	1.30	1.51
Other wage labor	1.25	0.82	0.49
Tailor/seamstress	1.22	1.72	2.38
Working own farm (crop)	1.22	1.44	1.53
Small trader (roadside stand or stall)	0.89	0.71	0.78
House maid	0.76	0.63	0.60
Other self employed	0.75	0.72	0.58
Share cropper/tenant	0.56	0.93	0.96
Earth work (govt program)	0.42	0.30	0.08
Tea garden worker	0.41	0.37	0.40
Service (private sector)	0.41	0.78	0.92
Other salaried worker	0.39	0.41	0.35
Medium trader (shop or small store)	0.29	0.39	0.35
Private tutor/house tutor	0.27	0.44	0.55
Earth work (other)	0.23	0.10	0.08
Beggar	0.22	0.12	0.11
NGO worker	0.19	0.24	0.11

Note: Bangladesh Integrated Household Survey. The most common occupations, focusing on women aged 18-65, separately for each round of the BIHS.

Table A3: Most Common Occupations in Each Division

	Percent							
Occupation	**All**	**Barisal**	**Chittagong**	**Dhaka**	**Khulna**	**Rajshahi**	**Rangpur**	**Sylhet**
Raising livestock	27.00	20.55	19.24	26.39	29.58	32.63	36.02	23.25
Raising poultry	25.22	30.80	33.54	25.39	21.37	22.55	22.69	22.25
Working own farm (crop)	9.71	8.28	5.13	10.81	13.63	10.02	8.73	7.05
Agricultural day labor	5.91	5.24	3.60	5.14	6.61	7.37	8.73	5.52
Share cropper/tenant	5.77	5.24	7.42	5.92	4.26	5.35	5.95	6.79
Medium trader (shop or small store)	3.56	3.43	4.14	3.23	3.63	3.57	2.35	5.16
Small trader (roadside stand or stall)	2.43	3.15	2.20	3.02	1.85	1.20	2.49	2.63
Other wage labor	2.33	2.70	3.78	2.38	1.13	1.83	1.77	3.37
Rickshaw/van pulling	1.57	1.30	1.44	1.73	1.58	1.64	1.82	1.16
Service (private sector)	1.46	0.96	1.84	1.93	1.61	1.11	0.43	1.42
Driver of motor vehicle	1.31	1.63	2.20	1.02	1.19	1.11	0.58	2.05
Other self employed	1.20	1.41	1.35	1.16	1.01	1.83	1.01	0.84
Tailor/seamstress	1.18	0.79	1.44	1.24	1.34	0.72	0.86	1.63
Mason	0.95	1.24	1.44	0.49	0.65	0.63	0.53	2.74
Handicrafts	0.95	1.01	1.80	0.65	0.45	1.83	0.62	1.00
Earth work (other)	0.85	1.46	1.17	0.71	1.19	0.14	0.38	0.95
Other salaried worker	0.79	0.45	0.72	0.67	0.80	0.53	0.77	1.79
Large trader (large shop or whole sale)	0.64	0.51	0.81	0.65	0.48	0.77	0.38	0.95
Raising fish / fish pond	0.63	0.06	0.31	0.53	2.02	0.48	0.19	0.00
Carpenter	0.59	1.01	0.81	0.65	0.42	0.39	0.14	0.74

Note: Bangladesh Integrated Household Survey, round 2015. The most common occupations in each seven divisions of Bangladesh, and the whole country.

Table A4: Difference in Means: Estimation vs. Control Sample

	mean: control	**mean: estimation**	**difference:** *t*	**difference:** *p*
Household size	3.35	3.50	-4.25	0.00
Household expenditure	2454.46	2468.05	-0.25	0.80
Age of husband	41.62	40.80	1.62	0.10
Age of wife	33.83	33.21	1.40	0.16
Education of husband	1.84	1.93	-2.43	0.02
Education of wife	2.00	2.11	-3.39	0.00

Note: Bangladesh Integrated Household Survey (2011/12, 2015, 2018/19). Mean values of observed characteristics of (1,114) households in the estimation sample, and (3,521) households that are dropped due to multiple job holding restriction (control sample).

Table A5: Estimation Results, Demand System: Selection-Corrected

	Husband's primary job ω_1 (1)	Husband's secondary job ω_2 (2)	Wife's primary job ω_3 (3)	Wife's secondary job ω_4 (4)
Husband's primary wage	14.53	-1.08	-4.80	-0.87
	(0.67)	(0.66)	(0.43)	(0.22)
Husband's secondary wage	-5.64	12.11	-2.91	0.36
	(0.94)	(1.10)	(0.68)	(0.28)
Wife's primary wage	-4.67	0.00	8.43	-0.29
	(0.40)	(0.44)	(0.29)	(0.11)
Wife's secondary wage	-1.32	-0.85	-0.30	3.11
	(0.27)	(0.24)	(0.19)	(0.14)
α (intercept)	-22.22	50.09	8.27	0.88
	(5.72)	(5.70)	(4.16)	(2.00)
α (husband's age)	0.06	0.01	-0.01	-0.01
	(0.02)	(0.02)	(0.02)	(0.01)
α (number of children)	-1.34	-1.15	-0.47	-0.06
	(0.35)	(0.37)	(0.28)	(0.12)
α (Dhaka)	-1.15	-0.48	0.30	0.60
	(0.55)	(0.53)	(0.42)	(0.22)
β	7.40	-14.32	4.58	0.20
	(1.69)	(0.88)	(0.83)	(0.45)
ζ	-0.31	0.74	-0.16	-0.05
	(0.10)	(0.10)	(0.03)	(0.02)
Inverse Mills' Ratio	1.63	-10.40	-6.33	0.13
	(3.91)	(3.56)	(2.95)	(1.17)

Note: Bangladesh Integrated Household Survey (2011/12, 2015, 2018/19). The coefficient estimates and standard errors (in parentheses) of the demand system. All values are multiplied by 100. We account for selection by including a predicted inverse Mills' ratio in the demand system.

Table A6: Estimation Results, Demand System: Childless Couples

	Husband's primary job ω_1 (1)	Husband's secondary job ω_2 (2)	Wife's primary job ω_3 (3)	Wife's secondary job ω_4 (4)
Husband's primary wage	14.05	0.45	-4.11	-2.00
	(0.93)	(1.04)	(1.01)	(0.70)
Husband's secondary wage	-8.57	12.94	-2.50	-0.83
	(1.76)	(2.50)	(1.18)	(0.87)
Wife's primary wage	-5.07	-0.88	8.80	-0.30
	(0.70)	(0.67)	(0.70)	(0.25)
Wife's secondary wage	-1.79	-1.13	-0.42	3.19
	(0.62)	(0.57)	(0.50)	(0.48)
α (intercept)	-6.49	37.77	1.24	0.27
	(6.21)	(5.69)	(4.96)	(2.56)
α (husband's age)	0.04	0.00	0.03	0.00
	(0.04)	(0.05)	(0.04)	(0.02)
α (Dhaka)	-1.89	-0.97	0.11	0.59
	(1.32)	(1.27)	(1.07)	(0.60)
β	6.90	-15.38	3.17	1.67
	(1.86)	(1.41)	(1.74)	(0.87)
ζ	-0.16	0.69	-0.14	-0.07
	(0.10)	(0.14)	(0.07)	(0.04)

Note: Bangladesh Integrated Household Survey (2011/12, 2015, 2018/19). The coefficient estimates and standard errors (in parentheses) of the demand system. All values are multiplied by 100. We select couples without children.

Table A7: Estimation Results, Demand System: Exactly Two Jobs

	Husband's primary job ω_1 (1)	Husband's secondary job ω_2 (2)	Wife's primary job ω_3 (3)	Wife's secondary job ω_4 (4)
Husband's primary wage	14.15	0.75	-5.89	-1.53
	(0.72)	(0.60)	(0.64)	(0.27)
Husband's secondary wage	-3.44	9.36	-1.22	-0.05
	(1.06)	(0.98)	(0.74)	(0.29)
Wife's primary wage	-4.80	0.31	7.93	-0.76
	(0.54)	(0.37)	(0.36)	(0.15)
Wife's secondary wage	-1.69	-0.56	-0.23	3.35
	(0.39)	(0.22)	(0.23)	(0.17)
α (intercept)	-22.73	31.79	-1.38	-0.97
	(4.49)	(2.81)	(2.37)	(1.48)
α (husband's age)	0.09	0.00	-0.06	0.00
	(0.03)	(0.02)	(0.02)	(0.01)
α (number of children)	-1.59	-0.74	-0.47	-0.02
	(0.36)	(0.28)	(0.28)	(0.12)
α (Dhaka)	-1.59	-1.37	-0.04	0.46
	(0.75)	(0.62)	(0.52)	(0.27)
β	8.55	-16.13	6.69	1.78
	(2.17)	(0.87)	(1.05)	(0.60)
ζ	-0.48	1.10	-0.40	-0.12
	(0.19)	(0.17)	(0.08)	(0.04)

Note: Bangladesh Integrated Household Survey (2011/12, 2015, 2018/19). The coefficient estimates and standard errors (in parentheses) of the demand system. All values are multiplied by 100. We select households where spouses have exactly two jobs.

Table A8: Estimation Results, Demand System: Clustered Standard Errors

	Husband's primary job ω_1 (1)	Husband's secondary job ω_2 (2)	Wife's primary job ω_3 (3)	Wife's secondary job ω_4 (4)
Husband's primary wage	14.34	-0.89	-4.70	-0.85
	(0.65)	(0.60)	(0.45)	(0.27)
Husband's secondary wage	-5.09	11.41	-2.49	0.32
	(0.88)	(1.00)	(0.71)	(0.30)
Wife's primary wage	-4.44	-0.38	8.69	-0.30
	(0.37)	(0.38)	(0.29)	(0.10)
Wife's secondary wage	-1.33	-0.84	-0.28	3.11
	(0.26)	(0.24)	(0.17)	(0.13)
α (intercept)	-20.34	36.35	1.14	1.00
	(3.92)	(3.51)	(2.39)	(1.05)
α (husband's age)	0.06	0.01	-0.01	-0.01
	(0.02)	(0.02)	(0.02)	(0.01)
α (number of children)	-1.53	-0.38	-0.12	-0.05
	(0.27)	(0.26)	(0.22)	(0.09)
α (Dhaka)	-1.11	-0.67	0.23	0.60
	(0.55)	(0.63)	(0.51)	(0.23)
β	7.90	-15.25	4.05	0.23
	(1.93)	(0.86)	(0.84)	(0.53)
ζ	-0.36	0.86	-0.16	-0.06
	(0.12)	(0.11)	(0.03)	(0.02)

Note: Bangladesh Integrated Household Survey (2011/12, 2015, 2018/19). Demand system estimates with standard errors (in parentheses) clustered at the village level. All values are multiplied by 100.

Table A9: Estimation Results, Demand System: Leave-one-out Wages

	Husband's primary job ω_1 (1)	Husband's secondary job ω_2 (2)	Wife's primary job ω_3 (3)	Wife's secondary job ω_4 (4)
Husband's primary wage	19.42	-6.48	-1.15	-11.79
	(1.64)	(1.38)	(1.29)	(1.87)
Husband's secondary wage	-6.12	15.25	-1.74	-7.40
	(1.71)	(1.55)	(1.40)	(2.02)
Wife's primary wage	-3.66	-1.85	9.20	-3.69
	(1.03)	(0.89)	(0.84)	(1.22)
Wife's secondary wage	-3.76	-4.44	-0.99	9.19
	(1.57)	(1.36)	(1.27)	(1.46)
α (intercept)	1.79	7.99	7.59	82.63
	(5.94)	(5.04)	(4.58)	(5.80)
α (husband's age)	0.09	-0.01	0.01	-0.08
	(0.02)	(0.02)	(0.02)	(0.02)
α (number of children)	-1.35	-0.21	0.30	1.26
	(0.29)	(0.26)	(0.24)	(0.28)
α (Dhaka)	-0.55	-0.03	0.61	-0.04
	(0.61)	(0.53)	(0.49)	(0.57)
β	-2.12	-1.61	-4.16	7.89
	(1.94)	(1.82)	(1.40)	(2.73)
ζ	-1.81	-2.67	-1.96	6.43
	(0.68)	(0.67)	(0.55)	(1.41)

Note: Bangladesh Integrated Household Survey (2011/12, 2015, 2018/19). The coefficient estimates and standard errors (in parentheses) of the demand system. All values are multiplied by 100. We tackle potential endogeneity in wages using leave-one-out instruments.

Table A10: Estimation Results, Demand System: Alternative Available Times, T'_{dk}

	Husband's primary job ω_1 (1)	Husband's secondary job ω_2 (2)	Wife's primary job ω_3 (3)	Wife's secondary job ω_4 (4)
Husband's primary wage	14.51	-1.51	-4.94	-1.33
	(0.62)	(0.56)	(0.43)	(0.28)
Husband's secondary wage	-5.97	13.45	-3.28	0.00
	(0.84)	(1.00)	(0.61)	(0.33)
Wife's primary wage	-4.52	-0.60	8.91	-0.59
	(0.32)	(0.32)	(0.25)	(0.12)
Wife's secondary wage	-1.78	-0.83	-0.49	4.11
	(0.25)	(0.21)	(0.18)	(0.16)
α (intercept)	-15.68	38.72	1.90	1.36
	(3.52)	(2.79)	(2.06)	(1.51)
α (husband's age)	0.05	0.00	0.00	-0.01
	(0.02)	(0.02)	(0.02)	(0.01)
α (number of children)	-1.41	-0.44	-0.03	-0.05
	(0.24)	(0.22)	(0.22)	(0.10)
α (Dhaka)	-1.11	-0.78	0.25	0.73
	(0.50)	(0.48)	(0.41)	(0.26)
β	7.39	-14.84	4.33	0.86
	(1.65)	(0.84)	(0.76)	(0.63)
ζ	-0.31	0.74	-0.15	-0.09
	(0.10)	(0.09)	(0.03)	(0.03)

Note: Bangladesh Integrated Household Survey (2011/12, 2015, 2018/19). The coefficient estimates and standard errors (in parentheses) of the demand system. All values are multiplied by 100.

Table A11: Estimation Results, Demand System: Alternative Available Times, T''_{dk}

	Husband's primary job ω_1 (1)	Husband's secondary job ω_2 (2)	Wife's primary job ω_3 (3)	Wife's secondary job ω_4 (4)
Husband's primary wage	15.01	-7.30	-1.28	-0.59
	(0.61)	(0.61)	(0.50)	(0.18)
Husband's secondary wage	-6.67	10.11	0.29	-0.29
	(0.37)	(0.35)	(0.36)	(0.11)
Wife's primary wage	-6.07	-5.11	13.06	0.15
	(0.62)	(0.51)	(0.82)	(0.15)
Wife's secondary wage	-0.86	-1.05	-0.29	2.26
	(0.21)	(0.18)	(0.18)	(0.10)
α (intercept)	-8.50	-11.23	52.88	2.41
	(2.29)	(2.95)	(2.40)	(0.69)
α (husband's age)	0.02	-0.01	0.02	0.00
	(0.02)	(0.02)	(0.02)	(0.01)
α (number of children)	-1.23	-0.22	-0.40	0.02
	(0.22)	(0.19)	(0.20)	(0.07)
α (Dhaka)	-0.85	-0.14	-0.19	0.54
	(0.47)	(0.40)	(0.42)	(0.17)
β	8.66	7.51	-16.44	-0.21
	(1.35)	(1.64)	(0.91)	(0.33)
ζ	-0.54	-0.36	1.13	-0.03
	(0.13)	(0.12)	(0.18)	(0.02)

Note: Bangladesh Integrated Household Survey (2011/12, 2015, 2018/19). The coefficient estimates and standard errors (in parentheses) of the demand system. All values are multiplied by 100.

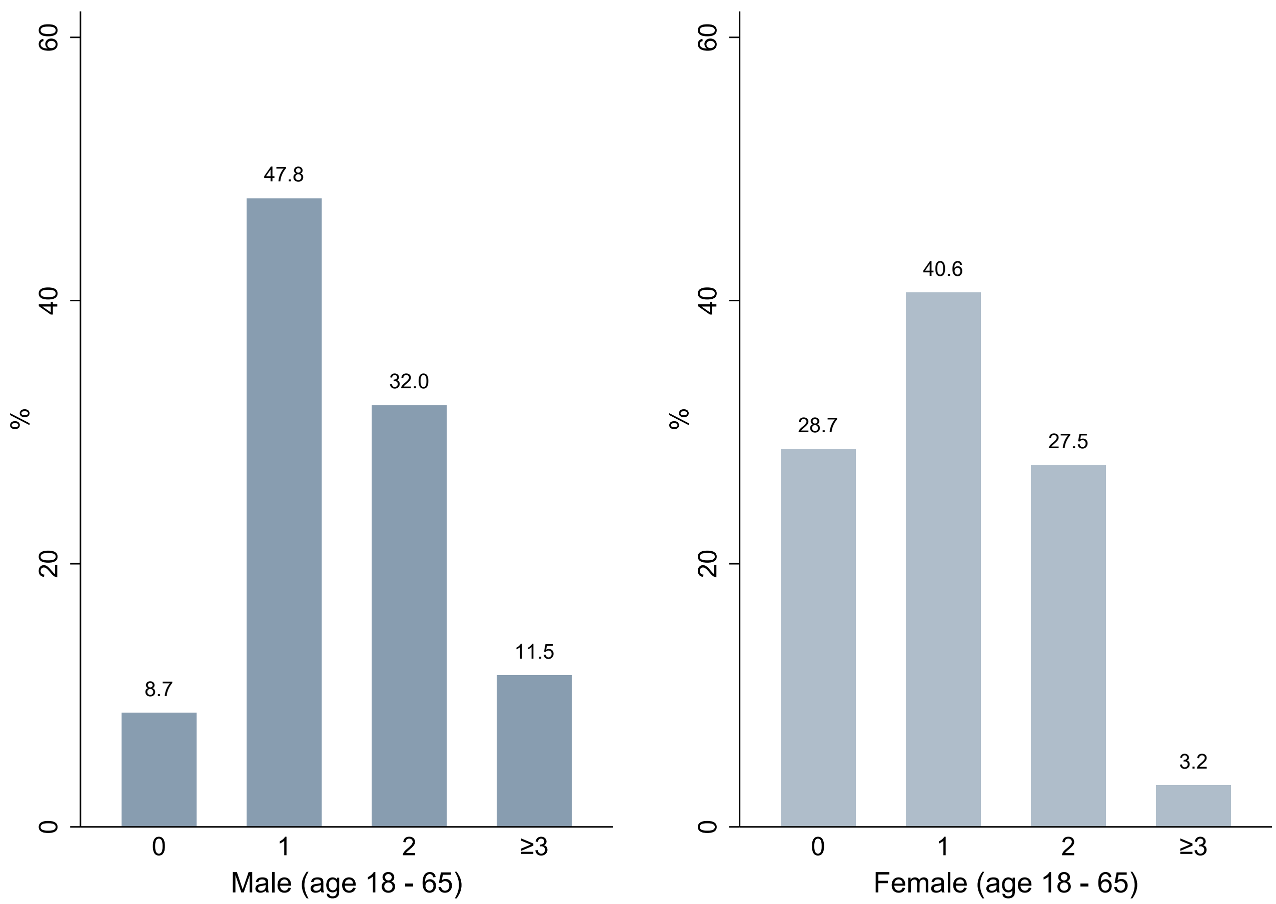
Table A12: Estimation Results, Demand System: Alternative Available Times, T'''_{dk}

	Husband's primary job ω_1 (1)	Husband's secondary job ω_2 (2)	Wife's primary job ω_3 (3)	Wife's secondary job ω_4 (4)
Husband's primary wage	13.62	-1.58	-5.48	-2.56
	(0.52)	(0.45)	(0.41)	(0.35)
Husband's secondary wage	-6.12	15.38	-4.99	-1.67
	(0.81)	(1.06)	(0.61)	(0.52)
Wife's primary wage	-4.73	-0.73	10.34	-1.77
	(0.32)	(0.30)	(0.25)	(0.21)
Wife's secondary wage	-2.68	-0.69	-1.50	6.65
	(0.26)	(0.21)	(0.20)	(0.23)
α (intercept)	-11.44	42.09	2.15	1.75
	(3.32)	(2.61)	(2.09)	(2.35)
α (husband's age)	0.04	0.01	0.00	-0.02
	(0.02)	(0.02)	(0.02)	(0.01)
α (number of children)	-1.20	-0.47	0.09	-0.01
	(0.22)	(0.20)	(0.21)	(0.16)
α (Dhaka)	-1.09	-0.92	0.17	0.99
	(0.45)	(0.44)	(0.43)	(0.36)
β	6.42	-15.18	5.93	3.22
	(1.43)	(0.79)	(0.73)	(0.93)
ζ	-0.25	0.68	-0.18	-0.15
	(0.08)	(0.07)	(0.03)	(0.04)

Note: Bangladesh Integrated Household Survey (2011/12, 2015, 2018/19). The coefficient estimates and standard errors (in parentheses) of the demand system. All values are multiplied by 100.

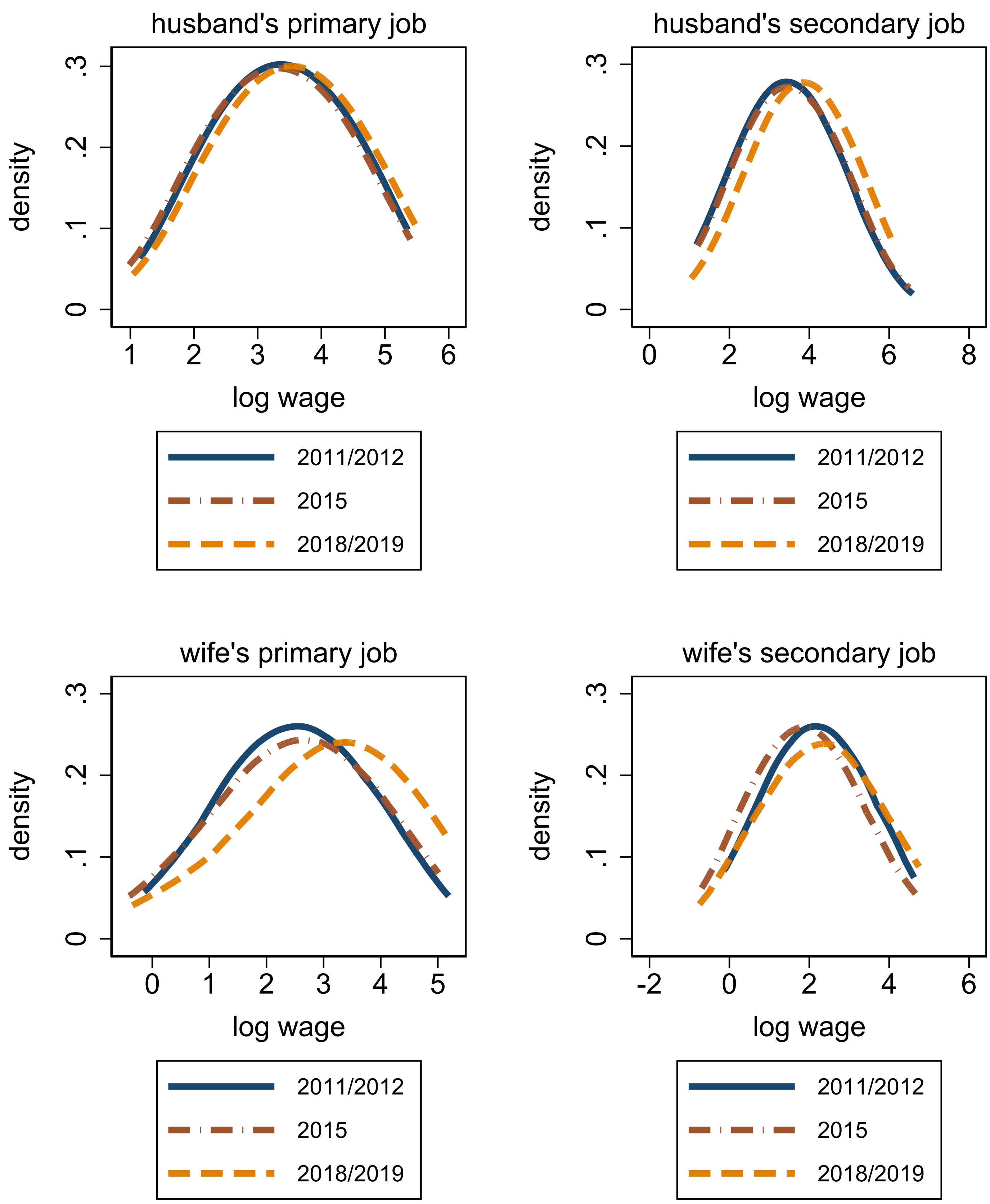
C Additional Figures

Figure A1: Multiple Job Holding in Rural Bangladesh



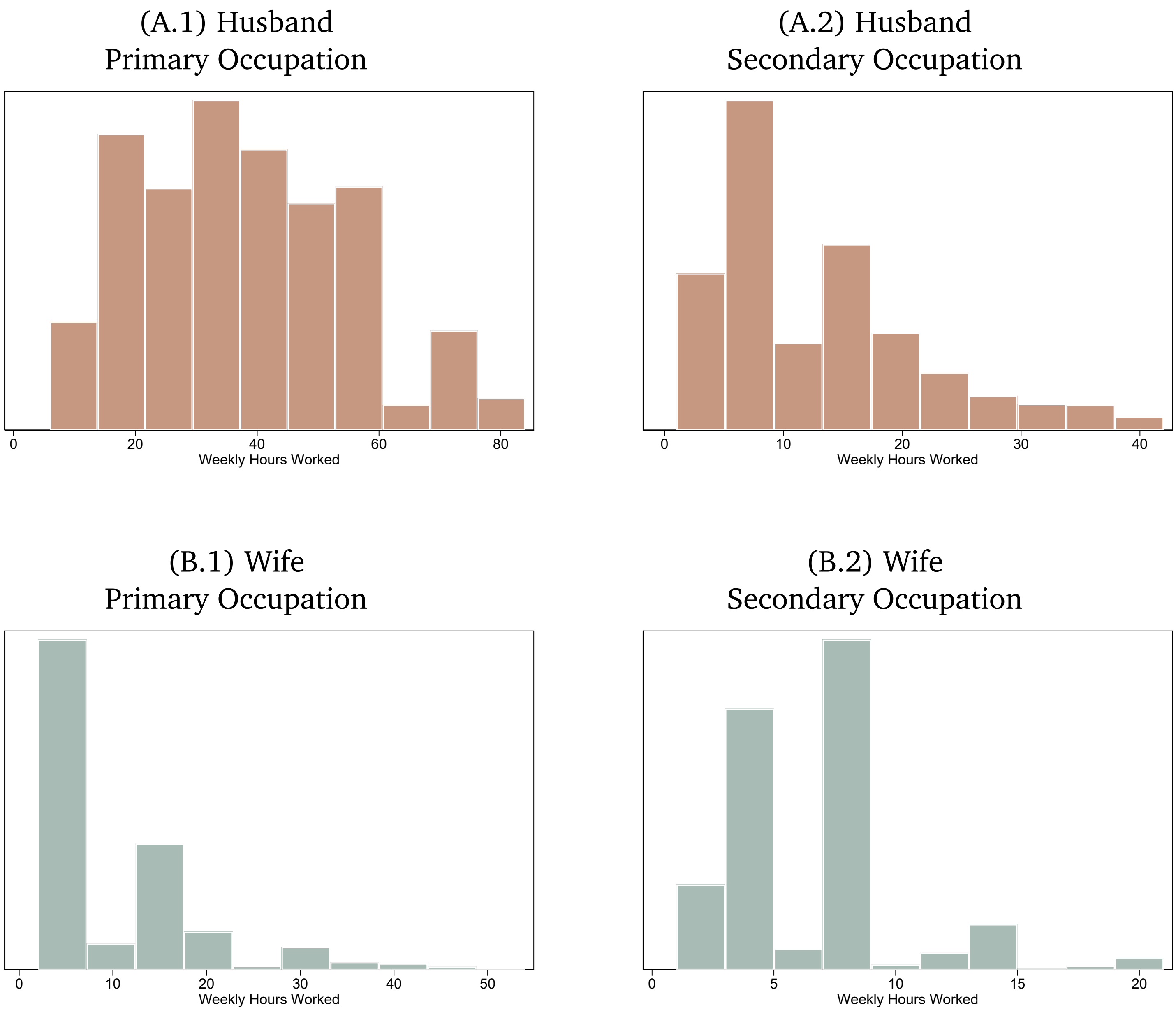
Notes: Bangladesh Integrated Household Survey (2011/12, 2015, 2018/19). Number of jobs held, for all adults aged 18-65.

Figure A2: Wage Distribution by Year



Notes: Bangladesh Integrated Household Survey (2011/12, 2015, 2018/19). Kernel density of primary and secondary wages of husbands and wives.

Figure A3: Hours Worked by Occupation



Notes: Bangladesh Integrated Household Survey (2011/12, 2015, 2018/19). Weekly hours worked in primary and secondary occupations.