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Abstract

We model intra-household dynamics in two rural provinces of Mozambique through the lens of computable general equilibrium (CGE) methods. The main features of the model are: 1) a household social accounting matrix that captures allocation of labor and resources, and transfers among household members; 2) the explicit use of social norms in labor allocation across gender; 3) a mechanism that links agricultural production to time poverty; and 4) the identification of leisure as a commodity that is being produced. Simulation results and sensitivity analyses show how social norms interact with the allocation of labor and resources at the household level to produce adverse results on farm production or limit the gains from technological improvements.

Keywords: time poverty; gender; intra-household allocation; household accounting matrix; Mozambique
JEL Classification: D13, J22, Q12

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We model intra-household dynamics in two rural provinces of Mozambique through the lens of computable general equilibrium (CGE) methods. The main features of the model are: 1) a household social accounting matrix that captures allocation of labor and resources, and transfers among household members; 2) the explicit use of social norms in labor allocation across gender; 3) a mechanism that links agricultural production to time poverty; and 4) the identification of leisure as a commodity that is being produced. Simulation results and sensitivity analyses show how social norms interact with the allocation of labor and resources at the household level to produce adverse results on farm production or limit the gains from technological improvements.

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1 Introduction

The collective model of the household, with its cooperative and non-cooperative bargaining versions, has become the standard approach in household economics in the recent decades (Chiappori, 1988), McElroy and Horney (1981), Lundberg and Pollak (1993)). This development has been mainly in response to empirical and theoretical weaknesses of the unitary model (Doss, 1996), Maluccio et al. (2003), Udry (1996),McPeak and Doss (2006)). The collective model considers aspects of a bargaining process between two individuals, usually husband and wife, as crucial to understanding household dynamics. Most studies use the individual's economic position or ability to earn a livelihood as a proxy for bargaining power. However, the approach omits broader institutional constraints that shape choices and decisions of different groups of individuals, such as men and women. McElroy (1990) was the first to suggest "extrahousehold environmental parameters" like social networks, or local and national legal structure as determinants of the fall-back position in the traditional household model. Later on, theoretical contributions by Darity (1995), Warner and Campbell (2000) and Agarwal (1997), and the qualitative case study by van Staveren and Odebode (2007) have investigated further the role of social norms and gendered institutions in influencing intra-household allocation of labor and resources.

Our contribution in this paper is an adaptation of the computable general equilibrium (CGE) modeling framework to household dynamics of smallholder farmers in low-income countries.

Gender CGE modeling has already been done at the macroeconomic level. The work of Fontana and Wood (2000) was the first attempt to include gender in CGE modeling by accounting for unpaid work and leisure time. Subsequently, studies by Arndt and Tarp (2000), Arndt and Benefica (2011) and Latorre (2016) have accounted for the gender dimension in CGE models, although they do not pay attention to household and leisure activities. These macroeconomic studies examine gender effects on the economy through variables such as gender differentiated labor shares or male- and female-headed households. Although their analyses are gender disaggregated, no account is being made for intra-household dynamics.

Our starting point is the development of a household social accounting matrix that captures allocation of labor and resources, and transfers among members of the household. Adapting Pyatt (1991)'s insight to the topic of this paper, "the [household] accounting matrix provides a framework both for models of how the [household] economy works as well as for data which monitor its workings" (Pyatt (1991), p. 315). In addition, we explicitly take account of social norms in labor allocation decisions of the man and the woman and link these decisions to production and consumption outcomes.

Drawing on well-known uses of the CGE framework, our approach is geared to numerical simulations that are helpful to evaluate effects of shocks and household-oriented policies on the household and its members. In this paper we are particularly interested in evaluating how changes in time poverty of men and women affect agricultural production and consumption patterns of the household. The data that feeds the model comes from a household survey conducted in two provinces of Mozambique in 2013. Details on the survey and the socio-economic context within which we apply our model are presented in the next section. The rest of the paper is organized as following: Section 3 goes over the model, Section 4 discusses simulation results and sensitivity analyses. The paper concludes in Section 5 with a review of main results and possible extensions for further research.

2 Research context

Specific features of the model outlined in this paper are based on observed household characteristics and gender norms among rural households in Northern Mozambique. Data was collected during the months of April through August of 2013 from a sample of 206 randomly selected smallholder farming households in the districts of Mogovolas and Mogincual from the region of Nampula province.[1] Both districts are rural and have poor infrastructure. Agriculture remains the principal livelihood activity of most people. About 63 percent of households have more than one plot of land under cultivation, and the average size of land at the household level is a little over one hectare. Poor conditions of roads, sparse location of cultivable land and the lack of means of transportation translates into considerable walking time to the farm, which is 54 minutes away from the average respondent's house. Lack of basic utilities infrastructure requires households to collect water from wells, community hand pumps and rivers. This adds an average of 17 minutes to the work time that individuals and especially women have to allocate to ensure the subsistence of the household.

The average household size in the sample is 5.4 members. More than 71 percent of households have at least one infant while about 73 percent have at least one child over the age of 6. A wide gender gap exists when it comes to rates of literacy. About 50 percent of the men in the sample are literate while less than 15 percent of the women can read and write. One implication of the

[1] Please see Arora (2015) for details on data collection.

gap in literacy is the difference in the fall-back options that man and women have and, thus, in their bargaining power. Overall, more women than men rely on household farming as their primary livelihood activity as shown in Table 1.

[Table 1: Principal occupation across gender]

Like many farm households elsewhere in rural Africa, smallholder farmers in Mozambique produce food and cash crops to meet their day-to-day consumption needs. About 86 percent of the households in the sample sell a portion of their farm production for cash income. On average, 28 percent of total farm production of the household is sold in the market. Still, significant reliance on subsistence agriculture and lack of other livelihood opportunities means that spells of food deficit are quite common among these smallholders. Food deficits intensify during the wet or peak agricultural season (between the months of December and March) when households run out of crop reserves. The proportion of food deficit households in the sample during the wet season of 2012-2013 was more than 46 percent. This is in addition to the adverse effects that the lack of a diverse diet has on individual's health in this region.[2]

2.1 Gender relations among smallholders

Household farming in Mozambique is mostly based on a joint system, with both the man and the woman working together on the plot of land. In very few cases households practice separate plot farming.

Although women and men allocate roughly equal amounts of time to crop production, women allocate more time to direct and indirect care provision. The gender division of labor (GDOL) for the sample is highly unequal as shown in Figure 1. Men allocate about half of their awake time to leisure activities while women take only 18 percent of their awake time to rest or for personal care. Overall, women put considerably more time towards household sustenance (chores and fetching wood and water) and direct care which together take 45 percent of their awake time, while men allocate significantly more time to paid work outside the farm compared to women.

[Figure 1: Division of awake time across gender and activities]

Additional information about household power relations in production and consumption spheres are summarized in Table 2. It is generally the case that women have more say in household consumption decisions than in the sphere of farm production. This separation of roles by gender in the decision making process has implications for the relative power position of men and women to bargain over resource allocation since farm production and off farm work are the two activities that are usually remunerated.

[Table 2: Household decision-making process]

[2] Smallholder households in the region mainly consume starches (grains, roots and tubers), beans and nuts (mainly peanuts). More than 80 percent of households in the sample have consumed all these food groups in the last week. Consumption of other important food groups rich in vitamins and minerals - meat and poultry, and dairy is very low. Less than 25 percent of households have consumed these food items in the last week. Consumption of dairy in Nampula is extremely low due to cultural preferences. Almost 75 percent of the households consume vegetables, which are mainly onions and tomatoes. Vitamin-A rich vegetables and fruits are consumed by more than half of the households, while green leafy vegetables are consumed by only 16.5 percent of households.

Besides these indicators that capture the effect of social norms on allocation of labor and resources, we also learn a great deal about social norms by looking at gendered consumption habits among the smallholder families. Social norms oblige women to prioritize feeding the household before feeding themselves. In more than 70 percent of households, women are the last ones to consume food and in 17 percent of these households women get left-overs, which often are not sufficient to feed a working adult (Quisumbing (1994), Sullivan (2008)). Women in more than 80 percent of the households responded that they had reduced their consumption of food during the last hunger season so that their children and husbands can eat sufficiently. These results suggest that women are more likely to suffer from poor nutritional outcomes which may adversely impact not only their general health but also their productivity in household activities (Block et al. (2004), Ransom and Elders (2003)).

3 The model

Insights on gender roles and household dynamics from the Mozambican case study discussed above inform the key features of the model we propose in this section. We start by outlining these key features, while the following sections go over some of the details. A complete account of all equations can be found in the appendix.

We work with a highly stylized model of the dynamic between gender norms and intra-household allocation of labor in a typical subsistence household in Sub-Saharan Africa. The core of the model follows Arora and Rada (2017). It seeks i) to analyze how social norms impact labor supply by gender, and ii) to trace the effects of unequal division of labor on agricultural production. With respect to the latter, we are particularly interested in quantifying how shocks that change the time constraint of the man and the woman affect production of agricultural output.

To achieve these goals we combine features of household economics with ideas from gender economics within a CGE framework. We formalize economic behavior of household members through simple utility maximization problems. The household is both a consuming and a producing unit. The household does not hire outside labor but it sells its own labor to the rest of the economy. One important features of our approach is that we consider how gender roles impact the allocation of labor in household production and the distribution of output produced by the household. In this sense, our approach is close to Darity (1995) and Warner and Campbell (2000). Distinct from Warner and Campbell (2000)'s framework, we focus on joint production system and make no distinction between the man's and the woman's plot and cash and food crops. This assumption allows us to extend the model to households where farm production is used entirely for household consumption.[3]

We also model changes in the man's labor allocation, which is missing from Darity (1995). The man can take over additional farming on the margin in the event of an increase in the demand for the woman's time. In this way, it is possible that both men and women work more as a result of a negative shock such as increased needs for direct care of a household member.

Warner and Campbell (2000) model the woman's utility problem as a function of her leisure, consumption of farm output, and purchased goods from the rest of the economy. The play of social norms is captured by the man's first mover advantage. We take these ideas a step further and along the lines of Burda et al. (2007) we formalize social norms through a parameter in the woman's utility function.

[3]This means that there are no cash crops and no surplus production.

3.1 The structure of the model as captured by the HAM

The structure of the model is captured by the Household Accounting Matrix (hereafter the HAM) presented in Table 3. The HAM conforms to standard bookkeeping rules. Rows summarize incomes or inflows, columns expenditures or outflows, and corresponding row and column totals are equal. The first four rows and columns show the costs and composition respectively of gross output in each sector. Columns E and F show total supply of the domestically produced farm and household commodities, while rows 5 and 6 show the use of commodities. Leisure is the third domestically produced commodity. Since leisure is consumed directly by the institution that owns the factor of production we simplify the HAM by not identifying leisure further in the commodity columns and rows. Value added produced by the two factors of production, man's labor and woman's labor, appears in rows 7 and 8, while payments to factors of production are shown in columns G and H. The remaining rows, aside of the last one, capture total income received and its uses by existing institutions. Factors of production are the *producing units* and institutions are the *consuming units*. The linkages between the two are taken up below.

[Table 3: A Household Accounting Matrix]

The household economy is divided into three producing sectors: farming, household, and leisure. The sectors are indexed f, s and l respectively. The household trades and sells its labor to the rest of the economy which is indexed by r. Farm activities include farm work (land clearing, weeding, harvesting) and food processing for sale. Travel time to and from the farm and the time spent on selling output are also included in farm activities. Household activities include primarily food processing for own consumption, cooking, cleaning and other maintenance works, fetching water and collecting firewood, care work and community voluntary work. The farm sector produces tangible commodities, which can be consumed or sold in the market; while the household sector generates tangible and intangible outputs which are entirely consumed by the household. Finally, the leisure sector produces an intangible commodity, personal care and non-work activities, which can affect the health and productivity of the individual.

The farm and the household sector are structurally similar in the sense that both use labor as the only factor of production. However, only the farm sector uses intermediate goods in the production process, mainly seeds, which are purchased from the rest of the economy, and and only farm goods are being traded. An important feature of our model is the treatment of leisure as a produced commodity. This means that the household economy is, overall, supply constrained.

The man and the woman indexed by M and F have a dual role: they act as *factors of production* and as *institutions*. As factors of production they earn factor incomes in return for their labor (rows 7 and 8). More specifically, the value added in activity i is the product of the hourly wage rate in that activity and the number of hours spent on it. The man and woman's factor incomes are the sum of the value-added they generate in household and farm activities plus the value of their leisure time. What the woman and the man (as institutions) actually receive is different from what they earn from their contribution to production. This difference is the result of transfers (see columns G, H, I and J). The first round of transfers is to themselves and to the household, which is the third domestic institution. The man and the woman retain all the leisure they produce. Farm output is controlled by the man who pays a wage to the woman in return for her work on the farm. The man and the woman also transfer part of their farm output to the household as food for consumption. The household, which consists of all the

persons in the household including the man and his wife, receives all the value-added from the household sector.[4]

The man and the woman also make transfers to the household in their role as institutions. These transfers are food and non-food items they buy from the rest of the economy and which are captured by cells (I11) and (J11). Outside the household there is the rest of the economy which represents the external sector with which the household trades, and from which the household can receive income for its labor.

3.2 Causal structure of the model

Since most equations of the model are relegated to the appendix, it is useful to get an understanding of the model in terms of its causal structure.

First, this household economy is constrained by the supply of labor in terms of the awake time available within a day (see Section B in the Appendix). At the sectoral level inputs and therefore production are driven by our assumptions on economic behavior. Importantly, consumption floors are autonomous drivers of demand in both the farm and the household sector. Changes in consumption floors drive reallocation of labor across all sectors. The man provides a fixed amount of labor to the household sector, which means that the woman must adjust her labor supply in order to meet the care needs of the household. The adjustment in the woman's working hours in the household impacts the distribution of the remaining time that both man and woman can allocate to the farm sector and to leisure (given their preferences and social norms discussed above).

Second, equilibrium requires that no excess demand exists in any of the three domestic sectors. The household commodity is consumed only by the household and therefore equilibrium is achieved where its supply meets the household's demand for it. Thus, output in the household sector is demand driven. Production of both farm and leisure commodities are determined by preferences and social norms, technology and the available awake time or labor supply that remains after satisfying the demand for the household good. In the farm sector the supply of farm commodity must equal the sum of imported intermediate goods and the final demand for the farm commodity by the man, the woman and the household. It follows that the price of the farm commodity must adjust in order to clear the domestically produced farm output, while imports of intermediates adjusts to meet production. Consumption of leisure is automatically equal to the number of hours of leisure which is the main input into the production of leisure.

Simultaneous equilibrium in all sectors finds equivalence in the saving investment balance. We model the household economy on the assumption that there is no fixed capital investment per se and that only the man saves, where Ω_M is his saving. Thus, the saving investment balance requires that domestic saving be equal to the (negative) of foreign saving:

$$\Omega_M = -\Omega_R = -(p_i I_f - p_e E_f - Y_{Mr} - YFr) \tag{1}$$

where I_f, E_f, Y_{Mr}, Y_{Fr} are imports, exports, income of man and woman, respectively, from the rest of the economy.

By definition, man's saving is equal to the difference between his income and his spending:

$$\Omega_M = Y_M - w_{Mf} M_l - P_{Hf} C_M - D_{MH} \tag{2}$$

[4]Specifically, we count the man and the woman in the household sector only in terms of their food consumption. This is necessary because the data does not allow the division of food consumption by individuals.

Since man's saving adjusts to meet (1), consumption of the farm good then solves from (2). It is necessary to point out that the man's consumption does not solve from his utility maximization exercise. Rather, his utility is a function of his 'profit' and the pleasure he gets from leisure.

3.3 Output and prices

We now provide a cursory discussion of output and price determination in the three sectors. As mentioned above, the farm sector is capacity-constrained. Quantity of value added in the farm sector, QVA_f, follows from a linear production function:

$$QVA_f = \varepsilon_M M_f + \varepsilon_F F_f \tag{3}$$

where M_f and F_f are solutions to the utility maximization problem; the man's productivity, ε_M, is fixed; and the woman's productivity responds positively to her leisure time according to:[5]

$$\varepsilon_F = \bar{\varepsilon} + F_l^{\phi} \tag{4}$$

Output supply is proportional to value added according to:

$$QA_f = \frac{QVA_f}{\theta} \tag{5}$$

where θ is calibrated to the base year and represents the proportion of value added to output supply. In other words, this parameter is $1 - a_f$ since there is only one intermediate good.[6] Given that we have only one farm commodity produced by only one sector or activity, total output will be the same as the marketed domestic output. Other relevant equations are the cost decomposition, the income identity and the equilibrium condition that the quantity supplied is equal to the quantity demanded. As explained above the demand price of the domestically produced farm good adjusts to establish equilibrium in the farm sector. Man's nominal return in the farm sector adjusts to clear the income identity, while the price of value added in the farm activity follows from the cost decomposition.

Determination of prices and output in the household and leisure sector is relatively simpler given that production of these commodities involves no intermediates and there is no trade with the rest of the economy.

Household sector output follows from the household's utility maximization problem and is given by the optimal consumption of the household good, C_s. As already mentioned the woman adjusts her labor time in order to meet this demand:

$$F_s = \frac{C_s - M_s \bar{\varepsilon}_s}{\bar{\varepsilon}_s} \tag{6}$$

where $\bar{\varepsilon}_s$ is the efficiency of labor in household production, and it is assumed to be the same for the man and the woman. In return for labor, the man and the woman receive a wage, $\bar{w}_s$. Difficulties in assigning a monetary value to household activities such as cleaning, cooking, and care work, requires that we use an imputed wage. In this paper we use data on hourly wage

[5] We assume an endogenous productivity only for the woman because she is more likely to be time-poor compared to the man.

[6] Equation (5) is in fact describing a Leontief technology for both the demand for value-added and the demand for intermediate inputs.

earned by domestic servants. This (nominal) wage rate is kept fixed throughout the simulations and it is assumed to be the same for the man and the woman. Furthermore, we assume that the price of the household good is also fixed and set to unity in the simulation exercises later on. Same level of labor productivity in the sector means that the return (or the real wage) to labor becomes the average labor productivity, or $\bar{\varepsilon}_s = \bar{w}_s/P_s$.

Output in the leisure sector is determined by the amount of time the man and the woman allocate to leisure according to their utility maximization problem (see Section B). Since we formalize leisure as a *production sector* we must assume that there is some way to produce leisure. One option is to fix productivity to unity i.e. one hour of leisure input produces one hour of leisure output.[7] It follows that output in the leisure sector is simply equal to the number of hours of leisure or $QA_{Ml} = M_l$ and $QA_{Fl} = F_l$. As for the other sectors, the HAM provides two additional equations. According to the cost decomposition, the value of leisure output is given by the amount of labor input which is in fact the number of hours of leisure evaluated at a wage. The question then is, what should be the wage in the leisure sector? One option is to assume that leisure is valued at the wage of the farm sector since the time spent on leisure eventually carries an opportunity cost in terms of the forgone farm output. Since labor input is the number of leisure hours produced, the price of leisure is simply the wage in the leisure sector. The second relevant equation is the demand decomposition. In this very simple setup, the supply of leisure is entirely consumed by the institutions that provided the factor of production.

4 Simulation results

We are now in the position to examine the model numerically. We focus on labor supply decisions and changes in time poverty, and how these may affect the household's production and consumption pattern, using three scenarios. First, a health care crisis represents a positive demand shock in the household sector. Second, a technological improvement in the household sector represents a supply shock that eases the time constraint. And, third, an increase in the man's contribution of labor to the household sector represents as well a supply shock but which affects the household economy differently than a technological improvement because of social norms and expectations associated with leisure consumption. Scenario I depicts an adverse shock while the other two scenarios present developments with the potential to improve the woman's well-being, household welfare and food security. Table 4 shows the impact of these different scenarios on farm and household sector output, household consumption, the man's and the woman's farm labor supply and farm labor productivity.

Before going into a discussion of the results, few words about the parameters and exogenous variables that feed into the simulations. These have been obtained from several sources: averages based on the household survey data for Mozambique; calibration of the model to this data; and estimates from the literature. We discuss here few of these leaving a complete description of the input data to the appendix.

We focus on the parameters that affect the behavior of the man and the woman as captured by their utility function. Man's preference for profits, γ_M, comes from the baseline data. It takes the value of $\gamma_M = 0.42$ and it is the time spent on farm work as a proportion of the total

[7] There can be other ways to think of how leisure is produced, and perhaps enjoyed. If social norms are strong and if they penalize women for being idle, we can think of the woman's productivity in the leisure sector as being lower than that of man (i.e. she does not enjoy leisure as much as the man). Such an assumption should have consequences for the way we value leisure.

time spent on farming, other paid activities and leisure. Considering the pronounced presence of gender norms in different aspects of social and economic lives of Mozambicans, we assign a high value to the social norm parameter μ, which we set to be equal to 10 in the baseline simulation. The inverse of woman's disutility of work parameter, ν, is on the lower range taking a value of 0.2. The leisure norm for the woman and the man, $\bar{F}_l$ and $\bar{M}_l$ respectively are calibrated to the baseline data. Finally, we assume that the responsiveness of the woman's farm labor productivity to leisure is high due to perpetual low levels of leisure time available to women. We set this parameter to $\phi = 0.8$.

[Table 4: Simulation results here]

Scenario I - A health care crisis

In this first scenario, we simulate a 10 percent increase in the floor of the household's consumption of household commodity. The exercise is designed to reflect the impact of a health crisis which requires additional labor time to care for a sick household member.

With the man's participation in care work and his labor productivity fixed, the immediate impact of the shock translates into a demand on the woman's labor time. The first and second column of Table 4 show that the woman's labor input in the household sector, F_s, increases by 2.83 percent, from a baseline of 7.61 hours to 7.90 hours. The reallocation in the woman's labor time sets off a chain of events throughout the household economy. The woman now has less time overall to divide between farm and leisure, which fall by 0.34 hours and 0.15 hours respectively. The impact of reduced leisure is evident in a decline of 1.11 percent in the woman's farm labor productivity.

As the woman reduces her time in the farm sector, the man increases his labor input to the farm by close to 0.15 hours. However, the increase in the man's labor input on the farm sector is insufficient to compensate for the decline in the woman's input as well as for decline in her productivity. As a result, farm production declines by 1.97 percent which induces a decline in the man's overall income and therefore in his transfers to the overall household. The reduction in the household's income, Y_H, means lower consumption of the farm good which shrinks by 2.32 percent.

Scenario II - A technological improvement

In this scenario, we increase labor productivity in the household sector by 4 percent to reflect a technological improvement that could, for example, reduce the time spent collecting water.

As noticed in column 3 of Table 4, a technological improvement relaxes the woman's time constraint. The woman distributes the freed up time between farm work and leisure. Output increases in both the farm and the household sector by 0.76 percent and 2.71 percent respectively. The woman also enjoys more leisure time. Interestingly, the increase in the woman's labor input in the farm sector allows the man to reduce his time in farming while still enjoying an increase in his income and thus overall utility.

Scenario III - A labor supply shock

Using a similar line of thought as in Scenario II, we now envision a situation where the man doubles his labor time in the household sector, from 1.5 hours to 3 hours per day. This change amounts to a redistribution of care work between the man and the woman which can be, at first sight, seen as a strategy to create equity by reducing the woman's time in care work. The question is whether such action would improve the household's overall welfare. The last column of Table 4 shows that an increase in the man's contribution to the household sector reduces the woman's time poverty but also agricultural production and, consequently, the household's

consumption. What happens here is that although the woman increases her labor input in the farm sector along with benefits from higher labor productivity, the man reduces substantially his contribution of time to farm work. In other words, the man redistributes his time from one activity to another while making minimal changes to his leisure. The main reason behind this result is the man's high preference for leisure.

5 Sensitivity analysis

We have said above that parameters used in the simulations have either been calibrated to the model based on a single year observation under the assumption that the household economy is in equilibrium, or they have been borrowed from the literature. In this section we investigate whether the values we have assigned to these parameters are reasonable by any measure. Sensitivity analysis provides a check on the robustness and reliability of both the model and the data that populates the model.

Each of figures 2, 3 and 4 presents a set of graphs that describe on the vertical axis *the percentage change* in agricultural output and in the gender leisure gap relative to the baseline given a certain shock at different values of parameters. Three sets of graphs relegated to the Appendix A show *absolute values* for the gender leisure gap in the baseline (Figure A.1), and the gender leisure gap for a specific shock (Figure A.2 and Figure A.3) at different values of the parameter. The results show that the model is reliable in the sense that results remain within reasonable bounds. The analysis focuses on two types of parameters: parameters that describe human behavior and preferences, and parameters that describe technology and production.

The model has three main parameters that capture human behavior. These are the inverse of the woman's disutility of work, ν, the social norm parameter, μ, that affects the woman's pleasure from leisure, and the man's preference for work, γ_M. Given limited space and the fact that ν and μ have similar effects on the results, we analyze the impact of variations in μ and γ_M when there is a 10 percent increase in the floor of the household's consumption (Scenario I above), and a 4 percent increase in household sector labor productivity (Scenario II). Lastly, sensitivity analyses are conducted in the context of the same shocks for variations in the leisure elasticity of woman's productivity in the farm sector, ϕ.

5.1 Sensitivity analysis on the social norm

We consider first a health care shock that requires the woman to increase her work time in the household sector. When the social norm is lenient (low levels of μ) the fall in farm output relative to the baseline is lower compared to a situation with a stronger social norm (see Graph 2.a). To remind the reader, the utility function of the woman is set up such that a stronger social norm penalizes the woman for her leisure time i.e. the woman is expected to work more. Sensitivity analysis suggests that in the context of less stringent social norms, a health care crisis will have a smaller negative effect on farm output (relative to the baseline).[8]

[Figure 2 here: Sensitivity analysis on the social norm parameter, μ]

[8] As shown in the figures in the Appendix it is necessary to remember that the sensitivity analysis is set up such that the baseline is moving. This means that at higher μ the woman provides considerably more labor to the farm sector while the man provides considerably less. Overall, labor input in the farm sector is about 29 percent higher when $\mu = 15$ compared to the case where $\mu = 1$.

At the same time, the rate of change in the gender leisure gap is decreasing as the social norm increases (see Graph 2.c). There appears to be a contradiction in results: as the social norm increases farm output declines more relative to the baseline when a health care crisis hits while, at the same time, the gender leisure gap shrinks relative to the baseline. This apparent contradiction is caused by the effect of social norm on individual behavior. According to the woman's utility function an increase in the social norm, all other things equal, leads to a decline in her leisure time and an increase in her work time on the farm. A health care crisis which increases F_s will have a negative effect on both her leisure and work time in the farm sector, all other things equal. However, changes in both the social norm and F_s complicate the woman's allocation of time. In effect, a higher μ will reduce the effect of a change in F_s on her leisure time but magnify the effect of this change on her work time in the farm sector. Thus, a higher F_s will reduce both the woman's leisure and her work time on the farm but the reduction in the farm work will be higher the higher is the social norm. In fact, if μ becomes, hypothetically, infinite the solution for the woman's leisure is fixed to the leisure norm $\bar{F}_l$ and changes in F_s will affect her work time in the farm sector only (see the solution for the woman's optimal choice for leisure and farm work in (13)).

A higher μ also means unequal treatment of the man and the woman which further translates into a larger baseline *absolute* gap in their leisure time (see top left graph in Figure A.1 in the Appendix). The man can therefore afford to take away from his (plentiful) leisure time and work more in the farm sector relative to the baseline to avoid a sharp decline in farm output and therefore in his profits. This explains the faster rate of decline in the gender leisure gap relative to the baseline as μ increases, although this is happening in the context of a larger absolute leisure gap in the baseline.

Graphs 2.b and 2.d show the response in simulation results to variations in the social norm given a positive shock to labor productivity in the household sector. This is Scenario II above where the woman can increase her labor supply in the farm sector as well as her leisure time. Recalling the negative relationship between the man and the woman's farm labor supply, the man's time on the farm falls and thus the gap in their leisure time begins to increase after a certain level of μ. The rate of growth of farm output is positive and increasing with the social norm. Farm output increases as a result of more labor provided by the woman and her higher productivity on the farm. The latter comes as a result of higher leisure she is now enjoying. These two positive effects compensate for the decline in the man's labor input on the farm. Beyond a certain level of μ any further rise in the social norm will have no further effect on the household economy as the woman's leisure reaches the leisure sanctioned by the society.

[Figure 3 here: Sensitivity analysis on man's preference for work, γ_M]

5.2 Sensitivity analysis on the man's preference for work

Figure 3 describes the same shocks as Figure 2 under variations in man's preference for work or profits i.e. a low preference for leisure. A health care crisis leads to a sharper contraction in output in the farm sector when the man has a high preference for farm profits as captured by the parameter γ_M. The reason is that at higher levels of γ_M the man already has very little leisure to give up in order to work more on the farm and compensate for the decline in the woman's labor supply, F_f. As γ_M increases the gender leisure gap is smaller in absolute terms both in the baseline and after the shock (see figures A.1 and A.2 in the appendix). However, when compared

to the baseline, beyond a certain level of γ_M the gender leisure gap is increasing as a health care shock hits the household (see Graph 3.c). This dynamic follows from the setup of man's utility function (see (10)). The man decreases his leisure time when the woman reduces her work time on the farm, all other things equal. This effect is weaker the higher is his preference for work. In fact when $\gamma_M = 1$ the man has no more leisure to give up which carries a similar logic as in the case of the woman's variation in μ and ν parameters. Household sector demands must be fulfilled entirely by the woman who has to reduce her leisure and farm work.

Opposite patterns of change are observed when a positive technological shock initially reduces the woman's work time in the household sector, F_s. Farm output increases as the man's preference for work is higher and the woman has more time available to work in the farm sector (see Graph 3.b). The gender leisure gap declines relative to the baseline after a certain threshold level of γ_M. It is also worth noting that the man's income and thus transfers to the household as an institution increase with a higher γ_M given a positive technological shock. This brings about a second round of effects as a result of higher household consumption of both the farm and the household commodity. An increase in C_s requires more of the woman's time in the household sector and thus reduces initial gains in her leisure.[9]

[Figure 4 here: Sensitivity analysis on leisure elasticity of productivity, ϕ]

5.3 Sensitivity analysis on the leisure elasticity of productivity

Figure 4 shows the effects of variations in the leisure elasticity of woman's productivity in the farm sector, ϕ. As before, farm output declines when a health care shock requires the woman to work more in the household sector at the expense of her time on the farm and the time to recuperate. This decline in output is more pronounced the higher is the elasticity parameter. In other words, the same amount of leisure has a larger effect on her productivity and therefore on farm output. The opposite effect takes place when a technological shock affects the woman's leisure time positively. Farm output increases at a faster rate the higher is the response of her productivity to leisure.

The analysis provides important insights on the role of social norms for the allocation of time across gender. Let's begin with changes in the gender leisure gap in the baseline as ϕ varies (see Graph A.1 in the Appendix). A higher ϕ, all other things equal, means that the woman is more productive and therefore we should expect to see a decrease in her time constraints. It turns out that, in fact, as ϕ increases the woman ends up working more in the household and less on the farm while enjoying less leisure. The man, on the other hand, works less on the farm and enjoys more leisure. Higher elasticity of her productivity with respect to her leisure does not work in her favor! The reason is that the man appropriates the gains from her productivity (he pays her a fixed amount per hour of work) and therefore sees an increase in his income. This means more transfers, and therefore more consumption by the household. The woman must meet the new demand by increasing her work time in the household sector.

The response in the gender leisure gap relative to the baseline in the presence of a shock is even more nuanced. The gap decreases slightly relative to the baseline as ϕ increases when the household experiences a negative health care shock (see Graph 4.c). But, this dynamic must be

[9]The effect on gender allocation of time of a change in γ_M is opposite of what happens when we change the woman's preference for work, ν (not shown visually here). A higher preference for work by the woman allows the man to enjoy more leisure by reducing his labor input on the farm.

put in the context of an increase in the absolute gap ($M_l - F_l$) mentioned above (Graph A.1). In other words, the leisure gap increases in absolute terms as ϕ increases but it does so less following the shock which leads to the apparent decrease in the gender leisure gap relative to the baseline. Overall, both the man and the woman experience a decline in their leisure when F_s increases relative to the baseline, but the man's leisure decreases more as ϕ increases since his profits are directly affected by the decline in the woman's productivity.[10]

In the aftermath of a technological shock the gender gap increases relative to the baseline (see Graph 4.d). A technological shock makes the woman more productive in the household sector. She has to work less in the household (i.e. F_s declines) which means she has more time to allocate to her own leisure but also to farm work. As the woman increases her work time on the farm, and as her productivity on the farm goes up because of more leisure, the man affords to cut his own work time on the farm and to enjoy more leisure. This increase in the leisure gap becomes larger in percentage terms at higher levels of ϕ. The reason is that, as explained above, the man appropriates the increase in income due to the woman's higher productivity which allows him to increase his own leisure time.

6 Concluding remarks

One of our goals in this paper has been to advance the CGE modeling framework as a valuable tool in the analysis of labor and resource allocation decisions at the household level. The question motivating the analysis is how social norms impact labor allocation decisions of men and women and, further, how these decisions affect agricultural production and household consumption. Our geographical focus is rural Mozambique, where strong patriarchal norms are present in both social and economic dimensions of people's lives.

The starting point of our approach is a household accounting matrix which considers labor input of the man and of the woman separately, and treats unpaid household tasks (direct and indirect care activities) and leisure as commodities produced within the household economy. Next, we calibrate the model using household survey data from a field study in Mozambique and simulate effects of a care-crisis shock, a technological improvement in the household sector and redistribution of household work between the man and the woman. We also conduct a series of sensitivity analyses to assess how results change in response to changes in key parameters. Simulation results vary with these parameters, however, sensitivity analyses show that the model remains stable. Overall, the results lead us to the following conclusions:

Social norms are important determinants of labor and resource allocation and therefore should be an integral part of formal models of household economies. Norms that induce differential treatment of men and women are consequential for the workings of the household economy and its members in various ways. First, a technology or policy-driven shock that seeks to address the economic hardship and time poverty of women will see its impact reduced if social norms dictate how gains are being distributed. Gains in a woman's leisure time depend on how the society perceives leisure of both women and men. If her time constraint eases with respect to one activity she may, under social constraints, simply redistribute her freed up time to another activity. At the same time, the man may cut back on his working time if labor contribution from the woman is sufficient to cover the household's needs. By extension, such dynamic of labor substitution between men and women leads to a smaller increase in agricultural output

[10]The decline in the woman's productivity is higher the higher is ϕ. When F_s increases her leisure declines which according to (4) leads to a decline in ε_F.

following an otherwise favorable shock to the household economy. Second, the strength of social norms matter. In our model this is captured by parameter μ and the leisure norm $\bar{F}_L$. We find that more stringent social norms reduce the ability of households to address external shocks. For example, a high μ means that the woman's leisure is close to the leisure sanctioned by the society. In response to a care-crisis she will have to give up her work time on the farm as there is no leisure time that she has left to use. A weak response from the man in these circumstances translates into a significant decline in farm output.

Subsistence household economies are more complex than meets the eye. Linkages between the farm sector, the household sector and leisure in the context of aforementioned social norms allow shocks in one sector to propagate across activities. We capture there linkages through several mechanisms: 1) the process of labor allocation across productive and reproductive sectors by the man and the woman; 2) the formalization of the woman's labor productivity on the farm as a function of her leisure time; and 3) the transfers between the working members of the household and the household's institutions (in this paper these are the household itself, the man and the woman). Couple of results are worth recounting. A health care shock which increases the demand for the woman's time in the household sector leads to a decrease in farm output since the man does not increase his work time on the farm sufficiently to compensate for the reallocation in the woman's time and for the reduction in her productivity. A positive technological shock that initially decreases the demand for the woman's time in the household sector also leads to an increase in farm output and therefore in the man's income and his transfers to the household. As the household income increases so does its demand for goods and household services. The end result is an increase in demand on the woman's work time and thus a reduction in the initial gain in her leisure time.

Policy interventions can benefit from a thorough understanding of how social norms impact the household. Given what has been said above we articulate few policy-related lessons: 1) policy should pay attention to how responsibilities are distributed across household members and in particular to the role of women in the production of direct and indirect care; 2) technology and infrastructure improvements can reduce the woman's time poverty and increase production in the farm sector but their effects may be mitigated by existing social norms; 3) incentives to redistribute household work between men and women can reduce time poverty of women and increases their agency on their own time, but prevailing norms and preferences can lead such redistribution to affect adversely agricultural production.

In conclusion, we think that our framework while highly stylized and parsimonious provides worthwhile insights into the interactions between intra-household allocation of labor and resources and social norms. The approach is flexible enough to allow researchers to adapt it to different contexts while keeping it informative.

Figures and Tables

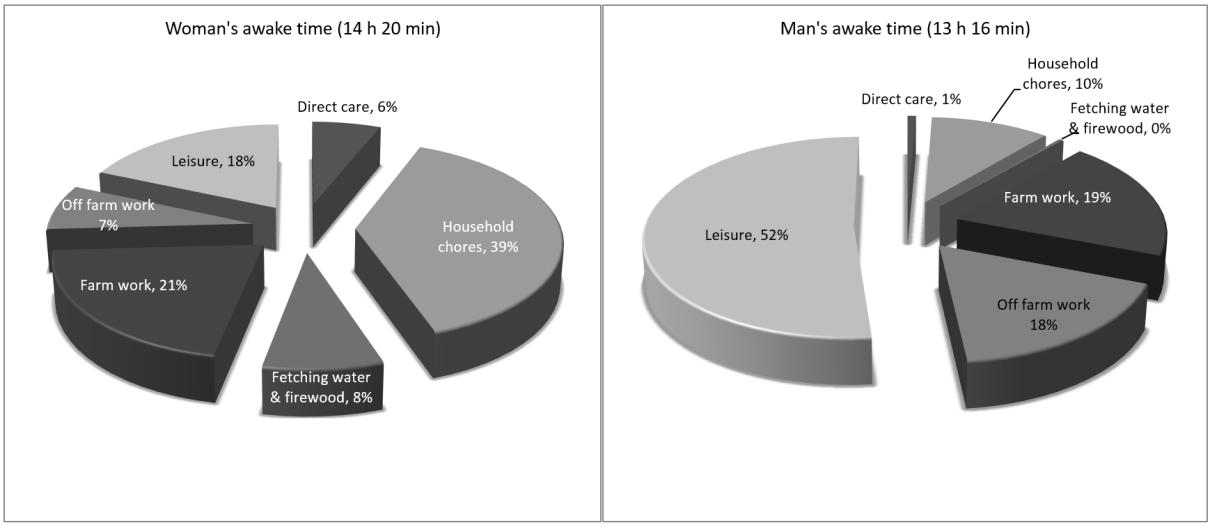

Figure 1: Division of awake time across gender and activities

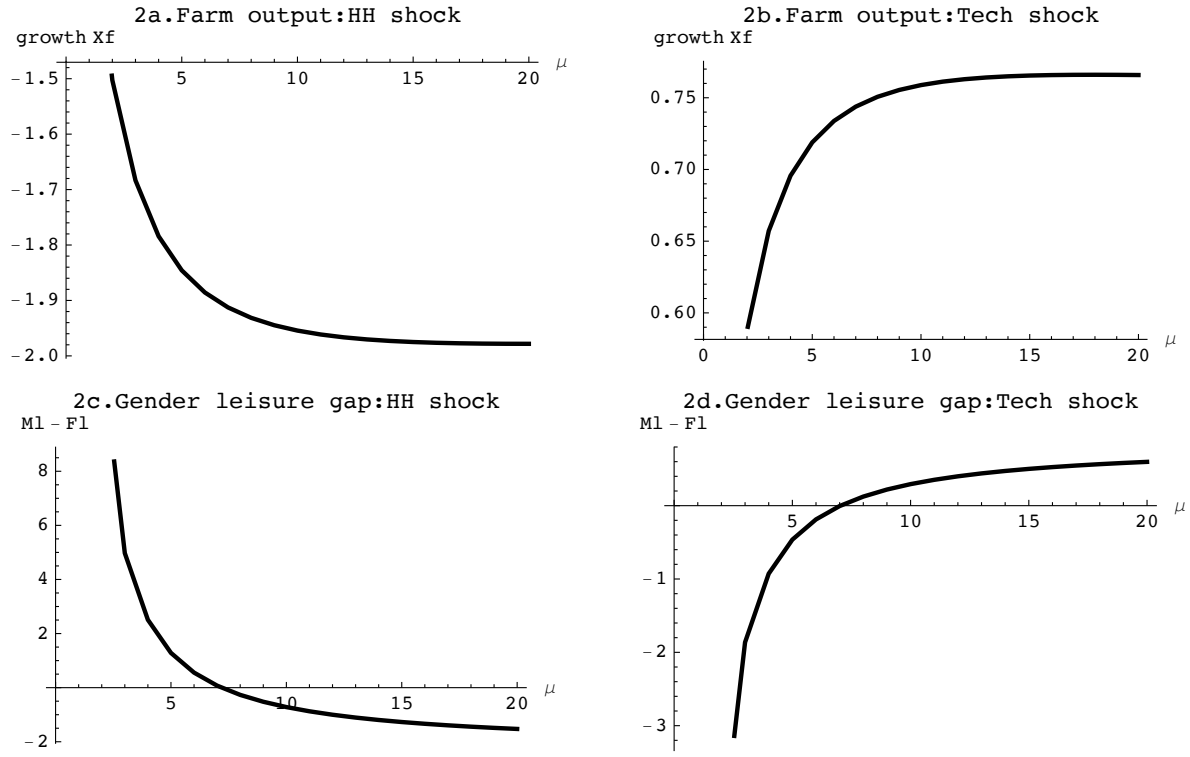

Figure 2: Sensitivity analysis on social norm parameter, μ

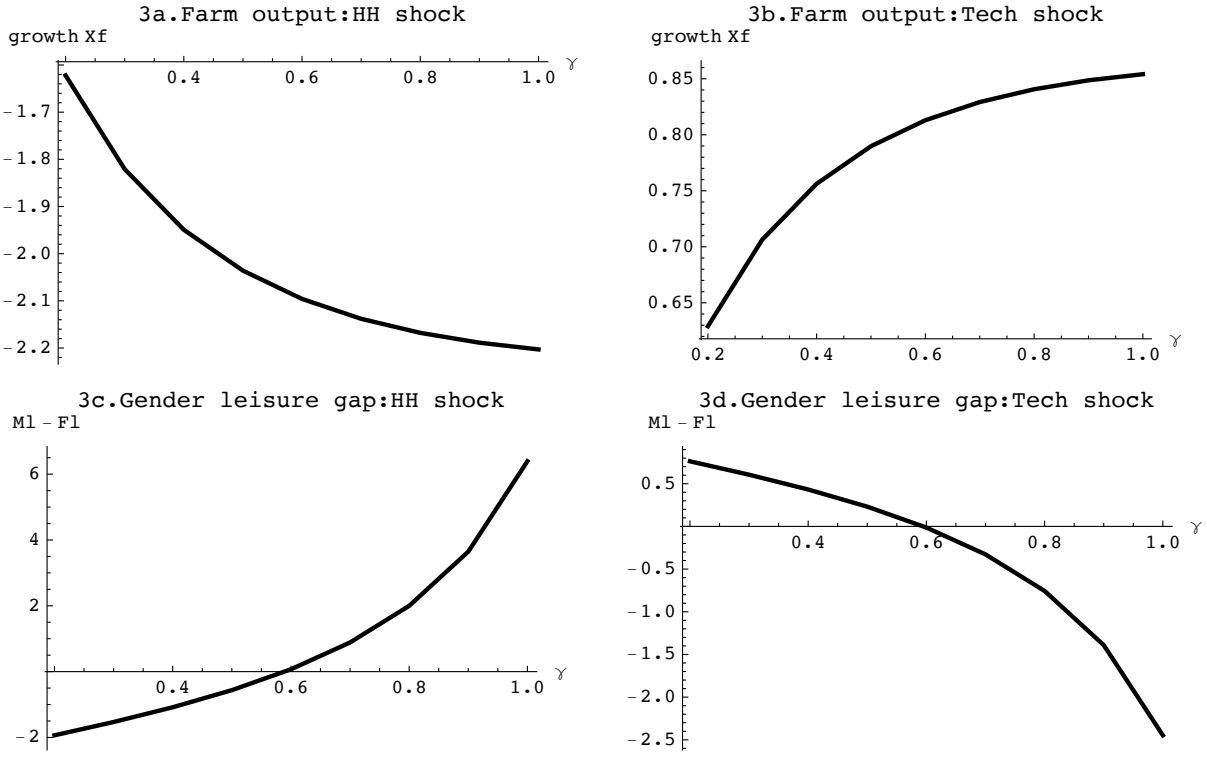

Figure 3: Sensitivity analysis on man's preference for work, γ_M

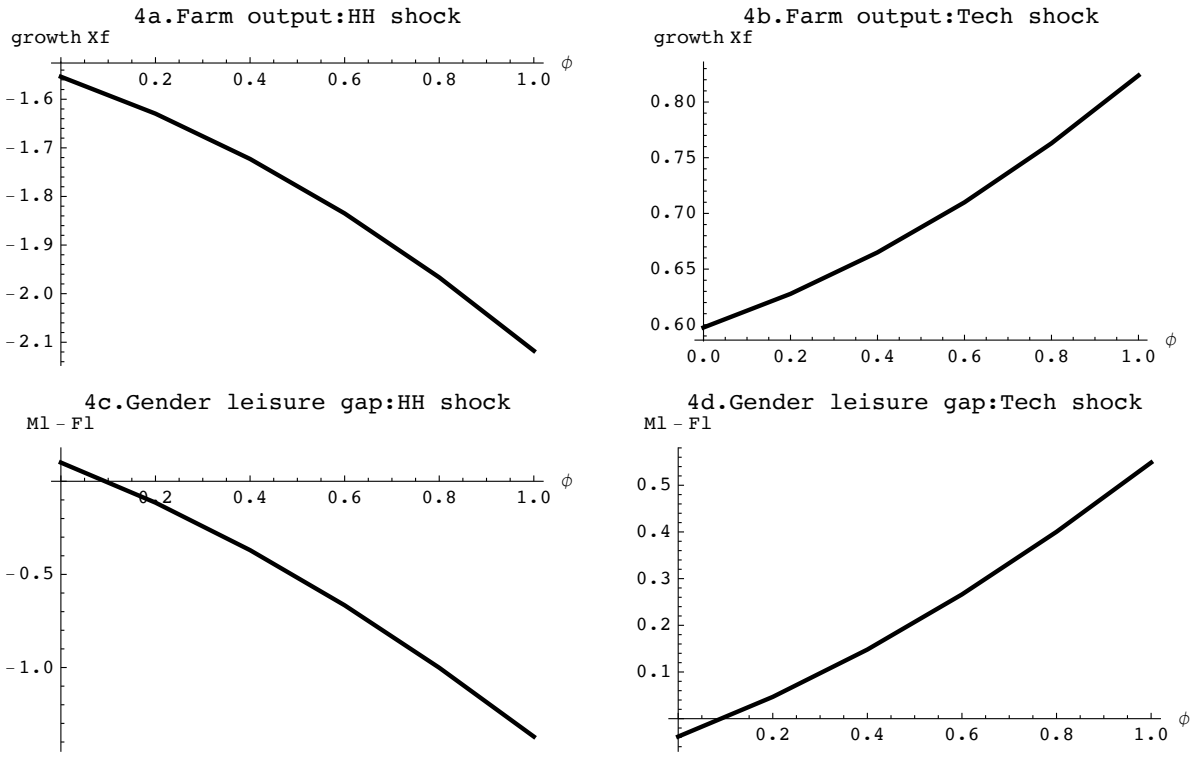

Figure 4: Sensitivity analysis on leisure elasticity of productivity, ϕ

	Principal man	Principal woman
Agriculture	72.8%	93.7%
Wage employment	11.2%	4.8%
Self employment (off-farm)	14.6%	<1%

Table 1: Principal occupation across gender

	Principal Man	Principal Woman	Joint decision
Production sphere			
Who makes decision related to selling crops	68.9%	11.6%	19.5%
Who makes decisions related to purchase of agricultural tools	87.4%	2.9%	9.7%
Consumption sphere			
Who makes decisions related to purchase of food items	35.9%	16%	48.1%
Who makes decisions related to purchase of non-food items for the man	80.2%	3.9%	15.9%
Who makes decisions related to purchase of non-food items for the woman	33.3%	38.6%	28%
Who makes decisions related to purchase of non-food items for children	39.9%	26.3%	33.8%

Table 2: Household decision-making

	Costs of production (Activities)				Commodities		Factors		Institutions				
	Farm	Household	Leisure (Woman)	Leisure (Man)	Farm	Household	Woman	Man	Woman	Man	Household	ROE	Total
	A	B	C	D	E	F	G	H	I	J	K	L	M
1.Farm sector					29.62								29.62
2.Household sector						28.57							28.57
3.Leisure (Woman)									13.68				13.68
4.Leisure (Man)										35.43			35.43
5.Commodities (Farm)	0.69								2.11	2.26	52.06	15.51	72.63
6.Commodities (Household)											28.57		28.57
7.Woman	15.60	23.82	13.68										53.10
8.Man	13.33	4.75		35.43									53.52
9.Woman							13.68	1.37				5.79	20.85
10.Man							7.99	40.89				26.23	75.11
11.Household							31.43	11.26	5.06	32.89			80.63
12.Rest of the economy					43.01								43.01
13.Savings										4.53		-4.53	
14.Total	29.62	28.57	13.68	35.43	72.63	28.57	53.10	53.52	20.85	75.11	80.63	43.01	

Table 3: HAM Numerical

	Baseline Value	Scenario I	Scenario II	Scenario III
Farm production	29.62	-2.42%	0.94%	-2.67%
Household production	28.57	3.00%	2.80%	1.07%
Household consumption (farm goods)	52.1	-2.72%	1.05%	-0.18%
Man's farm labor (hours/day)	2.58	2.66	2.54	1.22
Woman's farm labor (hours/day)	3.02	2.83	3.09	4
Woman's farm labor productivity	5.17	-1.07%	0.41%	5.47%
Woman's household labor (hours/day)	7.61	7.88	7.50	6.19

Table 4: Simulation results

A Appendix Figures

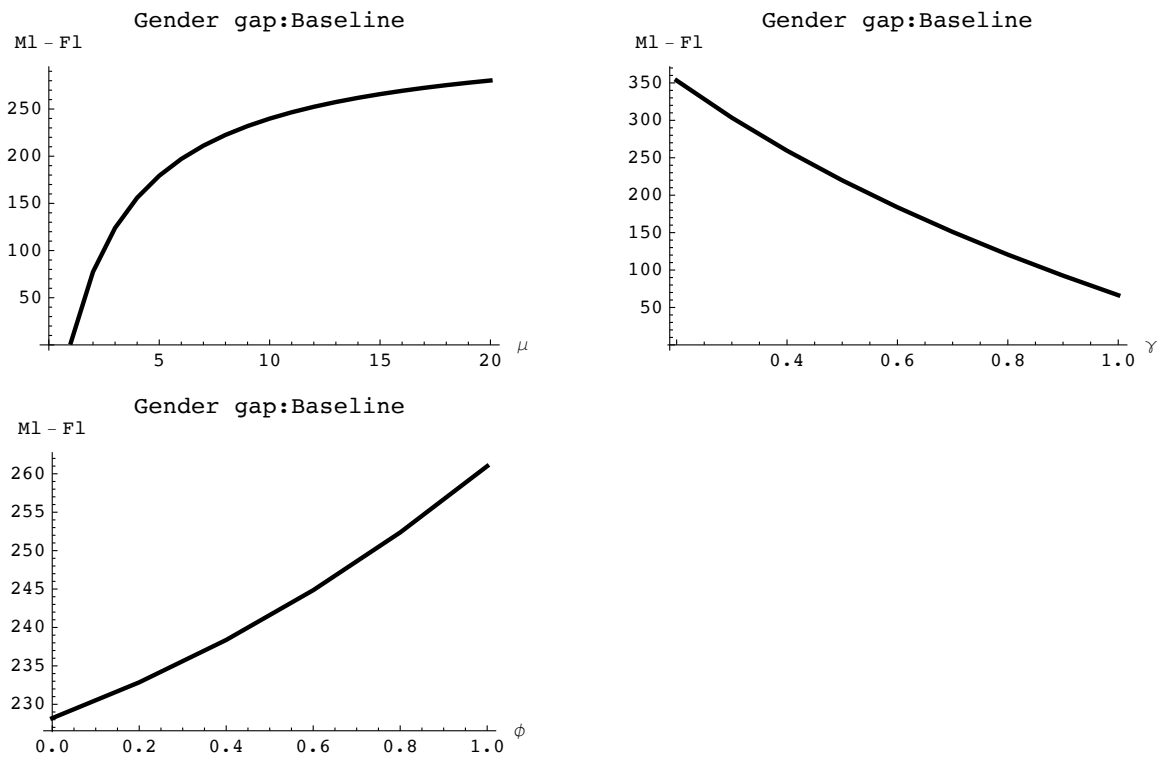

Figure A.1: Sensitivity analysis: the gender leisure gap in the baseline

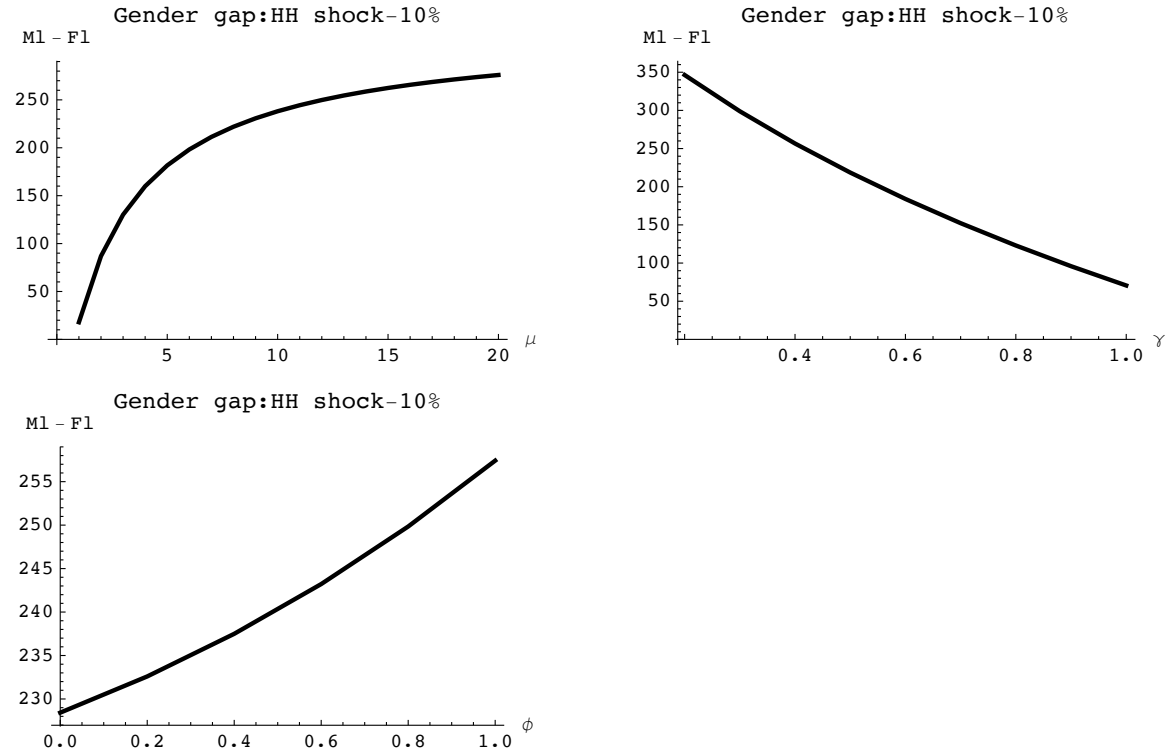

Figure A.2: Sensitivity analysis: the gender leisure gap after a health care shock

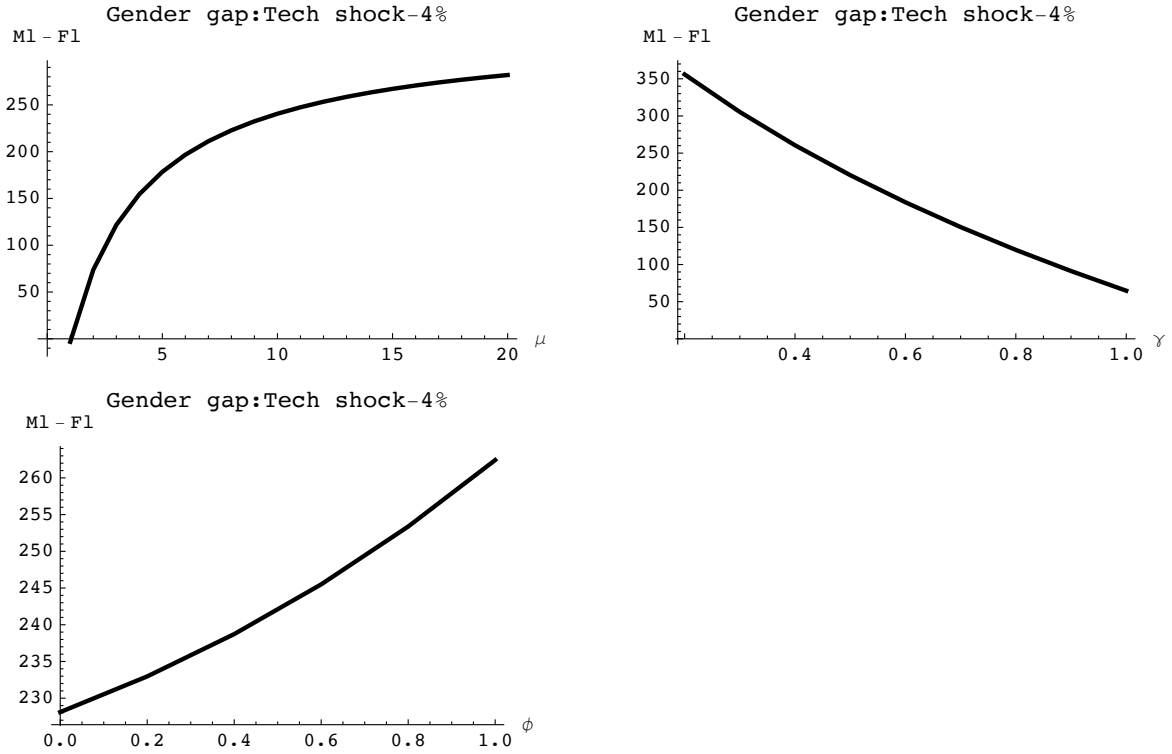

Figure A.3: Sensitivity analysis: the gender leisure gap after an improvemenet in technology

B The economic problem of the man, the woman and the household

The economic problem that the man, the woman and the household try to solve is standard in household economics: they maximize their own well-being given existing constraints. A first constraint they face is the available time to perform work and to rest. The man's total awake time, $\bar{M}$, is divided between the time he allocates to farming, M_f, to household production, M_s, to his own leisure, M_l, and to working in the rest of the economy M_r:[11]

$$\bar{M} = M_f + M_l + M_r + M_s \tag{7}$$

The man's working hours in the household sector and in the rest of the economy are fixed. We treat the man as a (primitive) capitalist who hires the woman and therefore must share the output with her. The man's utility is given by a simple log-linear function:

$$U_M = \gamma_M \log(QVA_f - \omega F_f - \bar{C}_f) + (1 - \gamma_M) \log(M_l - \bar{M}_l) \tag{8}$$

where QVA_f is value added in the farm sector, $\bar{C}_f$ is the household's consumption floor of the farm good (an input in the production function of the household sector), and $\bar{M}_l$ is the prevailing social norm for man's leisure. The optimal time spent on leisure and farm work are:

$$M_l = \gamma_M \bar{M}_l + (1 - \gamma_M)\Big[\bar{M} - M_r - M_s + \frac{1}{\varepsilon_m}[F_f(\varepsilon_F - \omega) - \bar{C}_f]\Big] \tag{9}$$

$$M_f = \gamma_M(\bar{M} - \bar{M}_l - M_r - M_s) - (1 - \gamma_M)\frac{1}{\varepsilon_m}\Big[F_f(\varepsilon_F - \omega) - \bar{C}_f\Big] \tag{10}$$

where γ_M is the man's preference for work, and both the payment to the woman, ω, and the household's consumption floor $\bar{C}_f$ are expressed in real terms.

In contrast with the man, the woman must adjust her time in the household sector, F_s, to ensure the reproduction of the household. She also works a fixed amount of hours F_r hours in the rest of the economy. The awake time that is left is divided between her work time on the farm, F_f, and leisure, F_l:

$$\bar{F} = F_f + F_s + F_l + F_r \tag{11}$$

Patriarchal societies often place additional constraints such as social norms and poverty on the ability of individuals, and especially of women, to maximize their well-being given standard constraints. For example, the woman may be sanctioned for leisure that goes beyond a certain level that is dictated by prevailing social norms. In order to capture these aspects of gender dynamics we use a utility function inspired by Burda et al. (2007):

$$U_F = C_F - \frac{1}{2\nu}(\bar{F} - F_s - F_r - F_l)^2 - \frac{\mu}{2}(F_l - \bar{F}_l) \tag{12}$$

where ν is the inverse of disutility of work, $\bar{F}_l$ is a society-sanctioned norm for a woman's leisure time, and μ is a social norm parameter. The woman's optimal allocation of her time to farming and leisure, after spending the work hours required by household maintenance, depends on the

[11] Work in the rest of the economy for both the man and the woman can include paid work on others' farms, paid work in non-agricultural sector and self employment in non-agricultural sector.

wage she receives and her preference for leisure as captured by ν. The woman, in her position as an institution, is being paid a fixed wage, w, by the man who is in charge of the farm.[12] The woman's optimal leisure and work on the farm given her budget and time constraints are (see derivations in the Appendix):

$$F_l = \gamma_F(\bar{F} - F_s - \omega\nu) + (1 - \gamma_F)\bar{F}_l \tag{13}$$

$$F_f = (1 - \gamma_F)(\bar{F} - F_s - \omega\nu) + \omega\nu - (1 - \gamma_F)\bar{F}_l \tag{14}$$

where $\gamma_F = \frac{1}{1+\nu\mu}$, and ω is the payment the woman receives, w, expressed in terms of the domestically produced farm sector good, or w/PH_f. Both the woman's leisure and her labor in the farm sector are affected negatively by an increase in the demand for work, F_s, in the household sector. At the same time, if she receives a higher return for her work on the farm she will allocate more hours to it at the expense of her leisure.

Lastly, the household must consume a minimum amount of food and household good. This is reflected in the consumption floors that enter a simple Cobb-douglas utility function (see equations in the Table). The household spends fixed shares of its income on farm and household commodities after it consumes the required minimum amounts of both.

C Complete list of equations

Notations	
f	Farm sector
s	Household sector
l	Leisure sector
Fl	Leisure (woman)
Ml	Leisure (man)
H	Household
r	Rest of the economy (ROE)

Parameters	
α_i	Yield of output per unit of activity, where $i = f, s$
b_f	Fixed intermediate input coefficient
θ	Proportion of farm value added to output supply
a_q	Armington function shift parameter
δ_q	Armington function share parameter

[12] We use wage here more as a concept for the overall return to the woman's labor on the farm. This return may or may not take a monetary form. The return is pecuniary if the man sells the surplus output, if any, and shares the revenue with his wife. However, the return to the woman's labor on the farm will first be in kind i.e. food. Moreover, this wage rate is different from w_f which is the imputed wage rate used for calculation of value added in the farm sector.

σ_q	Elasticity of substitution between the two uses of composite output i.e. imports (purchases) and household use
ρ_q	Armington function exponent equal to $\rho_q = \frac{1}{\sigma_q} - 1$
a_f	CET function shift parameter
δ_f	CET function share parameter
σ_f	Elasticity of transformation between the two destinations of domestic output i.e. exports (sales) and household use
ρ_f	CET function exponent equal to $\rho_f = \frac{1}{\sigma_f} + 1$
c_i	Weight of commodity i in the consumer price index where $i = f, s, lF, lM$
θ_M	Share of the man's factor income in farm sector retained for himself
θ_H	Share of the household in the income of the factor income of the man
β_M	Share of the man in the factor income iof the woman
β_H	Share of the household in the factor income of the woman
λ_M	Share of the household in the total income of the man less savings and leisure
λ_F	Share of the household in the ROE income of the woman
ϵ_i	Productivity in the leisure sector, where $i = lF, lM$
ϕ	Responsiveness of the woman's farm labor productivity to her leisure time
ν	Inverse of disutility of work parameter
μ	Social norm parameter
$(1 - \gamma_M)$	Man's preference for leisure
α_H	Household's preference for farm goods
ω	Return received by the woman for work on the farm

Variables

Prices

P_i	Import (purchase) price
P_e	Export (sale) price
PH_i	Price of output retained for own consumption, where $i = f, s$
PQ_i	Price of composite consumption good, where $i = f, s$
Q_i	Value added price, where $i = f, s$
PX_i	Aggregate produce price for commodities, where $i = f, s$
P_i	Activity price, where $i = f, s, Fl, Ml$
CPI	Consumer price index

Production

$QINT_f$	Demand for aggregate intermediate input in farm activity
QV_i	Value added production, where $i = f, s$
X_i	Activities output, where $i = f, s, Fl, Ml$
QQ_i	Composite goods demand, where $i = f, s$
QX_i	Composite commodities output , where $i = f, s$
QD_i	Composite household consumption, where $i = f, s$

E_f	Exports (sale of farm output)
I_f	Imports (purchases of market goods using farm income)
Factors	
M_i	Man's labor time in sector i, where $i = f, s, l, r$
F_i	Woman's labor time in sector i, where $i = f, s, l, r$
$\bar{M}$	Man's total awake time
$\bar{F}$	Woman's total awake time
w_{if}	Wage rate of institution i in the farm sector, where $i = M, F$
w_{ir}	Wage rate institution i in the ROE, where $i = M, F$
w_s	Wage rate in the household sector
ϵ_i	Labor productivity in the farm sector, where $i = M, F$
$\bar{\epsilon}_s$	Efficiency of labor in the household sector
$\bar{\epsilon}$	Constant in the woman's farm labor productivity function
Institutions	
Ω_r	Foreign savings
Ω_M	Man's savings
C_H	Household consumption of farm output
C_s	Household consumption of household output
$\bar{C}_i$	Consumption floor for commodity i, where $i = f, s$
C_i	Institution i's consumption of farm output, where $i = M, F$
R_i	Institution i's consumption of leisure, where $i = M, F$
Y_i	Income of institution i, where $i = M, F, H$
Y_{ir}	Income of the institution i received from ROE, where $i = M, F$
T_{MM}	Factor income of the man (factor) retained for himself (institution)
T_{MF}	Factor income of the man (factor) transferred to the woman (institution)
T_{MH}	Factor income of the man (factor) transferred to the household (institution)
T_{FF}	Factor income of the woman (factor) retained for herself (institution)
T_{FM}	Factor income of the woman (factor) transferred to the man (institution)
T_{FH}	Factor income of the woman (factor) transferred to the household (institution)
D_{MH}	Intra-institutional transfer from the man to the household
D_{FH}	Intra-institutional transfer from the woman to the household
$\bar{M}_l$	Leisure norm of the man
$\bar{F}_l$	Leisure norm of the woman

Table 5: Model definitions

Equations

Prices

1. $PQ_f = \frac{(PH_f * QD_f) + (P_i * I_f)}{QQ_f}$	Price of composite consumption good in farm sector
2. $PQ_s = \frac{(PH_s * QD_s)}{QQ_s}$	Price of composite consumption good in household sector
3. $PX_f = \frac{(PH_f * QD_f) + (P_e * E_f)}{QX_f}$	Aggregate produce price for farm commodities
4. $PX_s = \frac{(PH_s * QD_s)}{QX_s}$	Aggregate produce price for household commodities
5. $P_f = PX_f * \alpha_f$	Farm activity price
6. $P_s = PX_s * \alpha_s$	Household activity price
7. $P_{Ml} = \frac{w_{Mf} * M_l}{X_{Ml}}$	Man's leisure activity price
8. $P_{Fl} = \frac{w_{Ff} * F_l}{X_{Fl}}$	Woman's leisure activity price
9. $Q_f = \frac{P_f - (P_i * b_f)}{\theta}$	Farm value-added price
10. $Q_s = P_s$	Household value-added price

Production

11. $QINT_f = b_f * X_f$	Intermediate input in farm activity
12. $QV_f = \epsilon_M M_f + \epsilon_F F_f$	Linear production function for value-added in farm sector
13. $QV_s = X_s$	Value-added in household sector
14. $X_f = \frac{w_{Mf} M_f + w_{Ff} F_f}{\theta Q_f}$	Farm activity production function
15. $X_s = \frac{w_s * M_s + w_s * F_s}{P_s}$	Household activity production function
16. $X_{Ml} = M_l \epsilon_{Ml}$	Man's leisure activity production function
17. $X_{Fl} = F_l \epsilon_{Fl}$	Woman's leisure activity production function
18. $QX_f = \alpha_f X_f$	Marketed (distributed) farm output
19. $QX_s = \alpha_s X_s$	Marketed (distributed) household output
20. $QX_f = a_f \left[\delta_f E_f^{\rho_f} + (1 - \delta_f) QD_f^{\rho_f} \right]^{\frac{1}{\rho_f}}$	CET function of (sales) exports and domestic consumption of farm output
21. $QX_s = QD_s$	Composite household commodity output
22. $QQ_f = a_q \left[\delta_q I_f^{-\rho_q} + (1 - \delta_q) QD_f^{-\rho_q} \right]^{\frac{-1}{\rho_q}}$	CES/Armington aggregation function of imports (purchases) and domestic consumption of farm output
23. $QQ_s = QD_s$	Composite goods demand in household sector
24. $I_f = QD_f \left[\frac{PH_f}{P_i} \frac{\delta_q}{1 - \delta_q} \right]^{\frac{1}{1 + \rho_q}}$	Imports
25. $E_f = QD_f \left[\frac{P_e}{PH_f} \frac{1 - \delta_f}{\delta_f} \right]^{\frac{1}{\rho_f - 1}}$	Exports

Factors

26. $F_l = \gamma_F (\bar{F} - F_s - F_r - (\frac{\nu * \omega}{PH_f})) + (1 - \gamma_F) \bar{F}_l$	Woman's leisure time
27. $M_f = \gamma_M (\bar{M} - M_s - M_r - \bar{M}_l) - \frac{1 - \gamma_M}{\epsilon_M}$ $(F_f(\epsilon_F - \frac{\omega}{Q_f}) - \bar{C}_f)$	Man's labor supply in farm sector
28. $F_s = \frac{C_s - \bar{\epsilon}_s M_s}{\bar{\epsilon}_s}$	Woman's labor supply in household sector
29. $\epsilon_F = \bar{\epsilon} + F_l^{\phi}$	Woman's farm labor productivity function
30. $w_{Mf} = \frac{(Q_f QV_f) - (w_{Ff} F_f)}{M_f}$	Man's wage rate in the farm sector

Institutions

31. $T_{MM} = \theta_M(w_{Mf} * M_f) + (w_{Mf} * M_l)$	Factor income of the man (factor) retained for himself (institution)
32. $T_{MF} = \omega F_f$	Factor income of the man (factor) transferred to the woman (institution)
33. $T_{MH} = \theta_H(w_{Mf} * M_f) + (w_s * M_s)$	Factor income of the man (factor) transferred to the household (institution)
34. $T_{FF} = w_{Ff} * F_l$	Factor income of the woman (factor) retained for herself (institution)
35. $T_{FM} = \beta_M(w_{Ff} * F_f)$	Factor income of the woman (factor) transferred to the man (institution)
36. $T_{FH} = \beta_H(w_{Ff} * F_f) + (w_s * F_s)$	Factor income of the woman (factor) transferred to the household (institution)
37. $D_{MH} = \lambda_M(Y_M - \Omega_M - (w_{Mf} * M_l))$	Intra-institutional transfer from the man to the household
38. $D_{FH} = \lambda_F(w_{Fr}F_r)$	Intra-institutional transfer from the woman to the household
39. $Y_M = T_{MM} + T_{FM} + Y_{Mr}$	Man's total income
40. $Y_F = T_{FF} + T_{MF} + Y_{Fr}$	Woman's total income
41. $Y_{Mr} = w_{Mr} * M_r$	Man's income received from ROE
42. $Y_{Fr} = w_{Fr} * F_r$	Woman's income received from ROE
43. $Y_H = T_{MH} + T_{FH} + D_{MH} + D_{FH}$	Household total income
44. $C_M = \frac{(Y_M - \Omega_M - (w_{Mf} * M_l) - D_{MH})}{PH_f}$	Man's consumption of farm goods
45. $C_F = \frac{Y_{Fr} - D_{FH}}{PH_f} + \left[(\frac{\omega\nu\mu}{1+\nu\mu})(\frac{\bar{F} - F_s - F_r - \bar{F}_l}{PH_f})\right] + \frac{\omega^2\nu}{PH_f^2(1+\nu\mu)}$	Woman's consumption of farm goods
46. $R_M = X_{Ml}$	Man's consumption of leisure
47. $R_F = X_{Fl}$	Woman's consumption of leisure
48. $C_H = (\frac{\alpha_H(Y_H - PH_f\bar{C}_f - PH_s * \bar{C}_s)}{PH_f} + \bar{C}_f$	Household consumption of farm goods
49. $C_s = (\frac{(1-\alpha_H)(Y_H - PH_f * \bar{C}_f - PH_s * \bar{C}_s)}{PH_s} + \bar{C}_s$	Household consumption of household goods
59. $U_H = (C_H - \bar{C}_f)^{\alpha_H}(C_S - \bar{C}_s)^{1-\alpha_H}$	Household utility function
System constraints	
51. $M_f + M_s + M_l + M_r = \bar{M}$	Man's time constraint
52. $F_f + F_s + F_l + F_r = \bar{F}$	Woman's time constraint
53. $QQ_f = QINT_f + C_M + C_F + C_H$	Product market constraint (farm sector)
54. $QQ_s = C_S$	Product market constraint (household sector)
55. $P_eE_f + Y_{Mr} + Y_{Fr} + \Omega_r = P_i * I_f$	Net balance with ROE/ Balance between purchases and sales in ROE
56. $\Omega_r = -Y_M + (PH_fC_M) + (P_{Ml} * R_M) + D_{MH}$	Saving investment balance
57. $PQ_f * c_f + PQ_s * c_s + P_{Ml} * c_{Ml} + P_{Fl} * c_{Fl}$	Price normalization (CPI)

Table 6: Model equations

D Value of parameters and relevant variables

The values of parameters and exogenous variables that do not appear in the household accounting matrix are show in the table below. It is worth referring briefly to the sources for some of these. The CES and CET elasticities are based on the range recommended by Arndt et al. (2001) for Mozambique. They suggest a lower point of 0.3, a central point set at 1.5 and an upper point at 9.0. We expect the elasticity of substitution between consumption from own production and food purchases (CES) to be very low, and therefore set $\sigma_q = 0.8$. The reason is that most items purchased by the household are those that cannot be produced at home (e.g. condiments, non-food items). We set σ_f, the elasticity of substitution for the CET function, at the central point at 1.5. Although the household prioritizes household consumption from own production, it is relatively easier to purchase the same food items using income from the sales of crops.

Parameter/Variable	Value
Farm consumption floor ($\bar{C}_f$)	14.11
Household consumption floor ($\bar{C}_s$)	14.29
Armington function exponent (ρ_q)	0.25
CET function exponent (ρ_f)	1.67
Armington function share parameter (δ_q)	0.80
CET function share parameter (δ_f)	0.48
Armington function shift parameter (a_q)	1.70
CET function shift parameter (a_f)	2.00
Armington elasticity	0.8
CET elasticity	1.5
Responsiveness of the womans farm labor productivity to leisure (ϕ)	0.8
Households consumption preference for farm goods (α_H)	0.73
Mans preference for leisure ($1 - \gamma_M$)	0.58
Womans return for farm work (ω)	0.46
Social norm (μ)	12
Inverse of disutility of work (ν)	0.2
Intermediate input coefficient (b_f)	0.02
Yield of output per unit of activity (α_i, where $i = f, s$)	1
Proportion of farm value added to output supply ()	0.98
Woman's farm labor productivity (ϵ_i, where $i = M, F$)	5.17
Household labor productivity (ϵ_s)	3.13
Productivity in leisure sector (ϵ_i, where $i = Ml, Fl$)	1
Wage rate in the farm sector (w_i, where $i = Mf, Ff$)	5.17
Wage rate in the household sector (w_s)	3.13
Share of the man's factor income in farm sector retained for himself (θ_M)	0.41
Share of the household in the income of the factor income of the man (θ_H)	0.49
Share of the man in the factor income of the woman (β_M)	0.51
Share of the household in the factor income of the woman (β_H)	0.49
Share of the household in the total income of the man less savings and leisure (λ_M)	0.94
Share of the household in the ROE income of the woman (λ_F)	0.87
Man's Leisure norm ($\bar{M}_l$)	3.22

Woman's Leisure norm ($\bar{F}_l$)	1.43
Constant in the woman's farm labor productivity function ($\bar{\epsilon}$)	2.99

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