# Labor Market Equilibrium Effects of Cash Transfers

Evidence from a Structural Model and a Randomized Experiment

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*Abstract:* Critics argue that cash transfers (e.g. Bolsa Familia) to poor households would discourage work incentives. The few existing studies on the subject are far from conclusive: some do find a negative, others a positive, and again others no effect of cash transfers on labor supply. Important questions remain unanswered: In which context have cash transfers which effect on labor supply? What is the relationship between the size of the transfer and labor supply? I address these questions using a structural model and data from a large cash transfer program in Mexico. Perhaps surprisingly, I find that large cash transfers have a stimulating effect on labor supply, while small transfers provide disincentives to work.
*Keywords*: Poverty, Cash Transfers, Labor Supply

*Resumo:* Críticos dizem que programas de transferência de renda (como Bolsa Família por exemplo) diminuem os incentivos dos beneficiários de trabalhar. Os poucos estudos existentes sobre este tema não são conclusivos: alguns estudos encontram um efeito negativo, outros um efeito positivo, e outros nenhum efeito das transferências sobre a oferta de trabalho. Questões importantes permanecem sem resposta: em que contexto as transferências tem qual efeito sobre a oferta de trabalho? O que é a relação entre o tamanho da transferência e oferta de trabalho? Este artigo busca respostas a estes perguntas através de um modelo estrutural e dados de um programa de transferência de renda no México. Talvez surpreendentemente, meus resultados sugerem que transferências maiores estimulam oferta de trabalho, enquanto transferências pequenas geram desincentivos ao trabalho.
*Palavras-chave*: Pobreza, transferência de renda, oferta de trabalho

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# 1 Introduction

Cash transfer programs, such as *Bolsa Familia* in Brazil or *Progresa* in Mexico, are increasingly being implemented by governments to reduce poverty and inequality in rural areas.[1]. Such programs, however, also have a significant number of critics. One of their main arguments is that such transfers would discourage work incentives of recipients. The existing empirical evidence is far from conclusive: some studies find no effects on labor supply (Parker and Skoufias, 2000; Foguel and de Barros, 2008) while others find positive effects (Ribas and Soares, 2011; Alzúa et al., 2012), while again others find negative effects (Tavarez, 2010).

The inconclusiveness of existing empirical findings calls for more theoretical work on the relationship between cash transfers and labor supply. In this paper we use data from a cash transfer program in Mexico to estimate and a structural labor supply model. Comparative statics show how not only the magnitude but even the direction of the labor supply effect depends on parameters that describe the program and the environment in which it is implemented.

# 2 The Model

## 2.1 A simple two-household-two-commodities model

Consider a village populated by a poor household (henceforth **P**) and a rich household (henceforth **R**). Each household is composed of a male (henceforth $\mathbf{M_i}$) and a female member (henceforth $\mathbf{F_i}$) where $i \in \{\mathbf{P}, \mathbf{R}\}$. $\mathbf{M_i}$ has the opportunity to go out of village to work at exogenous wage $\bar{p}_L^M$. This captures the fact that the often only source of wage labor is seasonal work on some large commercial farm or seasonal construction work in some large city.
$\mathbf{F_i}$ cannot work abroad because she has obligations inside the village such as for example child and/or livestock care. $\mathbf{F_i}$, however, can work in the household's family business which operates inside the village (typically petty trade activities, i.e. buy commodities in a nearby town and resell with a mark-up inside the village).[2] We assume that a household cannot hire in non-household members to work for the family business (because of, for example, prohibitively high monitoring costs). Consequently, female labor supply is a function of the endogenous household specific female shadow wage $p_L^{F,i}$. The latter is determined in the household internal labor market equilibrium where demand for female labor must equal supply.
There are two commodities in the village economy: A staple (henceforth $q$) which may be produced by one or both of the two households using their respective land endowments and the available supply of female labor.
The second good in the economy is a (composite) manufactured commodity (henceforth $y$) that is produced *outside* the village and hence has to be imported by the two households (typically items such as soap, cooking oil, recharge cards for cell phones, batteries, etc.).

[1] see Lindert et al. (2006) and Fizbein and Schady (2009) for a comprehensive overview.

[2] Of course, in reality such labor market segregation by gender will not always be perfect. For example, a female without child care obligations may have the opportunity to do out-of-village wage labor work. Accommodating the possibility of a not perfectly segregated labor market would add complexity to the model that is disproportional to the little additional amount of information that we gain from doing so. In this paper we'll be using data from rural Mexico to estimate and validate the model. Descriptive statistics (see table 1) show that share of females in out-of village wage labor activities is only 10.5 percent. With a male share of roughly 50 percent the within-village service labor market is not as gender segregated as the out-of-village wage labor market.

Each household is assumed to maximize a utility function

$$u_i : f(q_i; y_i; l_{i,M}; l_{i,F}) \to \Re \qquad i \in \{P, R\} \tag{1}$$

where $u_i'(\cdot) > 0$ and $u_i''(\cdot) < 0$ and where $q_i$, $y_i$, $l_{i,M}$, $l_{i,F}$ being household $i$'s consumption of the staple, imported (composite) manufactured commodity, male leisure, and female leisure, respectively. For males, leisure is defined as $l_{i,M} = \bar{L}_{i,M}^{net} - L_{i,M}$, where $\bar{L}_{i,M}^{net}$ is the male's net time endowment and $L_M$ denoting his labor supply. Similarly, female leisure is defined as $l_{i,F} = \bar{L}_{i,F}^{net} - L_{i,F}$.
Each household maximizes (1) subject to it's full budget constraint:

$$I_i \equiv p_i^q \times q_i + p_y \times y_i + p_L^{F,i} \times l_{i,F} + \bar{p}_L^{M,i} \times l_{i,M} \tag{2}$$

where $I_i$ is a household's (full) income, $p_i^q$ denotes household specific shadow price of the staple, and $p_y$ is the village price of the imported manufactured composite commodity. Maximizing (1) with respect to (2) yields the demand function for the manufactured imported commodity

$$y_i : f(I_i; p_y; \mathbf{\Omega}) \to \Re \tag{3}$$

for the staple

$$q_i : f(I_i; p_q^i; \mathbf{\Omega}) \to \Re \tag{4}$$

and leisure, so labor supply is given by

$$L_{i,M} : f(I_i; \bar{p}_M^L; \mathbf{\Omega}) \to \Re \tag{5}$$

Equivalently, labor supply of the female is given by:

$$L_{i,F} : f(I_i; p_F^L; \mathbf{\Omega}) \to \Re \tag{6}$$

where $\mathbf{\Omega}$ is a vector of preference parameters.

*(i.) Transaction Costs*
An important characteristic of the model is the presence of transactions costs in consumption and production. Many items that form part of the consumption basket of villagers these days are not produced by the village, but have to be imported from the next market (e.g. some big town). Such items include soap, cooking oil, medicine, etc. Thus the effective price that a villager pays for the imported composite manufactured commodity is

$$p_y = \bar{p}_z + \bar{m}_y \times p_s \tag{7}$$

where $\bar{p}_z$ is the (exogenous) price of one unit of $y$ at the next market from which it is imported. But then in order for this one unit to reach the village $\bar{m}_y$ units of an 'import service' with price $p_s$ are required.

Also, if a household sells one unit of its staple production, $m_q$ units of export service are required for the one unit of staple to get from the household's plot to the market where it is sold.[3] The selling price is consequently $p_q^s = \bar{p}_q - m_q \times p_s$. Similarly, if a household wishes to buy one unit of staple, $m_q$ units of import service are required. The purchase price of staple is consequently $p_q^p = \bar{p}_q + m_q \times p_s$.

If a household is selling, buying or stays self sufficient is determined by the household specific shadow price for the staple. If the shadow price is lower (higher) than the selling (purchase) price, then utility maximization requires the household to sell (buy) the staple. If the shadow price falls in between the selling and purchase price, the household should stay self sufficient (i.e. neither sell nor buy). The household shadow price is determined in the household internal staple equilibrium

$$q_i^x + q_i^p \equiv q_i + q_i^s \tag{8}$$

where $q_i^x$ is household $i's$ staple production, $q_i^p$ and $q_i^s$ is the purchased and sold quantity respectively, and $q_i$ is consumption.

*(ii.) Service production*

Above we described how both consumption of $y$ as well as purchases and sales of $q$ require some amount of export/import 'service' for these commodities to get from the village to the market and/or vice versa. Technically, we assume that the household acts as a firm which 'produces' this import/export 'service' according to the production function $s : f(L_{F,s,i}, K_{s,i}, \mathbf{\Theta}) \rightarrow \Re$, where $L_{F,s,i}$ denotes female labor, $K_{s,i}$ is capital, and $\mathbf{\Theta}$ a vector of technology parameters where $s'_L(\cdot) > 0$ and $s''_L(\cdot) < 0$, as well as $s'_K(\cdot) > 0$ and $s''_K(\cdot) < 0$. We think of capital as cash (e.g. money needed to by commodities in bulk in order to resell with a mark-up inside the village.). We assume that capital is a share $\bar{\mu}_i$ of the household's cash income:

$$K_{s,i} = \bar{\mu}_i (L_{i,M} \times \bar{p}_M^L + q_i^s + T_i) \tag{9}$$

Profit is thus given by

$$\pi_{s,i} = p_s \times f(L_{F,s,i}, K_{s,i}, \mathbf{\Theta}) - p_F^L \times L_{F,s,i} - K_{s,i} \tag{10}$$

Profit maximizing labor demand for service production is $arg \max_{L_{F,s,i}} \pi_{s,i}$:

$$L_{F,s,i}^D : f(p_s, p_L^F, K_s, \mathbf{\Theta}) \rightarrow \Re \tag{11}$$

*(iii.) Agricultural Production*

The staple production function maps female labor ($L_{F,q,i}$), a household's land endowment ($\bar{A}_i$)

[3]The assumption here is that there is no farm gate selling. That farmgate selling is rather the exception that the rule has stated in (?;(?);(?)). Furthermore, we assume that there are no sunk costs that would arise from a household transporting staple to the market without being able to sell it (and hence would have to transport it back to the village after the market day)

and a vector of agricultural technology parameters ($\boldsymbol{\Xi}$) onto the output space $q_i^x$:

$$q_i^x : f(L_{F,q,i}, \bar{A}_i, \Xi) \rightarrow \Re \tag{12}$$

We assume land to be fixed endowment, and there is no land land market. Profit maximizing labor demand for agricultural labor is $arg\max_{L_{F,q,i}} \pi_{i,q} = p_q^i \times q_i^x - p_F^L \times L_{F,q,i}$ :

$$L_{F,q,i}^D : \ f(p_q^i, p_F^L, \bar{K}_i, \boldsymbol{\Xi}) \rightarrow \Re \tag{13}$$

*(iv.) Household Internal Labor Market Equilibrium*
The female shadow wage $p_L^F$ is then determined in the household internal labor market equilibrium where demand for female labor must equal supply

$$L_{F,s,i}^D + L_{F,q,i}^D \equiv L_{i,F} \tag{14}$$

*(v.) Poverty*
In our model poverty manifests itself in two ways. Firstly, **R** possesses a larger land endowment than **P**

$$\bar{A}_P < \bar{A}_R. \tag{15}$$

Secondly, we assume that **P** has less effective labor endowment. The negative relationship between poverty and labor productivity is well documented in the literature (**?**, **?**, **?**). For example, malnourished individual's concentration and capacity to do heavy physical work is limited. Furthermore, limited access to health care (e.g. medicine) translates into more sick days, hence less potential days of labor supply (**?**, **?**, **?**).
In our model we'll assume that the labor endowment of a household member is discounted by the degree of household poverty $\psi_i$, such that the *net* labor endowment is $\bar{L}/(1+\psi_i)$, where $\psi_i$ is zero if $i \in \mathbf{R}$ and strictly positive otherwise. For example if $\bar{L}$ =365 days and $\psi_{P,F} = 1/3$, then this would imply a net labor endowment of the rich female of 365 days while that of the poor female would only be 275 days. Lastly, the government implements a redistributive transfer to aid the poor household. That is, **P** receives monetary support (a "cash transfer') by the government while **R** does not.[4]

*(vi.) Household Income*
Consequently, household full income is defined as

$$I_i = \bar{L}/(1+\bar{\psi}_{i,F}) \times p_{i,F}^L + \bar{L}/(1+\bar{\psi}_{i,M}) \times \bar{p}_M^L + \pi_q + \pi_s + T_i \tag{16}$$

The first and second term denote the value of **M**'s and **F**'s net labor endowment. The third and fourth term denote profits made from staple and service production. The last term denotes a cash transfer by the government, whereby $T_R = 0$ and $T_P > 0$.

*(vii.) Equilibrium of the village economy*

[4]We ignore how the transfer is financed.

In equilibrium, the village's staple market is characterized by the identity

$$q_P + q_R + q_{ex} \equiv q_R^x + q_P^x \tag{17}$$

where the first two terms on the left hand side correspond to the staple demanded by the two households, respectively. The right hand side corresponds to staple production of the two households. Equation (17) determines the equilibrium trade balance $q_{ex}$. The village exports staple if $q_{ex} > 0$ and imports staple if $q_{ex} < 0$.

Secondly, in equilibrium the service market must clear

$$(y_P + y_R)\bar{m}_y + (q_P^p + q_R^p)m_q^p + (q_P^s + q_R^s)m_q^s \equiv s_P + s_R \tag{18}$$

where the right hand side is the service supplied by **P** and **R**. The left hand side represents the demand for service. The first term on the left hand side is the service demand for importing the manufactured commodity, and the second (third) term being the service demand to import (export) staple. Equation (18) determines the equilibrium price of the service $p_s$.

## 2.2 Model Solution

The model can be written as an $n \times n$ system of (non-linear) equations. The world market price of the imported manufactured good $\bar{p}_z$ is the numeraire of the system. The non-convexity exhibited by the 'switching' staple shadow price makes it that there is no closed form solution. We thus turn to a numerical approach to obtain a solution to the model. This requires functional form assumptions for (a) the utility function and the production function of (b) the service and (c) the staple. In the following we'll therefore assume a Stone-Geary utility function of the form

$$u_i = \bar{\alpha}_i \log(q_i - \bar{q}_i) + \bar{\beta}_i \log(y_i - \bar{y}_i) + \bar{\gamma}_F \log\left(\frac{\bar{L}^F}{1+\bar{\psi}_{i,F}} - L_{i,F}\right) + \bar{\gamma}_M \log\left(\frac{\bar{L}^M}{1+\bar{\psi}_{i,M}} - L_{i,M}\right) \tag{19}$$

where $\bar{q}_i$ and $\bar{y}_i$ are subsistence thresholds. For the service we assume a simple constant returns to scale production function of the form

$$S_i = \bar{\sigma}_i \times L_{F,s,i}^{\bar{\eta}_i} K_{s,i}^{1-\bar{\eta}_i} \tag{20}$$

where $\bar{\sigma}_i$ is a scale parameter. We further assume that staple production is Leontief:

$$q_i^x = \inf\{\bar{A}/\bar{a}_i, L_i/\bar{b}_i\} \tag{21}$$

where $\bar{a}_i$ and $\bar{b}_i$ are the Leontief input share parameters. Since the land distribution is exogenous in this model, this functional form assumption implies that the labor demand for staple production is fix.[5]

[5] In the appendix we present results for alternative functional form specifications

# 3 Parameter estimation and within-sample fit

In order to solve the model numerically we need values for its parameters. The model parameters are obtained from data collected on the control group of a randomized control trial (RCT) conducted in Mexico, which we henceforth refer to simply as the *Progresa* experiment. The next subsection briefly describes the *Progresa* experiment.[6]

## 3.1 The Progresa Experiment

In 1997, the Mexican government started the so called *Progresa* program with the aim of reducing rural poverty and inequality (Schultz, 2004). The program provides monetary grants to the lower tail of the village welfare distribution, i.e. the poorest households of a village. In order to identify the latter, the Mexican government used a multidimensional poverty index.[7] *Progresa* monetary grants are of substantial size, amounting to about 20 percent of average household monetary income in rural Mexico.

For the purpose of impact evaluation and feasibility of program implementation, the program was initially not implemented simultaneously in all villages. In 1997, the Mexican government determined all eligible households. Then, a set of villages where the program ought to be implemented first was chosen randomly. Households classified as 'poor' in these villages would receive the first *Progresa* transfer payment in early 1998. The remaining villages would only be incorporated into the program two years later. Households classified as 'poor' in these villages would receive the first *Progresa* transfer only in early 2000. The latter, therefore, serve as a control group for the years 1998 and 1999. In some 320 villages where the program would be implemented first (henceforth referred to as 'treatment villages') and in another 186 villages where the program would start two years later (henceforth referred to as 'control villages') the Mexican government conducted a comprehensive baseline, and a three follow-up surveys between and 1998 and 1999. These surveys are village censuses, i.e. data on all residents of these 506 villages was collected. We thus have a panel of the entire village welfare cumulative distribution function, consisting of program-eligible households at the lower tail and program-ineligible households at the upper tail, in each of the 320 treatment and 186 control villages.

Prior to the start of the program these 506 villages have characteristics that would describe many village economies across the globe. The average village size is 45 households, 95 percent of which report agriculture to be their main source of livelihood. One year after the start of the program, on average 60 percent of residents in treatment villages receive the government

[6] *Progresa* stands for *Progama de escolarisacion salud y alimentation* which is Spanish for 'program for schooling, health, and nutrition'. For more details on the *Progresa* program we refer the reader to Hoddinott and Skoufias (2004)

[7] see Skoufias et al. (2001) for a description of the method.

Table 1: Characteristics of the control group sample

| | Eligible Households | Ineligible Households |
|---|---|---|
| | Mean<br>[Std.Dev.] | Mean<br>[Std.Dev.] |
| *Household and Community Characteristics* | | |
| Gini Index for agricultural land ownership | 0.71 | |
| | [120.7] | [124.9] |
| Pre-program household poverty score | 701.6 | 882.5 |
| | [120.7] | [124.9] |
| Monthly Food consumption (per capita, peso value) | 182.5 | 198.4 |
| | [163.6] | [153.2] |
| Monthly Food expenditure (per capita, peso value) | 137.3 | 169.6 |
| | [130.1] | [145.4] |
| Monthly non-purchased food consumption (per capita, peso value) | 38.85 | 27.86 |
| | [591.9] | [48.1] |
| Monthly household disposable income (in peso) | 662.1 | 795.3 |
| | [362.6] | [2129.8] |
| Cultivated area (in hectare) | 0.46 | 0.75 |
| | [2.77] | [2.31] |
| Hourly wage rate | 5.27 | 6.97 |
| | [36.14] | [25.12] |
| Livestock holding index | -0.21 | 0.06 |
| | [2.41] | [3.63] |
| Household size | 5.44 | 4.82 |
| | [2.60] | [2.53] |
| Indigenous household head | 0.36 | 0.17 |
| | [0.48] | [0.37] |
| Education of head | | |
| no | 32.55 | 26.35 |
| primary | 62.03 | 64.52 |
| secondary | 4.92 | 6.95 |
| tertiary | 0.51 | 2.19 |
| *N* | 6857 | 1949 |

Notes: standard deviations are reported in parenthesis. Livestock index calculated using principal component analysis transfer. Table 1 shows descriptive statistics of households classified eligible (i.e. 'poor') and households classified ineligible (i.e. 'non-poor') by the government.[8] The table suggests that the program was effective in targeting the lower tail of the village welfare distribution, i.e. the poorest households of a village. Program-eligible households have, on average lower food consumption, income and education levels, as well as lower land and livestock holdings, compared to program-ineligible households. These differences are all statistically significant.

## 3.2 Obtaining values for the model parameters

In this section, we estimate the parameters of the model exploiting the data available from the *control group* of the *Progresa* experiment. The vector of parameters writes:

$$\mathbf{\Gamma} = \{\bar{A}_i, \bar{p}_z, \bar{p}_q, \bar{p}^L_M, \bar{L}_{i,F}, \bar{L}_{i,M}, \bar{\psi}_{i,F}, \bar{\psi}_{i,M}, \bar{\alpha}, \bar{\beta}, \bar{\gamma}_M, \bar{\gamma}_F, \bar{m}^p_q, \bar{m}^s_q, \bar{m}_y, \bar{\eta}_i, \bar{\sigma}_i, \bar{a}_i, \bar{b}_i\} \quad (22)$$

that is land endowment ($\bar{A}_i$); the world world market price of the staple $\bar{p}_q$; the out-of-village wage $\bar{p}^L_M$. The net yearly labor endowment of male and female respectively $\bar{L}_{i,F}/(1+\bar{\psi}_{i,F}), \bar{L}_{i,M}/(1+\bar{\psi}_{i,M})$; the price of the imported composite manufactured commodity $\bar{p}_z$; as well as the preferences for staple ($\bar{\alpha}$), imported manufactured commodity ($\bar{\beta}$), and male and female[9] leisure ($\bar{\gamma}_M$ and $\bar{\gamma}_F$); the amount of service needed to import one unit of the imported manufactured commodity ($\bar{m}_y$); the amount of service needed to import or export one unit of the staple ($\bar{m}^p_q$ and $\bar{m}^s_q$), the labor intensity and scale parameters of the service production function ($\bar{\eta}_i$ and $\bar{\sigma}_i$), as well as the Leontief share parameters $\bar{b}_i$ and $\bar{a}_i$ for agricultural production.

Values for a subset of $\mathbf{\Gamma}$ can be observed directly from the data available on the control group. Denote $\mathbb{C}$ and $\mathbb{T}$ the set of households in the experimental data that live in control and treatment villages, respectively. Also, let $\mathbb{P}$ denote the set of households in the experimental data that are eligible for the *Progresa* transfer, and $\mathbb{R}$ those that are not. For the poor household of our model, we can then obtain an estimate for some model parameter $\kappa_P \in \mathbf{\Gamma}$ by taking the sample average of the observed value of this parameter across program eligible households in the control group:

$$\widehat{\kappa_P} = n^{-1}_{i\in\{\mathbb{C}\cap\mathbb{P}\}} \sum_{i\in\{\mathbb{C}\cap\mathbb{P}\}} \kappa_i^{exp} \quad (23)$$

where $\kappa_i^{exp}$ denotes the observed value for household $i$ in the experimental data. In an analog manner, for the rich household of our model, we do obtain an estimate for some model parameter $\kappa_R \in \mathbf{\Gamma}$ by taking the sample average across program *ineligible* households in the control group

[8] We present descriptive statistics of the control group, one year after the start of the program. Ideally, we would present characteristics of all sample households in both treatment and control villages prior to the start of the program. Unfortunately, key variables such as food consumption and income plus value of consumed own agricultural production are not available in the baseline survey.

[9] Due to the assumption of a constant returns to scale utility function, we have that $\bar{\gamma}_F = 1 - \bar{\alpha} - \bar{\beta} - \bar{\gamma}_M$

of the experimental data:

$$\widehat{\kappa_R} = n^{-1}_{i\in\mathbb{C}\cap\mathbb{R}} \sum_{i\in\mathbb{C}\cap\mathbb{R}} \kappa_i^{exp} \tag{24}$$

For example, an estimate of the parameters $\bar{A}_P$ and $\bar{A}_R$ (land endowment of **P** and **R**, respectively) is obtained by taking the average land endowment of program eligible and ineligible households in the control group, respectively. We are thus following a representative household approach in our numerical simulations.

Furthermore, respondents in the control group were asked for the daily wage that an agricultural worker can earn, and we take the average of these answers across the control group to obtain and estimate for $\bar{p}_L^M$.

The market price of the staple $\bar{p}_q$ can be obtained from administrative records of the Mexican Ministry of Agriculture. We then assume a gross labor endowment $\bar{L}$ of 365 days for each **F** and **M**, respectively. As the numeraire of the system we set the world market price of the imported manufactured composite commodity ($\bar{p}_z$) to one. The Leontief production function was calibrated using data from a household survey[10] representative for rural Mexico which was conducted around the same time as the *Progresa* control group data collection took place. This survey gives us information about the amount of labor days needed to cultivated one hectare of corn.

However, there is a vector $\mathbf{\Lambda} \in \mathbf{\Gamma}$ of model parameters that can neither be observed directly from the data nor obtained from administrative records. This vector writes $\mathbf{\Lambda} = \{\bar{\alpha}, \bar{\beta}, \bar{\gamma}_M, \bar{m}_y, \bar{m}_q^p, \bar{m}_q^s, \bar{\eta}_i, \bar{\sigma}_i, \mu_i, \psi_{M,i}, \psi_{F,i}\}$. In order to obtain values for these parameters we do exploit the fact that we do observe from the control group data a couple of in the model endogenous variables, such as the average yearly quantity of consumed staple per household $q_i^{exp}$, as well as the average yearly out-of-village labor supply of men $L_{i,M}^{exp}$, and lastly women's average yearly labor supply to service activities $L_{i,s,F}^{exp}$.[11] The superscript *exp* is used to indicate that these values are obtained directly from the experimental data (we will denote from the model predicted values with the superscript *sim*).

Define the vector $\mathbf{Y}_{\mathbb{C}}^{exp} = \{q_i^{exp}, L_{i,M}^{exp}, L_{i,s,F}^{exp}\}$. And denote $\mathbf{Y}^{sim}(\mathbf{\Lambda})$ the vector of from the model obtained values of these variables. We then select $\mathbf{\Lambda}$ so as to minimize the standardized squared distance between $\mathbf{Y}_{\mathbb{C}}^{exp}$ and $\mathbf{Y}^{sim}(\Lambda)$

$$\min_{\mathbf{\Lambda}} E = \left( \frac{\mathbf{Y}_{\mathbb{C}}^{exp} - \mathbf{Y}^{sim}(\mathbf{\Lambda}, \mathbf{X}(\mathbf{\Lambda}))}{\mathbf{Y}_{\mathbb{C}}^{exp}} \right)^2 \quad s.t. \quad \mathbf{X} = g(\mathbf{\Lambda}) \tag{25}$$

[10] *Encuesta nacional de hogares rurales*

[11] actually, we observe weekly values for these variables that we then aggregate to yearly variables. The potential pitfalls of this kind of aggregation are discussed below.

The full Lagrangian writes[12]:

$$\begin{aligned}
\min_{\Lambda} E &= \sum_{i=P,R} \left( \frac{q_i^{exp} - (\bar{q} + \bar{\alpha} \frac{I_i - \bar{y} \times (p_y) - \bar{l_M} \times \bar{p}_M^L - \bar{l_F} \times p_{F,i}^L}{p_i^q}}{q_i^{exp}} \right)^2 \\
&+ \left( \frac{L_{i,M}^{exp} - \left( \frac{\bar{L}}{1+\bar{\psi}_{i,M}} - \bar{l_M} - \bar{\gamma}_M \frac{I_i - \bar{q} \times p_i^q - \bar{y} \times p_y - \bar{l_F} \times p_{F,i}^L}{\bar{p}_M^L} \right)}{L_{i,M}^{exp}} \right)^2 \\
&+ \left( \frac{L_{i,F}^{exp} - \left( \frac{\bar{L}}{1+\bar{\psi}_{i,F}} - \bar{l_F} - \bar{\gamma}_F \frac{I_i - \bar{q} \times p_i^q - \bar{y} \times p_y - \bar{l_M} \times \bar{p}_M^L}{p_{F,i}^L} \right)}{L_{i,F}^{exp}} \right)^2 
\end{aligned} \tag{26}$$

$$\forall \;\; i \in \{P, R\} \quad s.t.$$

$$p_i^q = (\bar{p}_z - \bar{m}_q^s \times p_s) \tag{27}$$

$$p_y = \bar{p}_z + \bar{m}_y \times p_s \tag{28}$$

$$S_i = \bar{\sigma}_i \times K_{s,i}^{1-\bar{\eta}_i} \times \left( \frac{K_{s,i}^{-1+\bar{\eta}_i} \times p_{F,i}^L}{(\bar{\eta}_i \times p_s \times \bar{\sigma}_i)} \right)^{\frac{\bar{\eta}_i}{(-1+\bar{\eta}_i)}} \tag{29}$$

$$K_{s,i} = \mu(L_{i,M} \times \bar{p}_M^L + q_i^s + T_i) \tag{30}$$

$$L_{D,s,i} = \left( \frac{K_{i,s}^{-1+\bar{\eta}_i} \times p_{F,i}^L}{(\bar{\eta}_i \times p_s \times \bar{\sigma}_i)} \right)^{\frac{1}{(-1+\bar{\eta}_i)}} \tag{31}$$

$$\pi_{q,i} = p_i^q \times q_i^x - p_{F,i}^L \times L_{D,q,i} \tag{32}$$

$$\pi_{s,i} = p_s \times S_i - p_{F,i}^L \times L_{D,s,i} \tag{33}$$

$$I_i = \frac{\bar{L}}{1 + \bar{\psi}_{i,M}} \times \bar{p}_L^M + \frac{\bar{L}}{1 + \bar{\psi}_{i,F}} \times p_{F,i}^L + \pi_{s,i} + \pi_{q,i} + T_i \tag{34}$$

$$y_i = \bar{y} + \bar{\beta} \frac{I_i - \bar{q} \times p_i^q - \bar{l_M} \times \bar{p}_L^M - \bar{l_F} \times \bar{p}_L^F}{p_y} \tag{35}$$

$$q_i^x + q_i^p = q_i^{exp} + q_i^s \tag{36}$$

$$L_{i,F}^{exp} = L_{D,s,i} + L_{D,q,i} \tag{37}$$

$$q_P^x + q_R^x = q_P + q_R + ROW \tag{38}$$

$$S_P + S_R = (y_P + y_R)\bar{m}_y + (q_P^p + q_R^p)\bar{m}_q^p + (q_i^s + q_i^s)\bar{m}_q^s \tag{39}$$

[12] For the purpose of readability, we omit henceforth the subscript $\mathbb{C}$, which applies to all variables of the Lagrangian.

Table 2: Parameter values

| | Poor Household ($P$) | Rich Household ($R$) |
|---|---|---|
| land endowment ($\bar{A}_i$) in ha. | [0.528] | [1.227] |
| price of the staple $\bar{p}_q$ in USD/kg | [.276] | [.276] |
| out-of-village wage $\bar{p}^L_M$ in USD/day | [3.5] | [3.5] |
| labor endowment of M ($\bar{L}_{i,M}$) in days/year | [365] | [365] |
| labor endowment of F ($\bar{L}_{i,F}$) in days/year | [365] | [365] |
| labor productivity discount factor of M ($\bar{\psi}_{i,M}$) | [.056] | [0] |
| labor productivity F ($\bar{\psi}_{i,F}$) | [.321] | [0] |
| price manufactured commodity $\bar{p}_z = 1$ | [1.0] | [1.0] |
| preference staple ($\bar{\alpha}$) | [ 0.056] | [ 0.056] |
| preference manufactured commodity ($\bar{\beta}$) | [0.502] | [0.502] |
| preference leisure of M ($\bar{\gamma}_M$) | [0.123] | [0.123] |
| preference leisure of F ($\bar{\gamma}_F$) | [.32] | [.32] |
| service per import of manuf. cmdity ($\bar{m}_y$); | [.027] | [.027] |
| service per import staple ($\bar{m}^p_q$); | [.010] | [.010] |
| labor intensity in service production ($\bar{\eta}_i$) | [.10] | [.10] |
| technology in service production and ($\bar{\sigma}_i$) | [8.64] | [1.33] |
| capitalization share of family business ($\mu$) | [0.087] | [0.43] |

Table 2 shows the parameters obtained from this exercise, as well as all other parameter values of the model.

## 3.3 Within-sample fit

The first row in each panel of table 3 compares the actual from the control group observed value of some endogenous variable, $Y^{exp}_{\mathbb{C}\cap\mathbb{P}}$, with the from the model simulated value, $Y^{sim}_{\mathbf{P}}(\mathbf{\Gamma})$. We'll refer to the difference between the latter two as the 'within-sample goodness of fit'. We call it 'within-sample' because the parameters underlying the simulation were obtained partly from the control group, i.e. from the same sample that we are comparing the simulated values to. Table 3 reveals that the within sample fit is perfect, i.e. the from the model simulated value reproduces exactly the actual from the control group observed value of some endogenous variable.

A good within-sample fit is an important starting point to ensure the benchmark model can replicate behavior observed in the data. However, this provides no direct evidence on how reliable the model predictions are under changes to the policy environment. In the next section

Table 3: Results: Within-sample & out-of-sample validation (program-eligible households)

| | Male | | Female | |
|---|---|---|---|---|
| | simulated | actual | simulated | actual |
| annual labor supply (in days) | | | | |
| control | 228.0 | 228.0 | 17.3 | 17.3 |
| treatment | 191.53 | 215.8 | 19.10 | 29.8 |
| ATE (se) | -36.492 | -10.58(7.97) | 1.71 | 12.41 (8.41) |
| Ln ATE | -0.160 | -.155 (.109) | 0.098 | .151(.112) |

Notes: The values in parenthesis in the third row of each panel are the standard errors of the regression coefficient obtained from OLS regression in equation (41)

we'll analyze the model's performance in out-of-sample tests, where we'll see if the model is able to reproduce the outcomes of the *Progresa* treatment group sample. Recall that we did *not* use the latter sample during the calibration of the model (we have exploited exclusively information on the control group). Therefore the label 'out-of-sample validation'.

# 4 Model (Out-of-Sample) Validation

## 4.1 Method

Now we add a cash transfer to the income of **P** in our model, and then solve the model to obtain the predicted outcomes of the treatment group. As a measure of the performance of the model, we compare the latter to the actual from the experimental data observed outcomes of the *treatment group*.

Formally, we compute the simulated treatment effect for some outcome $Y_j$ as the difference between *simulated* control group and *simulated* treatment group:

$$\bar{\theta}^{sim} = Y^{sim}_{\mathbf{P},T_P>0}(\mathbf{\Gamma}) - Y^{sim}_{\mathbf{P},T_P=0}(\mathbf{\Gamma}) \tag{40}$$

We then compare $\theta^{sim}$ to the experimental benchmark $\bar{\theta}^{exp}$, an estimate of which is obtained from the OLS regression

$$Y_{j,i} = \alpha_0 + \widehat{\theta^{exp}} \times D_i + \beta \mathbf{X}_i + u_i \tag{41}$$

where $D_i$ is a dummy that takes the value one if some program-eligible household $i$ resides in a treatment village, and zero if in a control village. $\mathbf{X}_i$ is a vector of controls.

## 4.2 Cautionary note

Differences in levels between simulated and actual experimental data are very likely to be due to the simplified nature of our model which may not capture the entire set of mechanisms underlying household behavior. Additionally, however, there a couple of other factors one has to take into consideration. Comparing simulated treatment and actual treatment effect as a source of model validation relies on the assumption that $\widehat{\theta}^{exp} = \theta^{exp}$, i.e that the experimental benchmark is correctly identified. In the case of the *Progresa* experiment, there are a couple of sources of bias which pose a threat to identification (in the following, we'll just mention the most important)

*(i.) Randomization bias*

Random treatment assignment shall ensure that the treatment group is similar both in terms of observable and unobservable characteristics to the control group. As documented in Behrman and Todd (1999), due to village level rather than individual randomization, household characteristics in treatment vs. control group are not entirely balanced in the *Progresa* experimental data. In the OLS regression (41) we are controlling for some of these unbalanced variables. The presence of such pre-program differences between treatment and control group, however, suggests that there may be other unobserved variables (that consequently cannot be control for) which may confound the identification of $\theta^{exp}$. We do not expect that the lingering differences are large enough to bias the sign, but it may well affect the level of $\widehat{\theta}^{exp}$.

*(ii.) Stable Unit Treatment Value Assumption*

Another serious concern for the identification of $\theta^{exp}$ is that control villages are 'contaminated' by treatment villages (violation the Stable Unit Treatment Value Assumption (SUTVA)). If households in control villages are indirectly affected by the program, then $\widehat{\theta}^{exp}$ is either upward or downward biased, depending on the sign of the externality on households in control villages. Externalities exhibited by a cash transfer program across villages have not received much attention yet in the literature. Very recent evidence by Bobba and Gignoux (2011), however, suggest that these externalities do exist. Again, we do not expect that such externalities are large enough to bias the sign of the estimate, but it may well affect the level of $\widehat{\theta}^{exp}$.

*(iii.) Measurement Error*

The experimental data is probably measured with some non-zero degree of error. Sources of measurement error include under/over reporting (e.g. individuals have an incentive to underreport wealth related variables such as labor supply or consumption in order to seem 'poor' and hence eligible for Progresa), recall bias (respondents don't remember exactly how much they consumed), enumerator bias (respondents answer are affected by the presence of a stranger) etc. Since the model does not explicitly account for measurement error, any difference in *levels* of variables and treatment effects between simulated and experimental treatment group may be in part due to the measurement error in the data. Rather than comparing the *levels* of variables and treatment effects of simulated vs. actual treatment group as a source of model validation, it seems more appropriate to just focus on the *sign* of simulated vs. actual treatment effect. The latter is more robust to measurement error.

The conclusion of this subsection is that, due to the presence of sources of bias which pose a threat to the identification of the experimental treatment effect, comparing the *levels* of simulated vs. actual treatment group as a source of model validation may not be appropriate. It seems therefore more adequate to focus on the *sign* of simulated vs. actual treatment effect, which is much more more robust to these sources of bias.

## 4.3 Results (Out-of-Sample) Validation

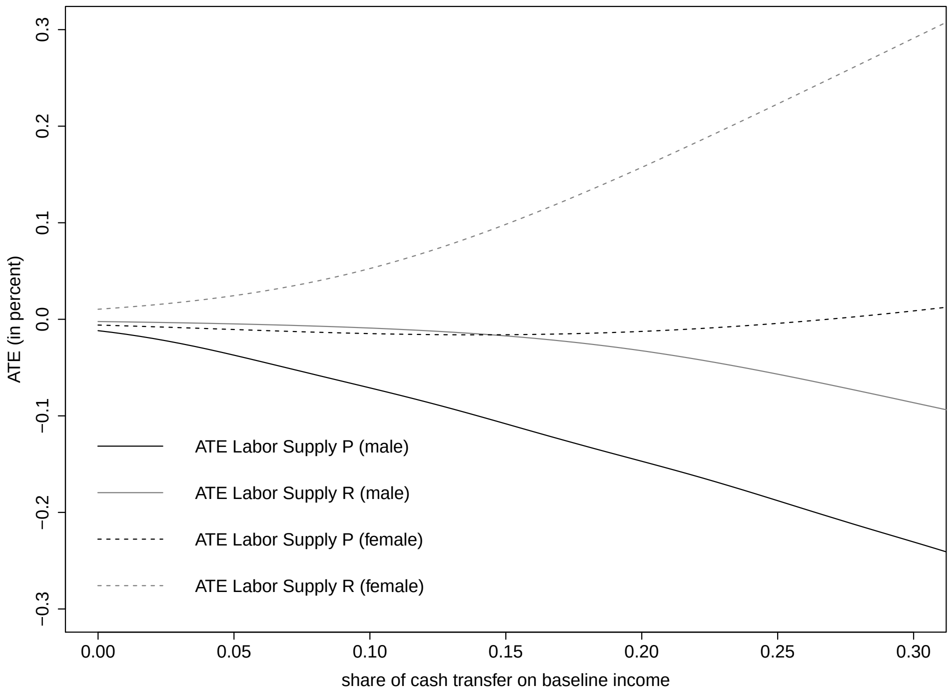
Table 3 compares simulated to experimental treatment group. The first row in each panel shows again the simulated level of the $\mathbf{P}$'s annual labor supply under a zero cash transfer, vis-a-vis average labor supply of eligible households in the control group, which we've seen and discussed already above in the 'within-sample fit' section.

Now, the second row in each panel contrasts the level of labor supply of the simulated treatment group to the experimental benchmark. The third row then compares the simulated treatment effect, $\theta^{sim}$ (left column), to the experimental treatment effect, $\widehat{\theta}^{exp}$ (right column). The left column in the fourth row expresses the simulated treatment effect in relative terms: $[Y^{sim}_{\mathbf{P},T_P>0}(\mathbf{\Gamma}) - Y^{sim}_{\mathbf{P},T_P=0}(\mathbf{\Gamma})]/Y^{sim}_{\mathbf{P},T_P=0}(\mathbf{\Gamma})$. The experimental equivalent (fourth row right column) is obtained by replacing the level of the dependent variable in OLS regression (41) by its natural logarithm.

The model predicts a *decrease* in male labor supply from 228.0 to 191.5 days per year, i.e. an annual decrease of 36.5 days (-16 percent). In the model this is because the cash transfer constitutes a positive income effect. The latter leads to an increased demand for leisure and, consequently, a decrease in labor supply. This compares to an actual from the experimental data observed treatment effect of -10.58 days (-15.9 percent). Thus, the model correctly predicts the direction and relative magnitude of the effect.

For females the model predicts an *increase* in labor supply from 17.3 to 19.1 days per year, i.e. an annual increase of 1.71 days (+9.8 percent). Why is it that female labor supply increases while male labor supply decreases? In our model, this is because the cash transfer generates a positive income effect which, ceteris paribus, increases demand for leisure (i.e. decreases labor supply). Contrary to the male case, however, there is a substitution effect in the female case: the cash transfer, via the household internal labor market equilibrium, increases the female wage which, ceteris paribus, increases female labor supply. Since the male wage is assumed to be exogenous, the substitution effect for the male is zero. In our model, the income effect for females is smaller than the substitution effect and, consequently, female labor supply increases. The simulated treatment effect compares to an actual from the experimental data observed treatment effect of 15.1 percent. Thus, the model correctly predicts the direction of the effect, but somewhat underestimates both the absolute and relative magnitude of the experimental treatment effect.

Figure 1: role of cash transfer amount




# 5 The Role of the Cash Transfer Amount

In section 4 we have used the actual Progresa transfer amount (which is roughly 20 percent of an eligible household's baseline income) in order to validate our simple model. Using this particular cash transfer amount, the model predicts a *decrease* in male labor supply from 228.0 to 191.5 days per year, i.e. an annual decrease of 36.5 days (-16 percent). In the model this is because the cash transfer induced positive income effect leads an increased demand for leisure and, consequently, a decrease in labor supply.

An exogenous male wage impedes the presence of any substitution effect. It is, consequently, only the income effect that affects male labor supply. It is thus straight forward to conclude that an increase (decrease) in the cash transfer amount will further decrease (increase) male labor supply.

Not as straight forward is to see the the sign of the *second order derivative* of the treatment effect. The latter tells us whether the marginal treatment effect is decreasing, increasing, or constant in $T_P$. Figure 1 shows the from the model predicted relationship between male labor supply and cash transfer amount. The figure reveals that the marginal treatment effect is increasing. At a first glance this result may seem counterintuitive. Because one would expect a concave relationship due to the decreasing marginal utility of consumption of leisure. The reason for this at a first glance puzzling result will become clear when we look at the second order derivative of the *female* labor supply treatment effect.

In section 4 we saw that, applying the Progresa cash transfer amount, the model predicts an increase in female labor supply from 17.3 to 19.1 days per year. In the model this is because the positive income effect generated by the transfer is smaller than the substitution effect generated by an increase in the female shadow wage. Consequently, female labor supply increases.
The important question that arises is if the substitution effect is always greater than the income effect along the entire interval of possible cash transfer amounts? Figure 1 shows that the answer to this question is no. For small cash transfer amounts, the substitution effect is *smaller* than the income effect. There exists some cash transfer amount $T^*$ for which the substitution effect equals the income effect. This leads to three possible scenarios. First, if $T_P = T^*$, income and substitution effect offset each other and, consequently, the female labor supply treatment effect is zero. Second, if $T_P < T^*$, then the income effect is greater than the substitution effect and female labor supply, consequently, decreases. Lastly, if $T_P > T^*$, then the income effect is smaller than the substitution effect and the female labor supply treatment effect becomes positive:

$$\frac{\partial L_{P,F}}{T_P} \begin{cases} < 0 \text{ if } T_P < T^* \\ = 0 \text{ if } T_P = T^* \\ > 0 \text{ if } T_P > T^* \end{cases}$$

Since the village's female labor endowment is assumed to be exogenous (i.e. no immigration/emigration), the female wage increases exponentially in $T_P$. This explains why the second order derivative of the female labor supply treatment effect is positive, i.e. the marginal treatment effect is increasing. And the latter, in turn, explains the *prima facie* puzzling positive second order derivative of the male labor supply treatment effect. The higher the cash transfer the more proportionally female labor supply increases, hence the more 'income' she adds to the household and, consequently, the proportionally higher the income effect for the male.

# 6 Conclusion

In the past two decades, redistributive transfer programs have been proliferating in developing countries. Opponents of such such transfers frequently argue that such transfers would discourage work incentives of recipients. The few existing (and exclusively empirical) studies on the subject are far from conclusive: some do find a negative, others a positive, and again others no effect at all on labor supply. The heterogeneity of existing empirical findings calls for a theoretical framework that allows to draw more general conclusions on when (i.e. in which setting) and why (i.e. through which mechanisms) cash transfers affect labor market outcomes.

In this paper we use data from an RCT to estimate and validate a two-household-two-commodity model. Comparative statics show how not only the magnitude but even the direction of the labor supply effect depends on parameters that describe the program and the environment in which it is implemented. Opposite to the common intuition, we find that large cash transfers *can* have a stimulating effect on labor supply, while lower cash transfer provide disincentives.

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