The impact of *Oportunidades* on human capital and income distribution: a top-down/bottom-up approach

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Abstract

This paper analyses the effects of *Oportunidades* conditional cash transfer program on human capital and labour markets, accounting for its partial and general equilibrium effects. Linking a microeconometric and a general equilibrium model in a bidirectional way, the paper explicitly takes spill-over effects of the program into account. Preliminary results suggest that partial equilibrium analysis alone may underestimate the program effects. Extending the coverage of the program leads to a significant increase in school attendance, which reduces labor supply and so increases equilibrium wages of the children who remain at work. This indirectly alters the income distribution.

1. Introduction

The Oportunidades conditional cash transfer program is one of the major social programs of the Mexican government. Around 14 billion of Mexican pesos (Finance 2011), or 1.1 billion dollar per year[1] are spent on Oportunidades, reaching 5.8 million households (SEDESOL 2012). The program provides a substantial income source to the urban and rural poor.

Oportunidades, successor of PROGRESA ("Programa de Educacion, Salud y Alimentacion"), has attracted national and international attention (World Bank 2006). The program aims at developing the human capital of poor households (Skoufias 2005). It provides cash transfers to poor households under the condition that they behave consistently with the accumulation of human capital. The program has three components: education, nutrition and health. The largest transfer of the program is on education (Azevedo and Robles 2010).

The program has been extensively evaluated (Levy (2006), Behrman, Sengupta et al.(2005), Schultz (2004) and Parker (2005)). Overall, these studies find the program to enhance welfare in several dimensions. Attanazio and Angelucci (2009) and Hoddinot (Hoddinot, Skoufias et al. 2003) focus on the effect on consumption and nutrition; Azevedo and Robles (2010) on school attendance and contemporaneous income, and Gertler (2004) on health.

[1] At 12.8 Mexican pesos per dollar of average exchange rate of Mexico for 2011 (www.exchangerate.com).

This paper focuses on the distributional consequences of Oportunidades, given that its beneficiary scale is likely to be significant from a macroeconomic point of view in terms. In particular, we analyze the impact of the educational component of the Oportunidades program on poverty and income distribution, accounting for its spill-over effects, and considering changes in the program design. This is the first attempt to link the Bourguignon, Ferreira and Leite (2002) behavioural microsimulation model to a to a macroeconomic CGE model that accounts for the general equilibrium effects of the program.

The rest of this paper is organized as follows. Section 2 provides a review of relevant micro-macro modeling approaches. Section 3 develops a framework for a macro-micro model that explicitly captures conditional cash transfers and allows the macro and micro components of the model to communicate iteratively in bi-directional way until converging to a joint equilibrium. The section first presents the microsimulation model and then the macroeconomic model. For each of the models, we present the model specification, the data and the parameter estimation. Section 4 applies the combined macro-micro model to the Mexican Oportunidades conditional cash transfer program and simulates the absence and an extension of the coverage of the program. Section 5 concludes.

Withdrawing the transfer does not alter the labor supply decisions of children that are already in school, but worsens income distribution. Extending the coverage of the program leads to a significant increase in school attendance, which reduces labor supply and so increases equilibrium wages of the children who remain at work. This indirectly alters the income distribution.

2. The interaction between micro and macro models

Evolution of microsimulation models

The seed of microsimulation as an instrument for economic analysis was planted by Orcutt (1957), and since the early 1980s the use of microsimulation models (MS) has been encouraged by the rise of large and detailed datasets on individual agents and the continuing increases in, and falling costs of, computing power (Bourguignon and Spadaro 2006, p.78). Early microsimulation studies were mainly focused on wage distributions (Diaz Bonilla 2005, p. 88). Almeida dos Reis and Paes de Barros (1991) consider the effect of education on wage distribution in Brazil; Juhn et al. (1993) looked at wage differentials in the US from 1963 to 1989 and Blau and Khan (1996) explain the excess of US wage differentials compared to other OECD countries during the 1980s. The second phase of microsimulations focuses on extending its application beyond wage distributions the analysis, for instance, of taxes on income distribution at the household level (Bourguignon and Ferreira (2003)). In the present phase, household data is being combined with data at a higher level (sector, market, or economy-wide) allowing, among others, to simulate the effects of economy-wide policies and shocks on a sample of economic agents including individuals, households, and firms. This allows to evaluate the full distributional impact of these events.

As illustrated in (Miller and Page 2007)

Figure 1, macro and microsimulation models can be linked in different ways. The link can be made by explicitly including selected micro behavior (typically labor supply or consumption demand) into a macro model, so that a single model reflects relevant micro and macro behavior in the economy under analysis (Cogneau and Robilliard (2006), Cockburn (2006), and Cockburn et al (2010)). Cockburn et al (2010), for example, replace the information on incomes and expenditures of the representative household groups in the CGE model by those observed in a household survey, seeking to conduct an explicit analysis of the poverty impact of macro-economic shocks on each sampled household using a single integrated model.

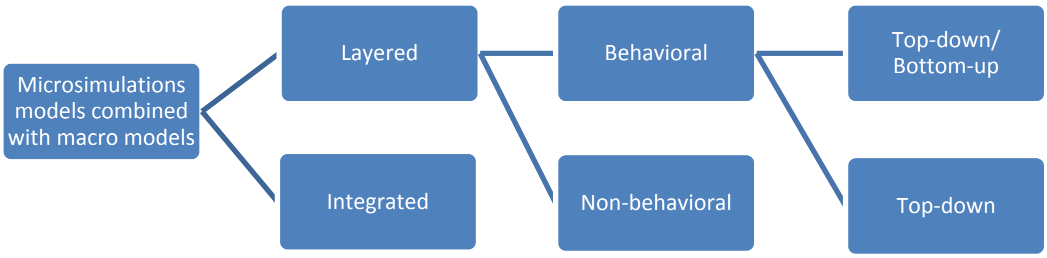


Figure 1 Types of microsimulation models combined with macro models

Alternatively, the macro and the micro model can be "layering", in the sense that the two models are kept as different entities and some degree of communication between them is allowed, i.e. simulated percentage changes in factor wages may be endogenous in the macro model and communicated to the micro model, where wages are exogenous. In this layered approach, the microsimulation model can be behavioural, which reflects individuals' behaviour.

Non-behavioural models have been applied in a set of different ways. Boccanfuso, Decaluwe et al. (2008) assume given probability distribution functions for the household incomes within a representative household group, and transmit the change in the mean income of the representative household group to the mentioned distribution; Vos and Sanchez (2010) adapt the method used by dos Reis and de Barros (1991) to allow individuals to change their labour market status as in the behavioural approach by selecting individuals to change labor status at random without explaining their behaviour; Herault (2010) proceeds by altering the population weights in the household survey in order to reproduce changes in employment estimated by the CGE model.

In the layered behavioral approach, a functional form is specified for selected behavior under analysis (i.e. labor supply), and its parameters are econometrically estimated. The behavioral approach has been applied in a "top-down" and "top-down/bottom-up" fashion. In the top-down fashion, the macro model informs the microsimulation model, but there is no feedback from the micro model to the macro model. Applications of this approach include Bourguignon, Robilliard et al (2004), Bourguignon, Ferreira et al (2002), and Debowicz (2010). In the "top-down/bottom-up" approach, initiated by Savard (2003), the communication is bilateral and iterative i.e. from the micro to the macro model and from the macro model to the micro model. The basic idea of the top-down/bottom up approach is to use the household microsimulation model to capture the behavioural responses of households and the CGE model to generate a price vector, including wages, that is communicated to the microsimulation model. In this case, the micro-household responses are aggregated and fed back into the CGE model, which is run again and communicates in an iterative way with the microsimulation model intending to converge to a joint solution (Savard (2003) and Cury, Pedrozo et al. (2010)).

The Domain of applicability of the macro-micro approaches

The extent of integration between the macro and micro models is among the most important modeling choices that a macro-micro modeler has to make (Bourguignon, Bussolo et al. 2010). While the integrated approach is theoretically more transparent (Davies 2009), it is still far from Orcutt's vision of a micro-based general equilibrium model where "the key role (is) played by actual decision-making units of the real world such as the individual, the household, and the firm" (Orcutt 1957, p.117). While the implementation of Orcutt's vision is an area under intense exploration in the framework of agent-based models (ABM)[2], the integrated approach raises the difficult question of how to deal with micro data that does not add up to macro data aggregates[3]. Also, the approach has been argued to be "deficient with regards to the microeconomic specification and behavioural responses of individual agents" (Colombo 2010, p.89). Integrated models tend to have a relatively aggregated labor market, probably reflecting that the production functions typically used in CGE models (Cobb-Douglas and CES) would generate unrealistic results if they were informed by individual-specific labor use. Explicitly including individual-level labor use in the production functions would not only give an

[2] Agent Based Models (also named agent-based object modeling) "proceed by abstracting the behavior of the individual agents in the system into simplified agents(...). Next, collections of these agent-based objects will be "solved" by allowing the objects to interact directly with one another using computation." (Miller and Page, 2007, p.66).

[3] In the case of Mexico, for example, we find that macro consumption was more than 5 times above the sample-weighted sum of micro-level consumption.

unrealistic impression of divisibility of individuals' labor use but, more importantly, would generate zero or indefinite production whenever a single individual is not at work[4].

While agent-based models evolve, the layered approach presents an interesting and promising alternative, advantageous when the concern is short-term distributional impacts in settings where realism is placed at a premium against theoretical niceties (Davies 2009, p.56). The layered approach allows to by-pass the problem of identifying the heterogeneity of factor endowments and preferences at the level of single households or individuals (Bourguignon, Robilliard et al. 2004, p.3) needed to inform an integrated model. In the layered approach, while non-behavioral microsimulations are less data and time demanding, only behavioral microsimulations are able to take full account of the heterogeneity of the economic agents as observed in micro-datasets to identify with precision who are likely to be winners and losers following a reform or shock. Non-behavioral models ignore the link between individual attributes and their outcomes (Vos and Sanchez 2010). Behavioral microsimulations fully take the heterogeneity of the economic agents observed in micro-datasets into account and so have a comparative advantage in terms of policy implications (Bourguignon, Bussolo et al. 2010, p.4),. Modelling the communication between the different spheres of the economy in an iterative bi-directional way(top-down/bottom-up approach), allows exploring the full effects of programs that, given their national scale, are expected to provoke interesting macro level effects with meaningful interactions with the direct micro-level effects of the programs that will jointly affect income distribution and poverty.

[4] A null quantity of an input is out of the domain of a CES production function and generates an unrealistic result (zero output) in a Cobb-Douglas production function, irrespective of how large other inputs are.

3. Model

This paper contributes to the to linking macroeconomic CGE models to microsimulations in the context of a conditional cash transfers program. To our knowledge, this is the first attempt to link an econometric-based microsimulation model (MS) that explicitly accounts for the conditionality status of conditional cash transfers to a macroeconomic model. The combined model allows identifying the direct and indirect effects of the conditional transfers.

It has been argued thatmacro-micro approach is called in the case of national-scale conditional cash transfers in support of the poor, where "the policy is targeted to a certain economic sector or group of individuals, but where the indirect general equilibrium effects are too significant to be dismissed" (Bourguignon, Bussolo et al. 2010, p.1).

Our model combines a microsimulation model with a macro CGE model in the tradition of the top-down/bottom-up nexus developed by Savard (2003). The microsimulation model follows closely Bourguignon, Ferreira and Leite (2002). The macro model is based on the IFPRI Standard CGE model, a model that captures relevant characteristics of developing economies, including small country assumption (exogenous world prices) and presence of market segmentation, and tracks the general equilibrium effects of macro events among the economy. The model has been widely applied to Latin America, Africa and Asia.

While Cury, Pedrozo et al. (2010) is also a top-down/bottom up macro-micro model with behavior that was applied to (Bolsa Familia) cash transfers in Brazil, it does not capture the conditionality of the transfers regarding children's school attendance. Since the conditionality is an essential characteristic of conditional cash transfer programs the microsimulation model used in this paper captures the effect of conditionality on time allocation of children that potentially receive the transfer..

By linking these two models in bi-directional way, we fully take into account the effects of the conditional transfers on children's time allocation behavior, the subsequent effects on the macro sphere, and the iteration with the feedback from the macro sphere to the households' behavior and incomes. Specifically, we link the CGE and the microsimulation model (MS) iteratively in the following way, as illustrated in Figure 2:

1. Changes in the design of the Oportunidades transfers are informed both to the macroeconomic CGE and the microsimulation model; the former at the representative household level, the latter at the sampled household level.
2. The MS model generates child-wise time allocation between school and work, and communicates it in aggregated way – as a percentage change in the supply of child-work - to the CGE, where child-work is exogenous.
3. The CGE model generates a new general-equilibrium solution, and transmits percentage changes in the average wage of the children (w_{CHILD}) and in other households' income Y_{-i}, to MS model, which are as such exogenous in the MS model.
4. Steps 2 and 3 are repeated iteratively in a loop until the two models converge to a joint solution.

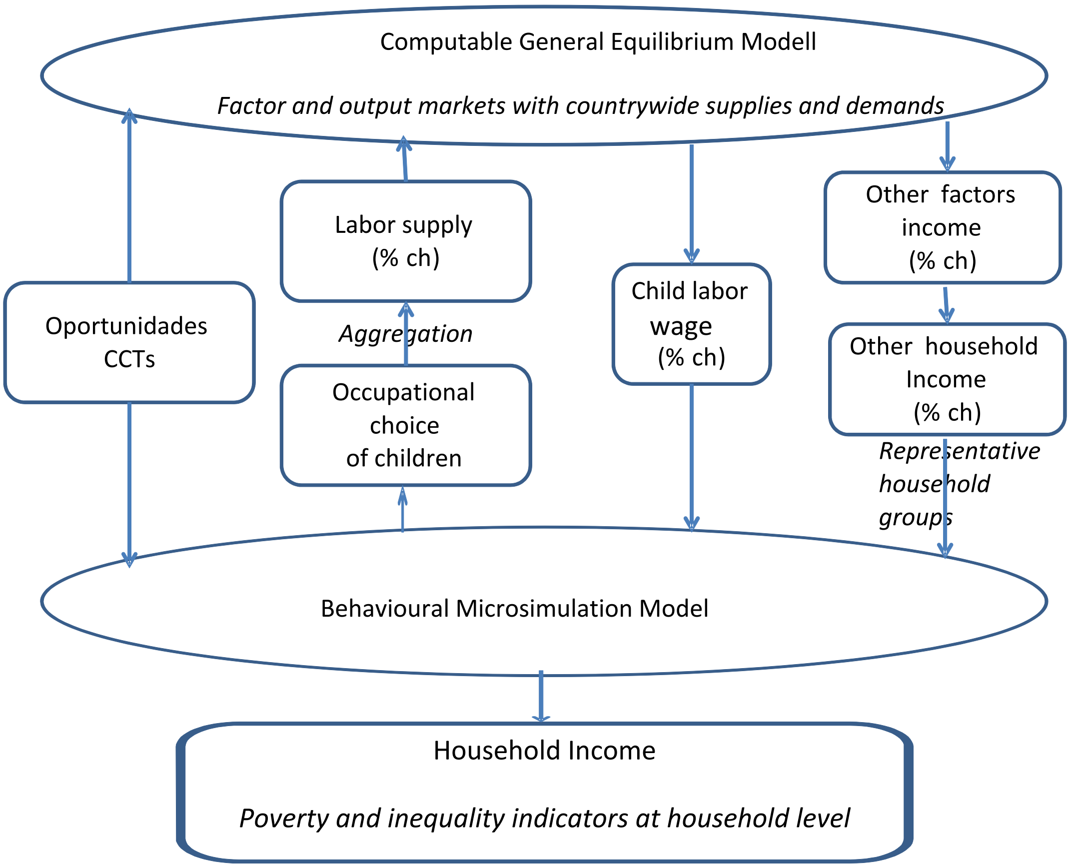


Figure 2 Modeling Oportunidades Conditional Cash Transfers: our macro-micro approach

Regarding the transmission channels in our model, if the Mexican government decided, for example, to extend the coverage of the Oportunidades program ($\sum_h TR_{h,G}$), we would expect to see the following effects, with magnitudes to be informed by results of model simulations:

1. *Direct income effect*: as the transfer increases households' incomes Y_h.
2. *Labor supply effect*: as new recipients get additional incentives to attend school, we expect to see a fall in the child labor supply with effect on households incomes Y_h.
3. *Wage effect*: as child labor supply falls, we expect to see excess demand for child work and, through the equilibrium of the child labor market $\sum_i V_{if} = \overline{VS_f}$, an increase in the average general-equilibrium real wage that the children who remain at work are able to get, affecting household incomes Y_h.
4. *Other effects of smaller magnitude. Among them:*
    a. *Production effect*: as child labor falls, we expect to find a fall in the contemporaneous value added that the economy is able to generate ($X_i = \Lambda_i \left(\sum_f \alpha_{if} \cdot V_{if}^{-\rho_i}\right)^{-1/\rho_i}$) and, in turn, in the national income that the economy is able to generate, with effect on household incomes Y_h.
    b. *Public deficit effect:* the extension of the program will increase government expenditure and tend to increase the public deficit ($GB = GR - \sum_i (P_i \cdot \bar{G}_i) + \sum_n tr_{nG}$), reducing in turn the available savings present in the economy for investment purposes.

We proceed now to describe in detail the micro and macro model that we use and their calibration.

Microsimulation model

We adapt the methodology of Bourguignon, Ferreira and Leite's (2002) to the case of Oportunidades. In this model, each child i can choose among the following occupational alternatives (j): not to attend school (alternative 0), which means they either help at home and/work in the labor market; to work and go to school (alternative 1) or to go to school and maybe also help out at home (alternative 2).

Child $\boldsymbol{i}$ will take occupational choice $\boldsymbol{k}$ if and only if the net utility of alternative k exceeds those of other alternatives $\boldsymbol{j}$, where $\boldsymbol{j \neq k}$:

$$\boldsymbol{S_i = k\ \ iff\ \ U_i(k) = S_k(A_i, X_i, H_i; Y_{-i} + y_{ik}) + v_{ik} > U_i(j) = S_j\left(A_i, X_i, H_i; Y_{-i} + y_{ij}\right) + v_{ij}}$$

$$\boldsymbol{for\ j \neq k.} \qquad 1$$

The net utility of an alternative is determined by a deterministic and a random component (Amemiya and Shimono 1989). The deterministic component depends on the age of the child A_i, other child-specific characteristics X_i, characteristics specific to the household to which the child belongs H_i, the child's contribution to household income – which depends on the child's occupational choice - y_{ik} and other household income Y_{-i}. The non-deterministic component reflects unobservable characteristics that affect who changes labour status when a change takes place. It is randomly assigned consistently with the observed outcome of the individual, as further explained below.

Linearizing Equation 1, and collecting all non-income explanatory variables of the deterministic component of net utility into a single vector, Z_i, we can write the latent net utility function of choice j as:

$$\boldsymbol{U_i(j) = S_j\left(A_i, X_i, H_i; Y_{-i} + y_{ij}\right) + v_{ij} = Z_i\gamma_j + (Y_{-i} + y_{ij})\ \alpha_j + v_{ij}.} \qquad 2$$

The child's occupational-choice-specific contribution to overall household income, $\mathbf{y_{ik}}$, is a function of its market wage, $\mathbf{w_i}$. For children in alternative 0 who work in the market and help at home - for example, by spending time on helping in the preparation of goods to be sold in a family business or in domestic tasks that may release time other household members can spend on income-generating activities - $\mathbf{w_i}$ would underestimate the children's contribution to overall household income. A way to account for the child's domestic contribution to overall household income is to multiply the market income by a constant, $\mathbf{K}$

$$y_{i0} = Kw_i$$

If K>1, the child's contribution to overall household income exceeds its market income. If K=1, the child's contribution to overall household income is equal to the market wage, i.e. the child does not contribute to domestic activities.

For a child working and going to school, his remuneration in the labor market is very likely to be below the one it would get if he had chosen alternative 0, because it spends less time working in the market. To recover this reduction in market earnings, assume the child's reduced wage can be modeled as a log-linear function of child-specific characteristics, X_i, as follows

$$\boldsymbol{\ln w_i = X_i\,\delta + m\,Ind\left(S_j = 1\right) + u_i,} \qquad 3$$

where $\mathbf{Ind\left(S_j = 1\right)}$ is an indicator function that only takes the value one if the child chooses to work and go to school (alternative 1), the coefficient $\mathbf{m}$ captures the effect of choosing alternative 1 as opposed to alternative 0 on the log of market income of the child and $\mathbf{M} = \mathbf{e}^{\mathbf{m}}$ captures the fraction of the market income that the child gets after the mentioned reduction. As a consequence, the income contribution of choosing alternative 1 can be defined as:

$$\mathbf{y_{i1}} = \mathbf{My_{i0}} = \mathbf{MKw_i}.$$

A child who only goes to school is likely to contribute only a fraction, D, of the income she could earn in the market, as she can only help at home when not attending school, and attending school does not yield any immediate economic returns to the household (our model does not capture that parent may attain utility from sending their children to school[5]).

$$\boldsymbol{y_{i2}} = \boldsymbol{Dy_{i0}} = \boldsymbol{DKw_i}.$$

We use 3 to impute wages, i.e. compute potential wages, for children who do not have a wage. u_i is randomly drawn from the distribution generated by the residuals of the OLS estimation.

Re-writing 2 in terms of w_i,

$$U_i(j) = Z_i\gamma_j + Y_{-i}\alpha_j + w_i\beta_j + v_{ij} \text{ where } \beta_0 = \alpha_0 K, \quad \beta_1 = \alpha_1 MK, \quad \beta_2 = \alpha_2 DK. \qquad 4$$

This solves the problem of dealing with alternative-specific income contributions of the child and hence allows for MNL estimation. Most available data sets do not allow to accurately measure y_{i0}, which limits identification of K. Assuming K=1, Equation 4 can be simplified as:

$$U_i(j) = Z_i\gamma_j + Y_{-i}\alpha_j + w_i\beta_j + v_{ij} \text{ with } \beta_0 = \alpha_0, \quad \beta_1 = \alpha_1 M, \quad \beta_2 = \alpha_2 D.$$

Conditional cash transfer CCT_{ij} raises total household income of school attendants. If the children not attending school receive no transfer, and those attending school are all allowed to receive the same transfer amount (T), $CCT_{i0} = 0$ and $CCT_{i1} = CCT_{i2}$ = T. We can re-write 5 as:

$$\boldsymbol{U_i(j) = Z_i\gamma_j + \left(Y_{-i} + CCT_{ij}\right)\alpha_j + w_i\beta_j + v_{ij} \;\; with\; CCT_{i0} = 0 \; and \; CCT_{i1} = CCT_{i2} = T} \qquad 5$$

If we could obtain estimates for α_j , β_j, v_{ij} and γ_j, Equation 5 provides sufficient information for simulating child labor supply in response to changes in the transfer.

To model the probability of the occupational choice j for each child i, a multinomial logit model (MNL) can be used. However, CCT_{ij}varies across j (i.e. $CCT_{i1} \neq CCT_{i0}$). A multinomial logit model allows to identify $(\gamma_j - \gamma_0), (\alpha_j - \alpha_0), (\beta_j - \beta_0)$ for non-alternative specific covariates, but, given that the transfer is alternative-specific, it is necessary to first estimate the parameters of a MNL model that does not include the transfer payment for recovering all three parameters $\alpha_0, \alpha_{1,} \alpha_2$ to be able to simulate the occupational choice of child i in a second step[6]. An alternative model would not allow to identify α_j.

The probability of choosing alternative k can be summarized in a MNL framework as:

$$\boldsymbol{P_{ik} = \frac{Exp[Z_i\gamma_k + Y_{-i}\alpha_k + w_i\beta_k]}{\sum_j Exp[Z_i\gamma_j + Y_{-i}\alpha_j + w_i\beta_j]}} \qquad 6$$

[5] REFERENCE TO STUDY THAT DOES EXPLICITLY CAPTURE UTILITY OF SENDING CHILDREN TO SCHOOL?

[6] A similar problem applies to the income contribution of the child, which also varies by occupational alternative, but has been re-formulated in terms of potential wages that do not vary by alternative, which solves the problem.

With j=0 as reference:

$$\boldsymbol{P_{ij}} = \frac{\boldsymbol{Exp[Z_i(\gamma_j-\gamma_0)+Y_{-i}(\alpha_j-\alpha_0)+w_i(\beta_j-\beta_0)]}}{\boldsymbol{1+\sum_{j=1}^{2} Exp[Z_i(\gamma_{j'}-\gamma_0)+Y_{-i}(\alpha_{j'}-\alpha_0)+w_i(\beta_{j'}-\beta_0)]}} \text{ for j=1,2}$$

and $\boldsymbol{P_{i0} = 1 - P_{i1} - P_{i2}}$ 7

To recover $\alpha_0, \alpha_1, \alpha_2$, coefficients of the multinomial logit model can be written as: $b_1 = \beta_1 - \beta_0$, $b_2 = \beta_2 - \beta_0$ and $a_1 = \alpha_1 - \alpha_0$ $a_2 = \alpha_2 - \alpha_0$, where a_1, a_2 are the coefficients on income and b_1, $b_2$on wages in alternative one and two, respectively. Substituting $\beta_0 = \alpha_0$, $\beta_1 = \alpha_1 M$, $\beta_2 = \alpha_2 D$ from above:

$$b_1 = \alpha_1 M - \alpha_0$$

$$b_2 = \alpha_2 D - \alpha_0.$$

This allows solving for the parameters of interest:

$$\alpha_1 = (a_1 - b_1)/\,(1 - M)$$

$$\alpha_2 = \alpha_1 + a_2 - a_1,$$

$$\alpha_0 = \alpha_2 - a_2,$$

$$D = (b_2 + \alpha_0)/\,\alpha_2.$$

The residuals v_{ij} cannot be observed, but $v_{ij} - v_{i0}$ can be drawn so to be consistent with the child's occupational j=1,2, assuming for convenience U(0)=0.

Having recovered α_j , β_j, v_{ij} and γ_j, and using Equation5, the microsimulation model can be written as:

$\Delta U_{1i} = b_1 \Delta w_i + \alpha_1 \Delta CCT_i + (\alpha_1 - \alpha_0)\, \Delta UCT_i + (\alpha_1 - \alpha_0)\, \Delta Y_{-i}$, where $\Delta U_{1i} = U_{1i}^s - U_{1i}^b$. U_{1i}^s is the simulated utility level of child i choosing category 1, and U_{1i}^b the base utility level of child i choosing category 1 i.e. without making any changes to the program. ΔUCT_i is any unconditional transfer the child or other household members receive.

$\Delta U_{2i} = b_2 \Delta w_i + \alpha_2 \Delta CCT_i + (\alpha_2 - \alpha_0)\, \Delta UCT_i + (\alpha_2 - \alpha_0)\, \Delta Y_{-i}$, where $\Delta U_{2i} = U_{2i}^s - U_{2i}^b$, with U_{2i}^s being the simulated utility level of child i choosing category 2, and U_{2i}^b the base utility level of kid i choosing category 2.

Data and parameter estimation

The data we use to microsimulate labor supply responses due to changes in the Oportunidades design come from the Mexican Encuesta Nacional de Ingresos y Gastos de los Hogares 2008, ENIGH 2008, provided by the Instituto Nacional de Estadística y Geografia. ENIGH 2008 is a national representative household survey that comprises information on labour and other factor earnings, transfers and consumption and allows identifying households that participate in Oportunidades. The survey asks household members about their non-labor income sources including Oportunidades transfers and it comprises information on whether the child receives a scholarship of the program. This allows us to construct a measure of the scholarship component of the program using the program rules described in **Error! Reference source not found.**.

Table 1 Monthly Scholarship, July to December 2008

Primary education	Boys & Girls	
Third grade	$130.00	
Fourth grade	$155.00	
Fifth grade	$195.00	
Sixth grade	$265.00	
Secondary education	**Boys**	**Girls**
First grade	$385.00	$405.00
Second grade	$405.00	$450.00
Third grade	$430.00	$495.00
Upper secondary/ High school	**Men**	**Women**
First grade	$645.00	$740.00
Second grade	$695.00	$790.00
Third grade	$735.00	$840.00

Source: http://www.normateca.gob.mx/Archivos/46_D_1786_.pdf

Our analysis concentrates on children aged 6 to 17, but we also restrict the sample and repeat the analysis for children aged 12 to 17. If a child is not assisting school we classify her into occupational alternative zero ("Not studying"). In all that follows, we may also refer to this category as "working". We group children that assist school but also reports a wage into category one ("School and Work") and children that only assist school into category two ("School only"). Table 2 summarizes the sample distribution of children by occupational choice. The table shows that most of the children study only, but the occupational composition varies by age group.

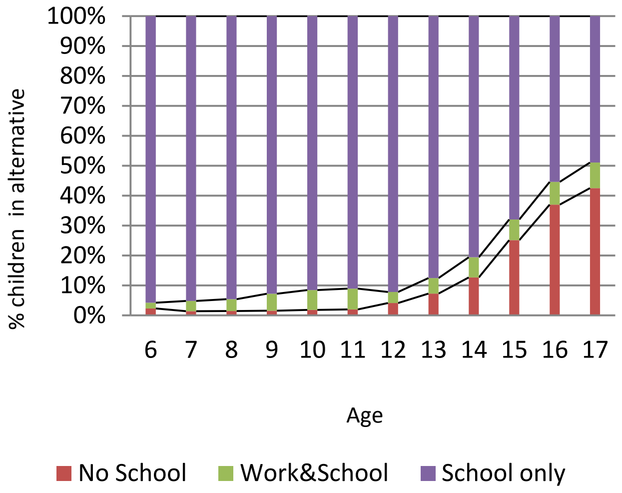
Table 2 Distribution of children by occupational choice

Choice	Frequency	Percent
Not Studying	3,543	11.68
Work and School	1,702	5.61
School only	25,086	82.71
Total	30,331	100

Authors' calculation based on ENIGH 2008

As Figure 3 suggests, around ages 12 to 13, the within age-group choice composition shifts towards increased labour market participation and the percentage of children that do not assist school increases (see Figure 3 and also Azevedo et al. 2010).

Figure 3 Occupational choice by age



Source: Authors' calculations.

For the microsimulation model, we have to estimate potential wages for those who do not report to have a wage. Table 8 summarizes the results of the estimation of the wage equation. Column (1) reports the results for all children and Column (2) for those aged 12 and more. We find that children who go to school and work earn 64% less income than those that only work with same observable characteristics. The results also show that increasing average rural-urban state-level wages by one percent increases children's wages by 0.35 percent, that boys earn more than girls, children in female headed households earn more than those in male headed households, and that living in the Noroeste region increases earning relative to Suroeste. For children age 12 to 17 education has a positive and nonlinear (decreasing) effect on earnings. We impute wages for those not declaring income using the predictions from the wage regressions and its Root Mean Square Error to inform randomly drawn error terms from a normal distribution.

To recover α_j , β_j, υ_{ij} and γ_j, we estimate a MNL. Summary statistic on the covariates by occupational choice can be found in Table 7. Prior to estimation, we convert all income figures into monthly thousands of Mexican pesos. We choose "Not studying" as base category in all that follows. Given that the MNL is estimated to recover the parameters in a first step to microsimulate in a second step, it includes only alternative invariant variables.

The results of the MNL are summarized in Table 9 for all children and in Table 10 for children those aged 12 and more. The signs of the estimates are as expected. Increasing household income increases the likelihood of studying, and studying and working as opposed to working. The table also shows that girls are more likely to study only than boys, average state-level wages reduce the likelihood to study relative to working, living in rural areas increases the likelihood of working instead of attending school; intra-household difficulties, as captured by a divorce of the household head, decreases the probability of studying and increasing potential wages reduces the likelihood of working and going to school or going to school only relative to working[7]. The rank of the child, measured by the descending order of the child in the age distribution across all its siblings, increases the likelihood of studying as opposed to working. This means that, controlling for the number of household members, having older siblings increases the likelihood of attending school.

[7] Note the result of the potential wage of reducing the likelihood of attending school only as opposed to working does not hold when looking at marginal effects. Increasing average potential wages increases the probability of studying. This might be so because more educated children tend to be more productive which might be reflected in their potential earnings (REVERSE CAUSALITY???).

Our parameter estimates of potential wages in alternative one and two are $b_1 = -0.416$ and $b_2 = -0.062$, respectively, and M=0 .5254. Our parameter estimates on Y_{-i} in alternative one and two are $a_1 = 0.019$ and $a_2 = 0.022$. Assuming $K = 1$ and solving for the parameters of interest yields:

$\alpha_1 = (a_1 - b_1)/\,(1 - M) = 0.9158$,

$\alpha_2 = \alpha_1 + a_2 - a_1 = 0.9188$,

$\alpha_0 = \alpha_2 - a_2 = 0.8968$, and

$D = (b_2 + \alpha_0)/\,\alpha_2$ =0.9089.

The residuals v_{ij} cannot be observed, but $v_{ij} - v_{i0}$ can be drawn so as to be consistent with the child's occupational j=1,2 using the MNL model, while assuming, for convenience, U(0)=0.

There are several limitations to this model, as pointed out by Bourguignon, Ferreira and Leite (2002). First, whether the child can be taken as a decision-maker, its parents decide or parents and children decide together about children's occupational choices depends on whether children can be modeled as household production goods, consumption goods or decision makers within the household (REFERENCES). In addition, the model assumes that intra-household labor supply decisions are made independently by each individual within the household and ignores issues of simultaneity of labor supply among siblings. In all the above, we assumed the child is solely reliable for its occupational choices for simplifying illustration. We are aware that in doing so, we ignore existing intra-household decision-making mechanisms. Second, it is very difficult to justify the choice of a two-step estimation approach by estimating first wages which are a function of the child's occupational choice and then letting the potential wages determine the occupational choice.

Computable general equilibrium model

Following general equilibrium theory, representative consumers (i.e., households) and producers in our model are treated as individual economic agents. Households maximize a Stone-Geary Utility function i.e. their consumer behavior is driven by a Linear Expenditure System (LES) taking income and commodity prices as given. Sector-specific producers have a constant elasticity of substitution (CES) value added function with arguments given by child-work, other labor, capital and land, and choose factor inputs to maximize profits assuming wages and prices are given.

Import and export world prices are given (small country assumption). Domestically produced goods, imports and exports are assumed to be imperfect substitutes. Imports are determined to minimize the cost of domestic absorption given import and domestic prices, and exports are determined to maximize producer profits given export and domestic prices. Commodity-specific domestic price changes equilibrate the commodity markets, and factor-specific wage changes equilibrate the factor markets. Households' incomes are the sum of factor and non-factor (Oportunidades and other transfer) income.

Regarding macroeconomic closures, the model has i) saving-driven investment, with exogenous marginal propensities to save for the households; ii) exogenous public expenditures and tax rates and endogenous public savings; iii) exogenous foreign savings and endogenous real exchange rate. The numeraire of the model is given by the consumer price index (CPI). The model is described in detail in Annex V. The (GAMS) code of the model is available from the authors.

The Mexican CGE model includes 14 sector-specific producers, 15 production factors, 16 representative household groups and 10 other accounts (including Oportunidades program), as described in the following figure:

Figure 4 Actors and Accounts in Mexican CGE model

Activity Sectors (14)

Agriculture, Livestock, Forestry, Fishing and Haunting; Mining; Electricity, water and gas provision by tube to final consumer; Construction; Manufacturing; Trade; Transport, mail and stocking; Information in massive media; Financial and insurance services; Professional, scientific and technical services; Education; Health and social assistance; Public services; Other services.

Production Factors (15)

Labor (13): Male skilled informal; Male unskilled informal; Male semi-skilled informal; Male skilled formal; Male unskilled formal; Male semi-skilled formal; Female skilled informal; Female unskilled informal; Female semi-skilled informal; Female skilled formal; Female unskilled formal; Female semi-skilled formal; Child labour

Others (2): Capital, Land.

Representative Household groups (16)

Non-oport non-poor urban male; Non-oport non-poor urban female; Oport non-poor urban male; Oport non-poor urban female; Oport poor urban male; Oport poor urban female; Oport poor rural male; Oport poor rural female; Oport non-poor rural male; Oport non-poor rural female; Non-oport poor urban male; Non-oport poor urban female; Non-oport poor rural male; Non-oport poor rural female; Non-oport non-poor rural male; Non-oport non-poor rural female.

Other Accounts (10)

Government; Income tax; Imports tax; Activity tax; Oportunidades; Rest of transfers from government to households; Change in stock; Saving-Investment; Rest of the World.

The parameters of the model were calibrated in the light of factor use informed by analysis of ENIGH microdata, the SAM specially prepared for the Oportunidades project (see below), and production, trade and consumption elasticities present in previous CGE analysis of Progresa conditional cash transfers done by Lee Harris and Coady at IFPRI (displayed in Annex).

Data for calibrating CGE model

A Social Accounting Matrix (SAM) is built for the year 2008, explicitly capturing Oportunidades transfers. A conceptual macro-SAM, where sectors, factors and household groups are aggregated into single ones, is presented in Figure 5 and in numerical form in Figure 6. In a SAM, a cell represents a payment from the column to the row where the cell is located. In the macro-SAM in Figure 5 and Figure 6, the macro activity - the aggregate of producers - buys intermediate inputs in the commodity market, pays to the aggregate of production factors for their contributions to value added, and pays taxes linked to its production value. The commodity account, in turn, pays to domestic activities for their production, to the rest of the world for Mexican imports, and to the government for the associated import taxes. The aggregate production factor passes most of its income to households and a minor part of it to non-residents, reflecting the remuneration of capital owned by non-residents. The aggregate of households, in turn, pays for final consumption in the commodity market, pays income taxes to the government, and saves the rest in the loanable funds market. The government spends in public consumption, Oportunidades transfers to households, other transfers to households, and payments to non-residents (e.g. interest payments on foreign public debt), saving the residual[8]. The rest of the world pays for Mexican's exports, transfers to domestic households, and contributes with foreign savings to the market of loanable funds. The saving-investment account, representing the market of loanable funds, is financed by savings of domestic households, domestic public sector and non-residents, and pays for fixed investment and changes in stocks (via an account with that name) to the commodity market.

In building the SAM, we started by estimating the Macro-SAM. In doing this, we used the following data:

- Global supply and demand of goods and services informed by Ministry of Finance for 2008
- Public accounts data for closest available year (2007) from INEGI (2011) "El ingreso y gasto publico en Mexico"[9] and implicit price level for 2007 and 2008[10]
- International accounts and average of buying and selling monthly exchange rates provided by Banco de Mexico for 2008.

Specifically, in completing the Macro-SAM we followed the following steps:

1. Inform the aggregate demand components and GDP using global supply and demand data
2. Inform totals for value of tariff revenue, rest of indirect taxes, and direct taxes using 'Indirect taxes net of subsidies 2008' informed by INEGI. Sistema de Cuentas Nacionales de México, and Table 2.1.1 in El Ingreso y Gasto Publico en Mexico, Edicion 2011 ("IGP")
3. Inform public expenditures. The total current public expenditure was informed by same item in IGP, Table 2.2.1.6 of, value for 2008. Expenditure in Oportunidades conditional cash transfers by figure "Programa de Desarrollo Humano Oportunidades" in Table 2.2.5.5 of same source. Balance of Payments 2008, Banco de Mexico informed interest on public external debt, foreign remittances to households and foreign savings[11].
4. Calculate residuals and check that each of the accounts in the Macro-SAM was balanced (income = expenditure)

All the values are reported in current billions of Mexican pesos of 2008. For converting 2007 values into 2008 values, we used series of implicit index price level[12]. For converting values originally in dollars into Mexican pesos, we used the average of buying and selling monthly exchange rates provided by Banco de Mexico for 2008.

[8] Negative in the case of the Mexican government, which has a current budget deficit, i.e. negative public saving.
[9] Available at http://www.inegi.org.mx/prod_serv/contenidos/espanol/biblioteca/Default.asp?accion=1&upc=702825002428
[10] Available at http://dgcnesyp.inegi.org.mx/cgi-win/bdieintsi.exe/CPreIQY.
[11] Calculated as minus the current account of the balance of payments of Mexico.
[12] Available at http://dgcnesyp.inegi.org.mx/cgi-win/bdieintsi.exe/CPreIQY.

Figure 5 Conceptual SAM

	Activities	Commodities	Factors	Households	Government	Saving-Investment	Changes in stocks	Rest of world	Oportunidades	Other public transfers
Activities		Domestic supply								
Commodities				Private final consumption	Public final consumption	Fixed investment	Change in stocks	Exports		
Factors	Value added at factor cost									
Households			Households factor income					Foreign remittances	Oportunidades	Other public transfers
Government	Activity taxes	Tariffs		Direct taxes						
Saving-Investment				Private saving	Public saving			Foreign saving		
Changes in stocks						Change in stocks				
Rest of world		Imports	Net factor income of non-residents		Public transfers to non-residents					
Oportunidades					Oportunidades					
Other public transfers					Other public transfers					

Figure 6 Numerical SAM Mexico 2008 (Billions of current Mexican pesos)

	Activities	Commodities	Factors	Households	Government	Saving-Investment	Changes in stocks	Rest of world	Oportunidades	Other transfers	Total
Activities		12,165									12,165
Commodities				7,856	1,307	2,696	612	3,417			15,889
Factors	10,964										10,964
Households			10,867					281	14	1,002	12,164
Government	1,201	35		813							2,049
Saving-Investment				3,494	-368			182			3,309
Changes in stocks						612					612
Rest of world		3,689	97		94						3,880
Oportunidades					14						14
Other transfers					1,002						1,002
Total	12,165	15,889	10,964	12,164	2,049	3,309	612	3,880	14	1,002	64,097

Source: Authors’ estimation.

For disaggregating the Macro-SAM to get to the final SAM, we followed these steps:

1. Split the value added of each production sector into production factors using shares of labor wages and gross operating surplus into each sector as informed by Use matrix, and data on factor incomes and allocation of the factors among activities. The data for constructing this part of the SAM comes from the ENIGH 2008. There are three basic factors: adult male, adult female and child labour. These factors vary by skill level and labour market segment. We define three skill levels for adult labour. Individuals that have not finished secondary schooling are classified as unskilled. Skilled are those that at least started Normal education, Carrera técnica o comercial, profesional, maestria or docotorado. The other educational levels are classified as semi-skilled, these have at least finished secondary education. We define an adult as being aged 18 and above. We classify children into two age groups: children aged below 12 and teenagers aged 12 to 17. The informal sector is defined by enterprise size and work-related benefits. An individual is classified to work in the informal labour market if the enterprise she is working for has less than 16 employees and if she does not receive work related social benefits. This definition is in line with other studies, such as Maloney (1999). A shortcoming is that we cannot use the information on social security contributions, as the data only indicates whether the person ever contributed and the length of contribution, but not whether she is currently contributing to a social security system.
2. Split household incomes among the representative household groups using income shares weighted by population weights, both informed by ENIGH 2008. The ENIGH income questionnaire is only collected for individuals aged 12 and above. Although the data contain information on earnings of children that are younger than 12, it is not possible to identify in which activity they work or how much time they spend in the labour market. We use incomes from primary and secondary labour earnings and self-employed incomes to construct wages. Transfer incomes are classified into Oportunidades, remittances and other transfers. In addition to monetary incomes, we aggregate in-kind incomes and transfers using the same categories. We use the US industrial code (SCIAN) to create economic activities that are represented in the SAM. For individuals with two jobs we take into account both labour earnings, but weight the individual by the relative time devoted to each of the activities to prevent over-representation in the workforce. Incomes from rent and estimated rent are included in profits. We use annualized quarterly information and weights to generate population representative statistics. All income information is in Mexican Pesos of 2008. For each factor group, i.e. adult male skilled, unskilled and semi-skilled formal and informal, etc., we aggregate total earnings by economic activity. Given that for children aged below 12 we do not have access to work-related information, we group them together into an separate activity.
   We restrict the sample to households with both incomes and expenses and so drop nine observations, leaving a sample of a total of 29,458 household observations. Total aggregate incomes have an estimated value of 3542626729061Mexican peso per year. For reducing misreporting within each factor group, i.e. labour market sector and skill level, we replace wages by median wages if the wage is below a fifth or more than five times higher than the median wage. This reduces average quarterly incomes from 36, 325 to 33,135 Mexican peso.
3. Share of each commodity in the total final private consumption value was informed by ENIGH 2008, which informs value of consumption at level of sampled household for each commodity and population weights. For each household, consumption is aggregated using the use matrix classification and ENIGH data. We combine three sets of consumption information from the survey: daily expenditures, monthly expenditures and expenditures in-kind as part of

salary or transfer payments. Expenditures are collected using different recall periods. We use standardized trimester information that is provided by the Instituto Nacional de Estadística y Geografia and annualize the data; that is, we multiply the information by a factor of four. In the case of in-kind transfers, we include the total expenses (transfer plus own expenses) in the aggregation of goods into UMAT classification. For generating population representative data, we weight the information using the population weights provided in the data. We define a location as rural if it has less than 2500 inhabitants and as urban otherwise. We use a standard regional classification and divide Mexico into eight regional groups: Noreste, Noroeste, Occidente, Oriente, Centronorte, Centrosur, Sureste, and Suroeste.

4. Split total domestic value added at factor cost and activity taxes into sectors using sector shares in domestic value added as informed by INEGI. Sistema de Cuentas Nacionales de México, Gross value added at basic prices 2008.
5. Inform intermediate consumption of each of the mentioned activities using last available supply matrix (2003) provided by INEGI.
6. Inform the demand for transaction costs using the last supply matrix (2003) provided by INEGI.
7. Generate imports splitting the import value informed by Macro-SAM and shares informed by commodity shares in imports INEGI 2008 Sistema Armonizado[13]
8. Split the tariff collection among commodities using the shares of the commodities in imports
9. Split commodities in current public expenditure in goods and services, changes in stocks, and fixed investment using use matrix 2003.
10. For export, split them using shares informed by commodity shares in exports INEGI 2008 Sistema Armonizado and use matrix 2003.
11. The rest of the values in the SAM were obtained as residual from other cells.

To balance the SAM, we used the cross-entropy software developed by Sherman Robinson and Scott McDonald, controlling for the figures in the Macro-SAM in order to replicate them exactly, which included the total expenditure of the Oportunidades conditional cash transfers.

[13] Available at http://dgcnesyp.inegi.org.mx/cgi-win/bdieintsi.exe/NIVR5503500090#ARBOL

4. Simulations

Given that in 2008 the Oportunidades program was well established in Mexico, we design the following simulations:

1. The absence of any Oportunidades transfer (conditional and unconditional transfers) i.e. $CCT_i = UCT_i = 0$.
2. The extension the conditional transfers to all the moderately poor children applying the existent rule for the amount transferred as function of grade and gender, as summarized in Table 1 Monthly Scholarship, July to December 2008Table 1. This means any transfer is unaltered, but the CCT gets further expanded as $CCT_i = f(school\ grade, gender)$ for moderately poor who initially are not CCT beneficiaries and are assisting school. For those that are not assisting school we design the CCT according to the level and grade they would be in if they were to assist school, given their latest schooling level and grade completed and taking gender into account.
3. Lagged human capital effect of the existing transfers
4. Simulations 3 for extension of conditional transfers to all the moderated poor

For simulating the impact of the program changes on poverty and income distribution, we translate the changes in the Oportunidades transfer under the different simulation scenarios back into changes in household income. We also incorporate changes in children's earnings due to alterations in labor supply and the general equilibrium effects on wages into changes in household income. In the base scenario, the vector of children's labor market earnings for the choices Not studying, Work & School and School only, can be written as w_b, Mw_b, and 0, respectively.

The wage of a child that does not study in the base and remains as such in the simulated state, will increase (decrease) with the average wage, $\hat{w}$, that results from the CGE model. A child that used to work only and is simulated to attend in addition school, will face a wage increase (reduction) given the movements in the average child wage stemming from the CGE. Her wage will also be reduced by the fraction , as she now spends less time in the labor market, as discussed in more above. A child that stops working and is simulated to studying only will lead to a reduction in household income by w_b, ignoring, for illustrational purposes, that this household's income may have increased by the CCT. A child that was studying only in the base and is simulated to work, will contribute her potential wage, $\tilde{w}_b$, adjusted for changes in average wages, to total household income (see Table 3).

Table 3 Income vector by simulation

Simulated Choice	Base Choice		
	Not Studying	Work & School	School only
Not Studying	$w_b(1+\hat{w})$	$w_b(1+\hat{w})$	$\tilde{w}_b(1+\hat{w})$
Work & School	$Mw_b(1+\hat{w})$	$Mw_b(1+\hat{w})$	$M\tilde{w}_b(1+\hat{w})$
School only	**0**	**0**	**0**

Change A[1,1]= $w_b(1+\hat{w})$- w_b=$\hat{w}$; Change A[2,1]= $Mw_b(1+\hat{w})$- w_b=M(1+$\hat{w}$); Change A[3,1]=- w_b

Change A[2,2]= $\hat{w}$; Change A[1,2]= $w_b(1+\hat{w})$- Mw_b= (1-M +$\hat{w}$); Change A[3,1]=- Mw_b

Change A[3,3]= 0; Change A[2,3]= $M\tilde{w}_b(1+\hat{w})$; Change A[1,3]=$\tilde{w}_b(1+\hat{w})$

This can be translated into a matrix of changes in child earnings as follows:

$$\begin{array}{ccc} \hat{w} & (1-M+\hat{w}) & \tilde{w}_b(1+\hat{w}) \\ M(1+\hat{w}) & \hat{w} & M\tilde{w}_b(1+\hat{w}) \\ -w_b & -Mw_b & 0 \end{array}$$

where changes are from the base choices in the column entries to the simulated in the row entries.

In SIM3, to get the simulated gender-specific shares of the adult labor force by skill level, we started from the existent gender-specific shares, and adjusted them considering the average gender-specific effect of the CCTs on the school level of a recipient, and the gender-specific share of recipients in the population of kids.

More specifically, we go over the following steps:

1. Using ENIGH, we observe the years of education of the employed adults: EDUC
2. Using ENIGH, we compute the share of unskilled, semiskilled and skilled in the employed adults by gender, using population shares.
    a. $UNSH_A$: Weighted share of unskilled in the female employed adult
    b. $SSKSH_A$: Weighted share of semiskilled in the female employed adult
    c. $SKSH_A$:
    d. $UNSH_B$:
    e. $SSKSH_B$:
    f. $SKSH_B$:
3. Using ENIGH, we compute the participation share in the Oportunidades CCT of the children by gender, using population weights:
    a. $PARTIC_A$: Participation rate for girls
    b. $PARTIC_B$: Participation rate for boys
4. We get from the literature the average gender-specific effect of the CCT on the school level of a recipient: $\Delta EDUCO_A$ and $\Delta EDUCO_B$ (figure and source to get).
5. Get simulated school level of adult population after Oportunidades has lagged effect on school levels (EDUCO):
    a. For a randomly chosen PARTIC (A and B) share of the employed adult/match within the same household-gender recipient with adult and EDUCO=EDUC + ΔEDUCO. For rest, EDUCO = EDUC.
    b. Based on EDUCO, repeat step 2, getting:
        i. $UNSHO_A$: Weighted share of unskilled in the female adult employed accouting for Oportunidades
        ii. $SSKSHO_A$: Weighted share of semiskilled in the female adult employed accounting for Oportunidades
        iii. $SKSHO_A$:
        iv. $UNSHO_B$:
        v. $SSKSHO_B$:
        vi. $SKSHO_B$:
6. Generate a table of shares by skill level, gender and pre-post program:

	Observed	Simulated
Unskilled, female	$UNSH_A$	$UNSHO_A$

Semiskilled, female	$SSKSH_A$	$SSKSHO_A$
Skilled, female	$SKSH_A$	$SKSHO_A$
Unskilled, male	$UNSH_B$	$UNSHO_B$
Semiskilled, male	$SSKSH_B$	$SSKSHO_B$
Skilled, male	$SKSH_B$	$SKSHO_B$

We will use this new shares to inform the CGE model.

SIM4 combines SIM2 with SIM3, extending the conditional transfers to all the (moderately) poor and considering the lagged human capital effect.

5. Results

Table 4 summarizes the results of the MS model and Table 6 the results of the MS-CGE model. The tables are organized as a transition matrix: the columns depict the original occupational choices and the rows the simulated choices. If all the diagonal elements contain entries of 100 and the off-diagonal elements are all zero, this means the simulation did not alter children's choices.

Table 4 Microsimulation of Oportunidades transfer (age 6 to 17)

Simulation 1			
	Base Choice		
Simulated Choice	Not Studying	Work and School	School only
Not Studying	100	0.3	0.07
Work and School	0	99.7	0
School only	0	0	99.93
Simulation 2			
	Base Choice		
Simulated Choice	Not Studying	Work and School	School only
Not Studying	87.41	0	0
Work and School	0.75	100	0
School only	11.84	0	100

Authors' estimation based on ENIGH 2008. Population weighted statistics reported.

Table 4 shows that the effect of withdrawing all Oportunidades transfers on children that are already attending school is very small. Only 0.07 percent of those that were only attending school initially and 0.3 percent of those working and going to school drop out of school in Simulation 1. Extending the program to all moderately poor children that are not yet covered by the program increases school enrollment substantially: of those that were initially working 0.75 percent are simulated to work and go to school and 11.84 percent study only in Simulation 2. The effect varies by gender. 1.13 percent of boys that were initially working now also go to school and 11.09 percent go to school only. Only 0.31 of girls that were initially working now also go to school and 12.7 percent are simulated to go to school only. Table 11 in Annex III. Simulation Results. reports the simulation results for the sample of children aged 12 to 17, which are very close to the results discussed, but slightly more pronounced.

Accounting for the general equilibrium effects of the program yields different results. Extending the coverage of the program has two effects. First, more children attend school and beneficiary households receive a transfer income. Second, less children at work cause a rise in average children wages by 17.8 percentage points. The results of the CGE-MS model are summarized in Table 5, they indicate that for some children the wage increase implies that a "wage effect" dominates the "Oportunidades effect" and so they stop going to school. The table shows that of those that work and go school in the base scenario, 3.1 percent are simulated to stop working and 0.52 percent drop out of school. Although very small in size, for those studying a small fraction is simulated to stop going to school. Of those not assisting school, a relatively higher fraction is simulated to remain in this state as in the MS model alone.

Table 6 CGE-MS results of Oportunidades schooling transfer

Simulation 1			
	Base Choice		
Simulated Choice	Not Studying	Work and School	School only
Not Studying	100	0	0
Work and School	0	99.94	0
School only	0	0.06	100
Simulation 2			
	Base Choice		
Simulated Choice	Not Studying	Work and School	School only
Not Studying	87.89	0.52	0.05
Work and School	0.51	96.38	0
School only	11.6	3.1	99.95

Authors' estimation based on ENIGH 2008

In all that follows, we will only concentrate only on the CGE-MS results.

Withdrawing all Oportunidades transfers (Simulation 1) reduces average incomes especially in the Suroeste and Centronorte region, while extending the transfer as stipulated in Simulation 2 increases average incomes especially in these regions (see Figure 7).

Figure 7 Changes in simulated average incomes relative to the base by region

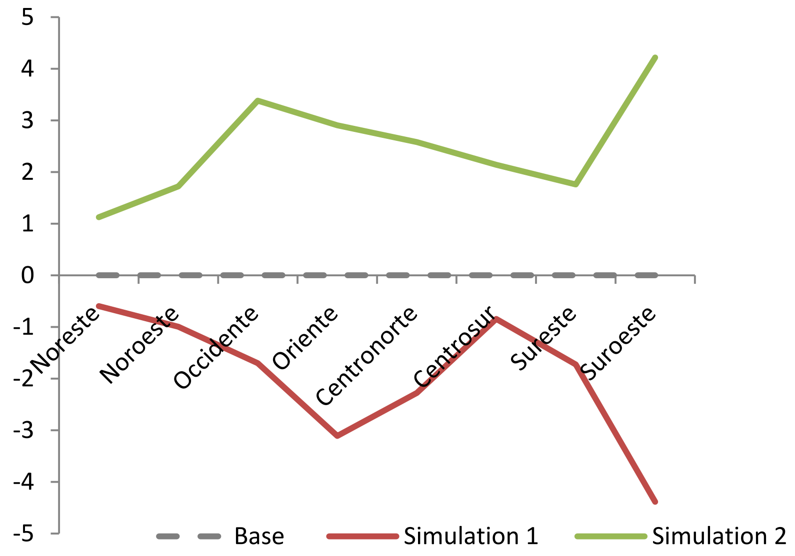
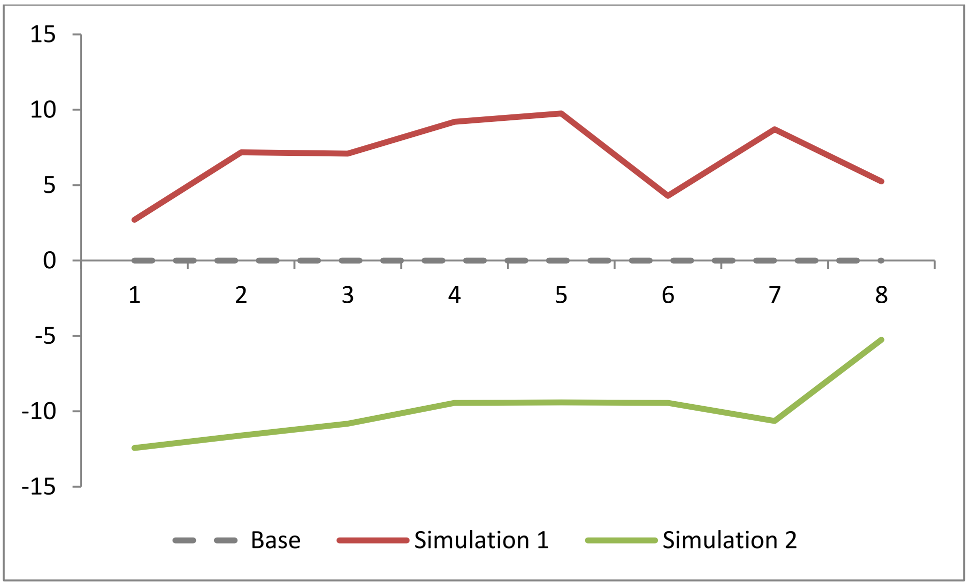


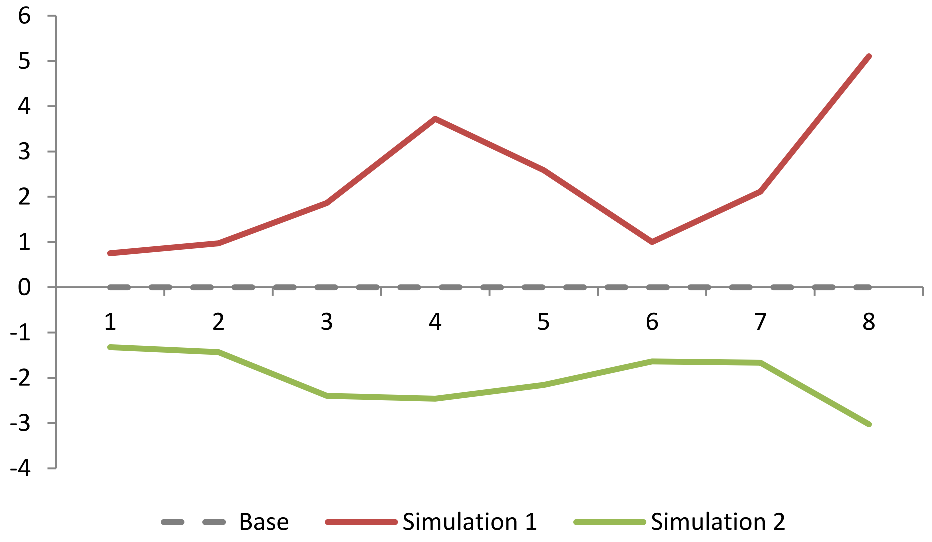
Figure 8 illustrates the effect of changes to the program on the poverty headcount by region relative to the base scenario using the national moderate poverty line (REFERENCE). The figure illustrates percentage the increase/reduction in the headcount measure by region and relative to the base. The impact of the program changes on other poverty measures and different poverty lines can be found in Annex III. Simulation Results . In line with the result on average incomes, withdrawing Oportunidades transfers of any kind increases poverty especially in Oriente, Sureste and Suroeste region while Simulation 2 reduces poverty.

Figure 8 Change in poverty headcount relative to the base by region, national moderate poverty line



Simulation 1 also increases substantially inequality especially in Oriente and Suroeste while Simulation 2 reduces inequality to a similar extend across the regions.

Figure 9 Change in inequality relative to the base by region, Gini Coefficient



6. Conclusions

TO BE DEVELOPED

Annex I. Microsimulation Literature

A Summary of the Microsimulation Literature on Conditional Cash Transfers following Bourguignon, Ferreira and Leite

Study	Country	Sample	Year (data)	Program Name	Scenarios	Impact
Bourguignon, Ferreira and Leite (2002)	Brazil	Children aged 10-15 and children aged 10-15 living in poor households	1999	Bolsa Escola	1. Bolsa Escola transfer, 2. doubling Bolsa Escolar transfers, 3. age-contingent transfer, 4. means-test raised, 5. combination of 2 and 4, 6. combination of 3 and 4, 7. no conditionality.	Simulation 1: 2.1 percentage point reduction in children out of school, 1.1 percentage point increase in fraction of children working and going to school, 1.8 percentage point increase in children attending school. Effect more pronounced for the poor: initially 9.1 percent working decreases in simulation to 4.7 percent, 23.7 percent working and studying increases to 24.7 percent and 67.3 percent increases to 70.6 percent attending school only. Doubling the transfer reduces fraction of children out of school by an additional percentage point, age-contingency of transfer does not alter to a great extent the results, amount seems more relevant than means-test. In terms of poverty, program in Simulation1 would reduce poverty by 1 percentage point and inequality by 0.5 percentage points, Simulation2 would reduce headcount by 1.3 percentage points.
Azevedo and Robles (2010)	Mexico	Children aged 12-18, 12-15, 16-18	1996	Oportunidades in 2005	1. Oportunidades design in 2005, 2. Increase UCT by 26 percent, 3. suspension of transfer to students in third to fifth grade of primary school and proportional increase in transfer to the rest maintaining UCT component, 4. suspension of transfer to grade three and five of primary school plus triplicating existing transfers, maintaining UCT, 5. triplication of the CCT plus UCT as	Simulation 1: 2005 CCT design increases school attendance by 1.18 percentage points for 12-15 year olds, by 1.17 for 16-18 year olds to study only and 0.34 percent work and study and 1.17 for 12-18 year olds to study only and 0.14 percent of work and study. The effect is more pronounced for the poor. Modifying the 2005 design for poor children according to the different scenarios yields in Simulation 2. does not alter occupational choices, Simulation 3 increases the fraction

					in 2, 6. quadruples transfer to secondary and high school students, maintain UCT, 7. transfer design based on opportunity costs as measured by average reported wage in 2005, 8. Reduction of 2005 transfer design by one half.	of students attending school only from 44.04 to 44.66, the fraction of students working and going to school from 10 to 10.8. Simulation 4 and 5 increase the fraction of children going to school only to 48.2 and 50.4 and the fraction of children going to school and working 10.91 and 11.25. Simulation 6 reduces the fraction of children not attending school by 4.71 percentage points, Simulation 7 by 0.56 percentage points and Simulation 8 increases the school dropouts by 2.58 percentage points. The program reduces poverty by 2 percentage points nationally and by 4 percentage points in rural areas. Also, inequality is reduced with the Gini dropping from 0.527 to 0.512.
Amarante, Arim, de Melo and Vigorito (2008)	Ururguay	Boys and girls aged 14 -17	2006	Asignaciones familiars	1. New asignaciones familiares regime, 2. Change in the transfer amount for children aged 0-12 and 13-17, 3. Equal transfer amount to all children aged below 18, 4. Simulation of transfer design on adult labor supply (assuming first children's labor supply is decided upon and then adults)	Simulation 1: increase in school attendance by about 2.5 percentage points. 14 % of children that are out of school in baseline return to educational system and 20% who initially work and study, study only in simulation. This effect does not vary much by the different simulation scenarios. The authors find a reduction in poverty by 1 percentage point and 2 percentage points for households with children. Also, the authors find the program to reduce inequality. The transfer is only reduces spouses labor supply and is simulated to reduce hours of work for eligible households. Results do not differ between the scenarios.
Bornhorst (2009)	Mexico	Children aged 10-16	1997	Oportunidades	Simulation of Progresa	7.5 percentage point increase in schooling.

Annex II. Summary statistics and Regression Results

Table 7 Summary statistics by Occupational Choice

	Not Studying	Work and School	School only
Wage (yearly)	7275	6189	0
Total hh income (yearly)	109709	133661	140243
Rural	0.40	0.26	0.28
Age	15.11	12.49	10.98
Male	0.53	0.65	0.50
Years of schooling	6.74	6.01	4.68
No child 0<age<6	0.57	0.50	0.52
No child 5<age<13	1.06	1.33	1.48
No child 12<age<18	1.68	1.14	0.94
No people age>17	2.94	2.56	2.63
Education head	4.77	6.92	7.59
Education spouse of head	3.50	5.37	5.96
Age head	45.93	43.34	43.61
Age spouse of head	32.51	30.38	32.10
Female headed household	0.24	0.26	0.21
Rank	2.04	2.02	2.12
Hrs. worked	19.54	16.13	0.00
N	3,543	1,702	25,086

Authors' calculation based on ENIGH 2008

Table 8 Child wage equation

$$\ln w_i = X_i \delta + m \, Ind(S_j = 1) + u_i$$

	(1) Age 6 to 17	(2) Age 12 to 17
Work & School	-0.644***	-0.593***
	(0.060)	(0.058)
Log average federative wage	0.346***	0.438***
	(0.064)	(0.072)
Male	0.214***	0.213***

	(0.048)	(0.053)
Years of schooling	0.009	0.153***
	(0.044)	(0.047)
Years of schooling^2	-0.001	-0.012***
	(0.003)	(0.003)
Age	0.389***	0.366
	(0.090)	(0.334)
Age^2	0.001	-0.001
	(0.003)	(0.011)
Female head	0.135***	0.127**
	(0.052)	(0.056)
Rural	-0.243***	-0.326***
	(0.051)	(0.054)
Noreste	0.219	0.096
	(0.152)	(0.166)
Noroeste	0.306***	0.337***
	(0.100)	(0.108)
Occidente	0.151	0.167
	(0.103)	(0.111)
Oriente	-0.062	0.053
	(0.112)	(0.115)
Centronorte	0.122	0.110
	(0.099)	(0.104)
Centrosur	0.178*	0.206**
	(0.101)	(0.105)
Sureste	-0.023	0.141
	(0.100)	(0.107)
Constant	-5.882***	-5.086**
	(0.528)	(2.484)
Observations	3,021	2,285
R-squared	0.596	0.262

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9 Multinomial logit estimates of child labor supply, all children

	(1)	(2)	(3)	(4)	(5)
	Multinomial logit estimates		Marginal effects at the mean of data		
	Work & School	School only	Not studying	Work & School	School only
Y_i	0.019***	0.022***	-0.001***	-0.000	0.001***
	(0.004)	(0.003)	(0.000)	(0.000)	(0.000)

Log mean fed. wage	0.411***	-0.157***	0.008**	0.025***	-0.033***
	(0.089)	(0.054)	(0.003)	(0.003)	(0.005)
Male	0.493***	-0.206***	0.011***	0.031***	-0.042***
	(0.063)	(0.040)	(0.003)	(0.002)	(0.003)
Years of schooling	0.000	-0.093***	0.006***	0.004***	-0.010***
	(0.037)	(0.025)	(0.002)	(0.001)	(0.002)
Years of schooling	0.008**	-0.002	0.000	0.000***	-0.000***
	(0.003)	(0.002)	(0.000)	(0.000)	(0.000)
Rank of child	0.355***	0.396***	-0.025***	-0.001	0.026***
	(0.036)	(0.022)	(0.001)	(0.001)	(0.002)
No child 0<age<6	-0.058	-0.122***	0.008***	0.002	-0.010***
	(0.042)	(0.026)	(0.002)	(0.002)	(0.002)
No child 5<age<13	0.297***	0.289***	-0.018***	0.001	0.017***
	(0.034)	(0.022)	(0.001)	(0.001)	(0.002)
No child 12<age<18	-0.613***	-0.705***	0.044***	0.002	-0.046***
	(0.043)	(0.025)	(0.002)	(0.002)	(0.002)
No people age>17	-0.278***	-0.240***	0.015***	-0.002*	-0.013***
	(0.034)	(0.019)	(0.001)	(0.001)	(0.002)
Rural	-0.412***	-0.211***	0.015***	-0.009***	-0.005
	(0.073)	(0.045)	(0.003)	(0.003)	(0.004)
Educ. Head	0.101***	0.169***	-0.011***	-0.002***	0.013***
	(0.009)	(0.006)	(0.000)	(0.000)	(0.001)
Age Head	0.006*	0.019***	-0.001***	-0.001***	0.002***
	(0.003)	(0.002)	(0.000)	(0.000)	(0.000)
Noreste	-0.160	-0.289**	0.020**	0.005	-0.025**
	(0.205)	(0.115)	(0.009)	(0.009)	(0.012)
Noroeste	0.618***	0.076	-0.007	0.029***	-0.023***
	(0.135)	(0.082)	(0.005)	(0.007)	(0.009)
Occidente	0.371***	-0.153*	0.008	0.027***	-0.035***
	(0.144)	(0.087)	(0.006)	(0.008)	(0.010)
Oriente	0.253	0.171*	-0.010**	0.004	0.006
	(0.154)	(0.090)	(0.005)	(0.006)	(0.008)
Centronorte	0.112	-0.068	0.004	0.008	-0.012
	(0.138)	(0.080)	(0.005)	(0.006)	(0.008)
Centrosur	0.042	0.153*	-0.009*	-0.004	0.013*
	(0.140)	(0.080)	(0.005)	(0.005)	(0.007)
Sureste	0.631***	0.108	-0.008*	0.029***	-0.020**
	(0.136)	(0.081)	(0.005)	(0.008)	(0.009)
Head divorced	-0.137	-0.321***	0.022***	0.008*	-0.030***
	(0.108)	(0.071)	(0.006)	(0.005)	(0.007)
Potential wage	-0.416***	-0.062***	0.005***	-0.016***	0.011***
	(0.035)	(0.008)	(0.000)	(0.001)	(0.001)
Constant	-0.736**	0.821***			
	(0.332)	(0.205)			
Observations	30,331	30,331	30,331	30,331	30,331

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10 Multinomial logit estimates of child labor supply, children aged 12 to 17

	(1)	(2)	(3)	(4)	(5)
	Multinomial logtit estimates		Marginal effects at the mean of data		
	Work & School	School only	Not studying	Work & School	School only
Y_i	0.013***	0.022***	-0.003***	-0.000	0.003***
	(0.005)	(0.004)	(0.000)	(0.000)	(0.001)
Log mean fed. wage	0.614***	-0.129**	0.012	0.035***	-0.047***
	(0.113)	(0.060)	(0.008)	(0.005)	(0.009)
Male	0.749***	-0.186***	0.018***	0.044***	-0.062***
	(0.079)	(0.044)	(0.006)	(0.004)	(0.007)
Years of schooling	0.554***	0.770***	-0.109***	-0.004	0.112***
	(0.110)	(0.049)	(0.007)	(0.005)	(0.009)
Years of schooling	-0.018**	-0.048***	0.007***	0.001***	-0.008***
	(0.007)	(0.003)	(0.000)	(0.000)	(0.001)
Rank of child	0.343***	0.440***	-0.062***	-0.001	0.063***
	(0.051)	(0.027)	(0.004)	(0.002)	(0.004)
No child 0<age<6	-0.068	-0.154***	0.021***	0.003	-0.024***
	(0.056)	(0.030)	(0.004)	(0.002)	(0.005)
No child 5<age<13	0.184***	0.265***	-0.037***	-0.002	0.039***
	(0.042)	(0.024)	(0.003)	(0.002)	(0.004)
No child 12<age<18	-0.302***	-0.530***	0.074***	0.006***	-0.080***
	(0.051)	(0.028)	(0.004)	(0.002)	(0.005)
No people age>17	-0.306***	-0.321***	0.046***	-0.002	-0.044***
	(0.046)	(0.024)	(0.003)	(0.002)	(0.004)
Rural	-0.557***	-0.258***	0.041***	-0.016***	-0.025***
	(0.092)	(0.050)	(0.008)	(0.004)	(0.008)
Educ. Head	0.074***	0.156***	-0.022***	-0.003***	0.024***
	(0.011)	(0.007)	(0.001)	(0.000)	(0.001)
Age Head	0.010**	0.024***	-0.003***	-0.000**	0.004***
	(0.004)	(0.002)	(0.000)	(0.000)	(0.000)
Noreste	-0.739***	-0.471***	0.080***	-0.015*	-0.065***
	(0.273)	(0.127)	(0.023)	(0.009)	(0.024)
Noroeste	0.163	-0.028	0.002	0.009	-0.012
	(0.167)	(0.091)	(0.013)	(0.008)	(0.015)
Occidente	-0.004	-0.300***	0.043***	0.012	-0.055***
	(0.176)	(0.098)	(0.016)	(0.009)	(0.017)
Oriente	0.151	0.011	-0.003	0.007	-0.004
	(0.183)	(0.100)	(0.014)	(0.009)	(0.016)
Centronorte	-0.246	-0.285***	0.043***	-0.001	-0.042***

	(0.167)	(0.090)	(0.014)	(0.007)	(0.015)
Centrosur	-0.199	-0.108	0.017	-0.005	-0.012
	(0.166)	(0.089)	(0.013)	(0.007)	(0.014)
Sureste	0.347**	0.094	-0.016	0.014	0.001
	(0.167)	(0.092)	(0.012)	(0.009)	(0.014)
Head divorced	-0.200	-0.297***	0.045***	0.002	-0.047***
	(0.133)	(0.078)	(0.013)	(0.006)	(0.014)
Potential wage	-0.405***	-0.057***	0.011***	-0.017***	0.006***
	(0.036)	(0.008)	(0.001)	(0.002)	(0.002)
Constant	-3.211***	-3.192***			
	(0.590)	(0.281)			
Observations	15,357	15,357	15,357	15,357	15,357

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Annex III. Simulation Results

Table 11 Microsimulation of Oportunidades schooling transfer (age 12 to 17)

Simulation 1			
	Base Choice		
Simulated Choice	Not Studying	Work and School	School only
Not Studying	100	0.07	0.1
Work and School	0	99.93	0.03
School only	0	0	99.87

Simulation 2			
	Base Choice		
Simulated Choice	Not Studying	Work and School	School only
Not Studying	100	0	0.06
Work and School	0	100	0.02
School only	0	0	99.93

Simulation 3			
	Base Choice		
Simulated Choice	Not Studying	Work and School	School only
Not Studying	85.8	0	0
Work and School	1.24	99.97	0
School only	12.96	0.03	100

Authors' estimation based on ENIGH 2008

Table 12 Average monthly incomes by region and simulation

Region	Base	Simulation 1	Simulation 2
Noreste	14449	14363	14612
Noroeste	14350	14207	14597
Occidente	12238	12030	12652
Oriente	9011	8731	9273
Centronorte	12166	11888	12479
Centrosur	13716	13600	14010
Sureste	11706	11504	11912
Suroeste	7472	7144	7787

Table 13 Poverty Headcount, national moderate poverty line, adult equivalent incomes

Region	Base	Simulation 1	Simulation 2
Noreste	18.5	19	16.2
Noroeste	18.1	19.4	16
Occidente	26.8	28.7	23.9
Oriente	41.3	45.1	37.4
Centronorte	28.7	31.5	26
Centrosur	23.3	24.3	21.1
Sureste	31	33.7	27.7
Suroeste	53.3	56.1	50.5
Total	28.7	30.7	26

Table 14 Poverty Headcount, national extreme poverty line

Region	Base	Simulation 1	Simulation 2
Noreste	2.22	2.59	1.67
Noroeste	4.02	4.89	2.92
Occidente	5.88	7.48	4.16
Oriente	10.2	14.4	8.82
Centronorte	5.66	7.98	4.46
Centrosur	3.47	4.33	2.4
Sureste	4.98	7.28	3.65
Suroeste	20.5	26.9	16.9
Total	6.46	8.59	5.02

Table 15 Poverty Headcount, 1.25$ a day per capita income

Region	Base	Simulation 1	Simulation 2
Noreste	0.73	0.91	0.60
Noroeste	1.91	2.57	1.11
Occidente	2.6	3.78	1.71
Oriente	4.19	7.62	2.94
Centronorte	2.6	4.05	1.86
Centrosur	1.11	1.62	0.663
Sureste	1.65	3.06	1.34
Suroeste	11.4	16.9	8.37
Total	2.92	4.48	2.04

Table 16 Poverty Headcount, 2$ a day per capita income

Region	Base	Simulation 1	Simulation 2
Noreste	3.22	3.58	2.36
Noroeste	5.52	6.34	4.32
Occidente	7.1	8.58	5.66
Oriente	13.9	17.3	11.9
Centronorte	8.52	10.4	6.58
Centrosur	4.43	5.16	3.3
Sureste	7.42	9.22	5.81
Suroeste	25.2	30.6	21.5
Total	8.62	10.4	6.95

Table 17 Gini Coefficient by simulation and region

Region	Base	Simulation 1	Simulation 2
Noreste	0.47	0.47	0.46
Noroeste	0.53	0.54	0.53
Occidente	0.49	0.49	0.47
Oriente	0.48	0.49	0.46
Centronorte	0.49	0.50	0.48
Centrosur	0.50	0.51	0.50
Sureste	0.51	0.52	0.50
Suroeste	0.52	0.55	0.51
Total	0.51		0.50

Annex IV. The CGE model

We describe the model below. We use capital characters for endogenous variables and non-capital ones for exogenous variables. For variables that are endogenous only in some closures of the model, we use capital letters, and insert a bar over the variable when in the present closure it is kept fixed (e.g. $\overline{FSAV}$ stands for endogenous variable foreign saving that is kept fixed in the chosen closure).

Production and consumption behavior

Following general equilibrium theory, representative consumers (i.e., households) and producers in our model are treated as individual economic agents. Representative consumers maximize their utility subject to a budget constraint, which is generated with a Stone-Geary utility function, such that the consumer problem can be represented mathematically as follows:

$$\underset{i}{\text{Max}}\, U_h = \prod_i (C_{hi} - \gamma_{hi})^{\beta_{hi}}$$

$$\text{subject to} \sum_i (P_i \cdot C_{hi}) = (1 - s_h - ty_h) Y_h$$

This leads to generate the Linear Expenditure System (LES) of demand i.e. the set of demand functions:

$$C_{hi} = \gamma_{hi} + \beta_{hi} \left[(1 - s_h - ty_h) Y_h - \sum_{i'} (P_{i'} \cdot \gamma_{hi'}) \right] P_i^{-1} \quad where\ i' \approx i \tag{1}$$

where U_h is the utility level of household h, C_{hi} is the level of consumption of good i chosen by household h, γ_{hi} is a minimum subsistence level of consumption of good *i* by household h, β_{hi} is the households' marginal budget share for good i, P_i is the market price of good i, s_h and ty_h are marginal savings and direct income tax rates (respectively), and Y_h is total income of household h.

Producer behavior

Producers are defined at the sector level. Each representative producer maximizes profits subject to a given set of input and output prices. Following neoclassical theory, we assume constant returns to scale. A constant elasticity of substitution (CES) function is used to determine production:

$$X_i = \Lambda_i \left(\sum_f \alpha_{if} \cdot V_{if}^{-\rho_i} \right)^{-1/\rho_i} \tag{2}$$

where X_i is the output quantity of sector i, Λ is a shift parameter reflecting total factor productivity (TFP), V_{if} is the quantity demanded of each factor *f* (i.e., land, labor and capital) in sector i, α_{if} is a share parameter of factor *f* employed in the production of good i, and the elasticity of substitution between factors σ_i is a transformation of $\rho_i > 0$ (i.e., $\sigma_i = 1/(1+\rho_i)$). Sector-specific profits π_i are defined as the difference between value added and total factor payments:

$$\pi_i = PV_i \cdot X_i - \sum\nolimits_f (W_f \cdot V_{if})$$

where PV_i is the value-added component of the producer price, and W_f are factor prices (i.e. factor remunerations). Maximizing sectoral profits subject to Equation 2 and rearranging the resulting first order condition provides the system of factor demand equations used in the model:

$$V_{if} = \Lambda_i^{-\frac{\rho_i}{1+\rho_i}} \cdot X_i \left(\alpha_{if} \cdot \frac{PV_i}{W_f}\right)^{1/(1+\rho_i)} \quad (3)$$

Intermediate inputs are also used in the production process. In our model we assume Leontief technology when determining intermediate demand of individual goods and when combining aggregate factor and intermediate inputs. Thus, demand for intermediates is based on fixed input-output coefficients $io_{i,j}$ defining the quantity of good i used in the production of one unit of good j. Thus, the complete producer price PP_i is the sum of the unitary value added and intermediate cost in sector i:

$$PP_i = PV_i + \sum\nolimits_{i'} P_{i'} io_{i'i} \quad (4)$$

Behavioral functions governing international trade

Given observed two-way trade between countries for similar goods, we assume imperfect substitution between domestic goods and goods supplied to and from foreign markets. An Armington specification (i.e., CES function) (Armington, 1969) is used to define the relationship between domestically-produced and imported goods:

$$Q_i = \Omega_i \left[\mu_i \cdot D_i^{-\theta_i} + (1 + \mu_i) M_i^{-\theta_i}\right]^{-1/\theta_i} \quad (5)$$

where Q_i is the composite good consumed domestically, and D_i and M_i are domestically supplied and imported quantities. In similar way, a constant elasticity of transformation (CET) function determines the relationship between the quantity of goods produced for domestic and foreign export markets:

$$X_i = \Gamma_i \left[\tau_i \cdot D_i^{\varphi_i} + (1 + \tau_i) E_i^{\varphi_i}\right]^{1/\varphi_i} (6)$$

where X_i is the output quantity of sector i, and D_i and M_i are domestically supplied and exported quantities.

Import price PM_i is determined by exogenous world imports prices (small country assumption) in foreign currency units pwm_i, nominal exchange rate EXR (local currency units per foreign currency unit), and import tariff rates tm_i, while export price PE_i is determined in analogous way:

$$PM_i = EXR(1 + tm_i) pwm_i (7)$$

$$PE_i = EXR(1 - te_i) pwe_i (8)$$

with te_i being the export tax rates and pwe_i the world export prices in foreign currency units.

Producer and consumer prices PP_i and P_i are determined such that in each sector the value of absorption equals the sum of the value of domestic supply and imports, and the value of production equals the sum of domestic supply and exports:

$$(1 - tc_i)P_i \cdot Q_i = PD_i \cdot D_i + PM_i \cdot M_i \quad (9)$$

$$PP_i.X_i = PD_i \cdot D_i + PE_i \cdot E_i (10)$$

Maximizing $P_iQ_i - PD_iD_i - PM_iM_i$ subject to Armington equation and rearranging the resulting first order condition gives the following equation defining the ratio of domestic production and imports:

$$\frac{D_i}{M_i} = \left(\frac{\mu_i}{1 - \mu_i} \cdot \frac{PM_i}{PD_i}\right)^{1/(1+\varphi_i)} \quad (11)$$

Similarly, minimizing $PP_iX_i - PD_iD_i - PE_iE_i$ subject to CET equation gives the ratio of domestic production and exports:

$$\frac{D_i}{E_i} = \left(\frac{\tau_i}{1 - \tau_i} \cdot \frac{PD_i}{PE_i}\right)^{1/(\varphi_i-1)} \quad (12)$$

Equilibrium conditions

With full employment and factor mobility across sectors, the following factor market equilibrium conditions holds:

$$\sum_i V_{if} = \overline{VS_f} \quad (13)$$

where VS_f is fixed total supply for factor f. However, in the model physical capital is fully employed but immobile among sectors, which means that physical capital has a set of sector-specific market-clearing wages[14]. Also, we allow the supply of child work to change, with its percentage changes informed by the microsimulation model.

Assuming all factors are owned by households[15], household income Y_h is determined by the sum of factor income and transfers received by them from other institutions:

$$Y_h = \sum_f \delta_{hf}(1 - tf_f)W_f + \sum_n tr_{hn} \quad (14)$$

where δ_{hf} is a coefficient matrix determining the distribution of factor earnings to individual households, tf_f is the direct tax on factor earnings (e.g., corporate taxes imposed on capital profits), and TR_{hn} are net transfers received by household groups from other institutions.

[14] To keep the description of the model simple, we focus on the case of fully mobile factors. For a description of the treatment in the model of factors fixed at the sector level, see ROBINSON-LOFGREN DESCRIPTION.

[15] In reality, part of factor incomes, e.g., the return to capital, can be owned by the government or foreign institutions. While this is allowed in the model that we actually implement, at this stage we ignore non-household factor ownership in order to simplify our discussion.

Finally, commodity market equilibrium requires that the composite supply of each good Q_i equals total demand, as shown below:

$$Q_i = \sum\nolimits_h C_{ih} + N_i + \overline{G_\iota} + \sum\nolimits_{i'} (io_{i'i} \cdot X_i) \tag{15}$$

where N_i is investment demand and G_i is government recurrent consumption spending, and where the equilibrating variable of the equations are the relative prices of the goods (i.e. relative prices adjust such that sector-specific markets clear).

Government and investment demand

The government is treated as a separate agent with income and expenditures, but without any behavioral functions. Total public domestic revenues GR is the summation of all individual taxes plus transfers received from other agents (e.g. foreign transfers):

$$\begin{aligned} GR = \sum\nolimits_i (tc_i \cdot P_i \cdot Q_i + tm_i \cdot PM_i \cdot M_i + te_i \cdot PE_i \cdot E_i) \\ + \sum\nolimits_h (ty_h \cdot Y_h) + \sum\nolimits_f \left(tf_f \cdot W_f \cdot \bar{V}_f\right) + \sum\nolimits_n tr_{Gn} \end{aligned} \tag{16}$$

Tax rates are exogenous in the model so that they can be used to simulate policy changes. The government uses its revenues to purchase goods and services (i.e., recurrent consumption spending), to transfer to other economic agents, and to save (i.e., finance public capital investment), as shown below

$$GR = \sum\nolimits_i (P_i \cdot \bar{G}_i) + \sum_n tr_{nG} + GB \tag{17}$$

where G_i is consumption spending from Equation 13, TR_{nG} are government net transfers to other institutions, and FB is the recurrent fiscal surplus (or deficit if negative). We assume that G_i is determined exogenously, implying that an increase in government revenues causes the fiscal surplus to expand (or deficit to contract).

There is also no behavioral function determining the level of investment demand for goods and services (i.e., N_i from Equation 13). The total value of all investment spending must equal the total amount of investible funds I in the economy. We therefore assume that value of N for each good i is in fixed proportion to the total value of investment, as seen below

$$I\ \theta_i = P_i \cdot N_i \tag{18}$$

where θ_i is the value share for each good i, and P_i is the market price determined by the equilibrium condition in Equation 13. To determine the value of I we must define our macroeconomic closures.

Current account and macroeconomic closures

In neoclassical general equilibrium theory there is no room for current account imbalances. However, CGE models are often calibrated to observed data for a country. Hence, Walras Law no longer holds unless we introduce real-financial flows into the model, such as incomes from holding foreign assets or the government's foreign borrowing. Current account imbalances must be accounted for since they affect the real side of the economy via the relationship between exports and imports, and between savings and investment. We start from the well-known identity linking a country's current account balance *CA* to national savings *S* and investment *I*:

$$CA = \sum_{i}(pwe_i \cdot E_i) - \sum_{i}(pwm_i \cdot M_i) + NFI = S - I = \Delta NFA = -\overline{FSAV} \tag{19}$$

The left-hand-side of the identity states that a country's current account balance is equal to its trade balance (export minus import value) plus net foreign incomes *NFI*, including exogenous net transfers from non-residents to residents and endogenous net factor payments to residents. A country is therefore running a current account surplus whenever the sum of its trade balance and *NFI* is positive, in which case i) national savings exceed national investment, ii) there are negative foreign savings, and iii) the country is accumulating net foreign assets *NFA*. In turn, total domestic savings is the sum of all household savings and the government's recurrent fiscal balance, as shown below:

$$S = \sum_{h}(s_h \cdot Y_h) + FB \tag{20}$$

Macroeconomic balance in a CGE model is determined exogenously by a series of "closure rules", the first of which is the current account balance. While this is a substantive research topic within macroeconomics, it is treated as an exogenous variable within our single-country open economy CGE model.

Our second closure rule concerns the identity of total savings and total investment. Either total savings *S* or total investment *I* (but not both) should be determined exogenously. We call this choice the "savings-investment" closure, which is a term borrowed from macroeconomics. If the CGE model is "savings-driven" (as here) then *I* is automatically determined by the level of total available savings (i.e., *I* = *S* – *ΔNFA*). Consistent with Equation 1 in which *s* is a fixed parameter, public savings are determined by equation xx, and foreign savings are exogenous, our model specification is savings-driven. Were we to choose an "investment-driven" closure, then total investment *I* would have been exogenously set at a fixed value or in proportion to a macroeconomic indicator (e.g., GDP), and total savings would be made endogenous by allowing marginal savings rates *s* to adjust proportionally for all households.

Finally, our treatment of the government balance in Equation 15′ is in fact the third closure rule in the model. We chose to make recurrent consumption spending *G* exogenous and allow the fiscal balance *GB* to adjust to changes in revenues G*R*. An alternative would have been to allow recurrent spending to adjust to changes in revenues, while holding *GB* constant. In this case, government spending on individual commodities G would be in proportion to total spending (i.e., analogous to investment demand in Equation 16).

Finally, the model has consumer price index (CPI) as numeraire:

$$\overline{CPI} = \textstyle\sum_{i,h} P_i c_{ih}^0 \tag{21}$$

i.e. the price of the original basket of goods consumed by the households is kept fixed, only allowing for variations in relative prices.

The model just presented is square i.e. its number of equations equals its number of equations. For a special case where there is only one household group, one factor, and one sector, the model has 21 variables $(C_{hi}, Y_h, P_i, X_i, V_{if}, PV_i, W_f, PP_i, Q_i, D_i, M_i, E_i, PM_i, PE_i, EXR, PD_i, N_i, GR, \quad GB, I, S)$ and 21 equations.

Annex V. Elasticities in the CGE model

Factor substitution $(1/\rho_i)$, Armington $(1/\theta_i)$ and CET $(1/\varphi_i)$ elasticities

	Factor substitution	Armington	CET
Agriculture, livestock, forestry, fishing, hunting	0.6	4	4
Mining	0.6	3	3
Electricity, water and gas provision	0.6	3	3
Construction	0.6	3	3
Manufacturing	0.6	3	3
Trade	0.6	3	3
Transport, mail and storage	0.6	3	3
Media	0.6	2	2
Financial and insurance services	0.6	2	2
Profesional, scientific and technical services	0.6	2	2
Education	0.6	2	2
Health and social assistance	0.6	2	2
Other private services	0.6	2	2
Public services	0.6	2	2

Source: IFPRI model for Mexico – Rebecca Lee Harris and David Coady

Household consumption elasticities and Frisch Parameter

	Non-oport non-poor urban male hhd	Non-oport non-poor urban female hhd	Oport non-poor urban male hhd	Oport non-poor urban female hhd	Oport poor urban male hhd	Oport poor urban female hhd	Oport poor rural male hhd	Oport poor rural female hhd	Oport non-poor rural male hhd	Oport non-poor rural female hhd	Non-oport poor urban male hhd	Non-oport poor urban female hhd	Non-oport poor rural male hhd	Non-oport poor rural female hhd	Non-oport non-poor rural male hhd	Non-oport non-poor rural female hhd
Frisch parameter	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
Agriculture, livestock, forestry, fishing, hunting	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Mining	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Electricity, water and gas provision	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Construction	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Manufacturing	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Trade	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Transport, mail and storage	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Media	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Financial and insurance services	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Profesional, scientific and technical services	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Education	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Health and social assistance	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Other private services	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Public services	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Source: IFPRI model for Mexico – Rebecca Lee Harris and David Coady

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