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**The Impact of *Oportunidades* on Human Capital and
Income Distribution**

A Top-Down/Bottom-Up Approach

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ABSTRACT

In an effort to inform social policy in Mexico, this paper analyzes the effects of a major social program on school attendance and household income distribution, accounting for its partial and general equilibrium effects. Linking a microeconomic simulation model and a general equilibrium model in a bidirectional way, the paper explicitly takes spillover effects of the *Oportunidades* conditional cash transfer program into account. Our results suggest that partial equilibrium analysis alone may underestimate the distributional effects of the program. Extending the coverage of the program leads to a significant increase in school attendance, which reduces labor supply and increases the equilibrium wages of the children who remain at work. This general equilibrium effect indirectly reduces income inequality and poverty at the national level.

Keywords: computable general equilibrium (CGE), microsimulation, Oportunidades, child-work, income inequality, poverty

JEL classification: O22; D31; D58

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1. INTRODUCTION

The *Oportunidades* conditional cash transfer (CCT) program is estimated to transfer 14 billion Mexican pesos (Mexico, Ministry of Finance 2011), or 1.1 billion U.S. dollars, per year, reaching 5.8 million households (SEDESOL 2012) and representing a substantial source of income for the poor. As such, it is a major social program of the Mexican government. A successor to PROGRESA (*Programa de Educacion, Salud y Alimentacion*, the Education, Health and Nutrition Program), *Oportunidades* has attracted national and international attention (World Bank 2006). The program aims to develop the human capital of poor households (Skoufias 2005) by providing cash transfers under the condition that households behave consistently with the accumulation of human capital. The program has three components—education, nutrition, and health—with education the largest (Azevedo and Robles 2010). The program is operated by SEDESOL (*Secretaría de Desarrollo Social*, the Social Development Secretariat) and seeks to eliminate the intergenerational transmission of poverty. *Oportunidades* cash transfers are individually delivered to the mothers of children of school age and vary depending on the number of children enrolled in school and their grade levels, and their attendance at health centers. All mothers participating in the program are informed with individually delivered pamphlets that the benefits of *Oportunidades* are not conditioned on participation in any political event or voting for any political party, and the rules of the program and the number of beneficiary families by locality, municipality, and state are available on the Internet¹ and in the Federal Register (Levy 2006).

Extensive evaluation of the program (Schultz 2004; Parker 2005; Behrman, Sengupta, and Todd 2005; Levy 2006) has led to a consensus that the program enhances welfare in several dimensions: nutrition (Attanazio and Angelucci 2009; Hoddinot, Skoufias, and Washburn 2003); health (Gertler 2004), and school attendance and incomes of the poor (Azevedo and Robles 2010).

Azevedo and Robles (2010) examine the effects of *Oportunidades* using the microsimulation model developed by Bourguignon, Ferreira, and Leite (2003) (BFL henceforth) to analyze the partial equilibrium effects of the transfers on children's time allocation, relaxing its identifying assumption, and applying it to *Oportunidades*. They find that increasing school attendance for higher-grade-level students could be relatively expensive, while shifting the subsidies from children in primary education to students in advanced grades could raise overall school enrollment in Mexico with no additional cost for the program.

However, national-scale CCTs in support of the poor can have important indirect general equilibrium effects. Only a combined macro-micro model is able to fully take these effects into account (Bourguignon, Bussolo, and Cockburn 2010, 1). This paper analyzes the impact of the educational *Oportunidades* transfer on child labor supply, income distribution, and poverty by explicitly taking the program's spillover effects into account. To our knowledge, this is the first study to link the BFL behavioral microsimulation model to a countrywide computable general equilibrium (CGE) model that considers the general equilibrium effects of the program. Using this integrated model and a comparative statics approach, our study takes a series of snapshots of observed and counterfactual scenarios in order to shed light on the effects of the *Oportunidades* program—effects that are actually perceived over time by the Mexican inhabitants. Ultimately, this paper hopes to contribute to the design of social policy by informing the decisionmaking process using a combined macro-micro model.

The paper is organized as follows. The next section provides a review of relevant macro-micro modeling approaches. Section 3 develops a framework for a macro-micro model that explicitly captures CCTs and allows the macro and micro components of the model to communicate iteratively in a bidirectional way until converging on a joint equilibrium. Section 4 applies the combined macro-micro model to the Mexican *Oportunidades* CCT program. The section also contrasts the general with the partial equilibrium effects of the program. The final section concludes by deriving policy implications and highlighting some limitations of our modeling approach. Separate appendixes describe the specification of the CGE model (Appendix A) and sensitivity analysis of critical model parameters (Appendix B).

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¹ Available at www.oportunidades.gob.mx.

2. THE INTERACTION BETWEEN MICRO AND MACRO 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 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, 78). Early microsimulation studies were focused primarily on wage distributions (Diaz Bonilla 2005). Almeida dos Reis and Paes de Barros (1991) considered the effect of education on the wage distribution in Brazil; Juhn, Murphy, and Pierce (1993) analyzed wage differentials in the United States from 1963 to 1989; and Blau and Khan (1996) explain the excess of U.S. wage differentials compared to other Organization for Economic Cooperation and Development (OECD) countries during the 1980s. The second phase of microsimulations focuses on extending their application beyond wage distributions and analyzing, for instance, the impact of different tax regimes on income distribution at the household level (Bourguignon and Ferreira 2003). Currently, household- or individual-level data are combined with data at a higher level, such as the sector, market, or economy. This allows the researchers to, among other things, simulate the effects of economywide policies and shocks on a sample of economic agents, including individuals, households, and firms, which enables evaluation of the full distributional impact of these events.

Figure 2.1 illustrates that 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 (the integrated approach), so that a single model reflects relevant micro and macro behavior in the economy under analysis (Cogneau and Robilliard 2006; Cockburn 2006; Cockburn, Corong, and Cororaton 2010). For example, Cockburn, Corong, and Cororaton (2010) replace the information on the incomes and expenditures of the representative household groups in the CGE model by those observed in a household survey, and so aim to conduct an explicit analysis of the poverty impact of macroeconomic shocks on each sampled household using a single integrated model.

Figure 2.1—Macro-micro modeling approaches

Source: Authors' elaboration based on literature review.

Alternatively, the macro and the micro models can be layered, in the sense that the two models are kept as different entities and some degree of communication between them is accounted for. For instance, simulated percentage changes in factor wages may be endogenous in the macro model and communicated to the micro model, where wages are exogenous. In the layered approach, the microsimulation model can be behavioral, that is, it can reflect individuals' behavior (the layered behavioral approach), or not (the layered nonbehavioral approach). Models in the layered nonbehavioral approach have been applied in different ways. Boccanfuso, Decaluwe, and Savard (2008) assume a given probability distribution function for the household incomes within a representative household group and transmit the change in the mean income of the representative household group to the probability distribution function; Vos and Sanchez (2010) adapt the method used by Almeida dos Reis and Paes de Barros (1991) to allow individuals to change their labor market status by randomly selecting individuals to change labor status consistently with the macro figures predicted by the CGE model, leaving the behavior of the individuals unexplained; Herault (2010) proceeds by altering the sample 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 the selected behavior under analysis (for example, labor supply), and the parameters of the model are econometrically estimated. The behavioral approach has been applied in *top-down* and *top-down/bottom-up* fashion. In the top-down approach, 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, and Robinson (2004); Bourguignon, Ferreira, and Leite (2002), and Debowicz (2010). In the top-down/bottom-up approach, first suggested by Savard (2003), the communication is bilateral and iterative, from the micro model 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 behavioral responses of households and the CGE model to generate a vector of commodity prices and factor wages equilibrating the associated markets, which are, in turn, communicated to the microsimulation model. In this case, the micro-household responses are aggregated and fed back into the CGE model, which communicates in an iterative way with the microsimulation model until they converge on a joint equilibrium solution (Savard 2003; Cury et al. 2010).

The extent of integration between the macro and micro models is among the most important modeling choices that a macro-micro modeler makes (Bourguignon, Bussolo, and Cockburn 2010). While the integrated approach is theoretically more transparent (Davies 2009), it is 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, 117). While the implementation of Orcutt's vision is an area under intense exploration in the context of agent-based models,² the integrated approach raises the difficult question of how to deal with micro data that do 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, 89). Regarding the micro specification, integrated models tend to have a relatively aggregated labor market, probably reflecting that the production functions typically used in CGE models—Cobb-Douglas, constant elasticity of substitution (CES), and Leontief—would generate unrealistic results if they were informed by individual-specific labor supply. Explicitly including individual-level labor use in the production functions would not only give an 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 the consistency between data available at the micro and macro levels improves and agent-based

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² Agent-based models (also referred to as 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, 66).

³ In the case of Mexico, for example, we find that macro consumption is more than five times the sample-weighted sum of micro-level consumption.

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 or Leontief production function, irrespective of how large other inputs are.

models evolve, the layered approach presents an interesting and promising alternative, which is advantageous when the goal is to analyze short-term distributional impacts in settings where realism is placed at a premium against theoretical niceties (Davies 2009, 56). In addition, the layered approach allows the researcher to bypass the problem of identifying the heterogeneity of factor endowments and preferences at the level of single households or individuals, which are needed to inform an integrated model (Bourguignon, Robilliard, and Robinson 2004, 3).

Among the layered approaches, although the nonbehavioral approach is less data and time demanding, only the behavioral approach is able to take full account of the heterogeneity of the economic agents as observed in micro-datasets and identify with precision who are likely to be the winners and losers following an economic policy or external shock. While the nonbehavioral approach ignores the link between individual attributes and their outcomes (Vos and Sanchez 2010), the behavioral approach takes the full heterogeneity of economic agents observed in micro-datasets into account and thus has a comparative advantage in terms of policy implications (Bourguignon, Robilliard, and Robinson 2010, 4). Modeling the communication between the different spheres of the economy in an iterative bidirectional way (top-down/bottom-up approach) allows the researcher to explore the full effects of programs that, despite being targeted at the household or individual level, are, given their national scale, expected to affect income distribution and poverty via the interaction of direct partial and indirect general equilibrium channels.

In light of the domain of applicability of the existent macro-micro approaches, we proceed now to design and calibrate a macro-micro model suitable to the assessment of the general equilibrium distributional effects generated by national-scale CCT programs.

3. MODEL

In the case of national-scale CCTs in support of the poor, where “the indirect general equilibrium effects are too significant to be dismissed,” a macro-micro approach is called for to analyze distributional impacts (Bourguignon, Bussolo, and Cockburn 2010, 1). Since one of the main goals of the *Oportunidades* program is to increase human capital by raising school attendance, this transmission channel needs to be taken into account when modeling the distributional impact of the program. In order to capture how changes in the allocation of children’s time lead to general equilibrium effects at the national level, which again affect children’s time allocation, the micro model needs to communicate to the macro model and vice versa.

The combined model must capture two main transmission channels:

1. *Occupational effect*: Changes in the coverage of the program, in the program design, or in child wages lead some households to reallocate the time of their children between school and work. This affects labor supply as well as transfer income and thus total disposable household income.
2. *Wage effect*: As some children withdraw from (or enter into) the labor market—in response to changes in the program design or other factors—the child labor supply falls (rises), excess demand (supply) for child labor will be generated, and, through the equilibrium of the child labor market, the average general equilibrium real wage that children who remain at work are able to receive will rise (fall), with an additional effect on total disposable household income.

While direct effects of changes in the program design on occupation can be captured by a microsimulation model, in order to capture the wage effect we need to link the microsimulation model to a macrosimulation model. The combined model should also account for the effect of the transfers on the fiscal balance and for the effect of changes in child labor supply on production. The IFPRI (International Food Policy Research Institute) Standard CGE Model satisfies these requirements.

The model used in this paper contributes to linking microsimulations to macroeconomic CGE models in the context of a CCT program. To our knowledge, this is the first attempt to link an econometric-based microsimulation model that explicitly accounts for the conditionality of cash transfers to a macroeconomic model. The combined model allows the identification of the expected direct and indirect effects of the CCTs on children’s time allocation, as well as the contemporaneous expected effects on income distribution and poverty.

Our model combines a microsimulation model with a macro CGE model using the top-down/bottom-up methodology developed by Savard (2003). The microsimulation model closely follows Bourguignon, Ferreira, and Leite’s (2003) model. The macro model is based on the IFPRI Standard CGE Model (Diao, et al. 2011), a model that captures relevant characteristics of developing economies and allows the researcher to track the effects of a variety of counterfactual scenarios on the commodity and factor markets and the income distribution of a countrywide economy.

Our study is in line with Cury et al. (2010), who also use a top-down/bottom-up macro-micro model and apply it to a cash transfer program (*Bolsa Familia* in Brazil). The model used in their study does not capture how the conditionality of the transfers affects children’s school attendance. Our microsimulation model explicitly captures the effect of conditionality on the time allocation of potential beneficiary children.

Several recent micro-empirical studies analyze indirect effects of CCT programs using ex post evaluation methods. For instance, Angelucci and De Giorgi (2008) analyze the impact of PROGRESA on consumption, accounting for nonbeneficiary families’ increase in consumption due to their increased capacity to borrow money resulting from the beneficiary households’ increased income. They find the impact of the program on consumption to be about 12 percent higher when these indirect effects of the program are taken into account. They do not find significant differences in labor earnings between treated and control households, suggesting that the reduction in child and adult labor supply for the treated is

likely to be too small to trigger a significant general equilibrium wage effect. Studying the impact of CCT programs on adult labor supply, Alzúa, Cruces, and Ripani (2012) find some evidence that PROGRESA decreased adult female labor supply and shifted adult male labor supply toward agricultural activities in control households. Still, they find the program to have increased average hourly wages for men in treatment communities by about 7.5 percent. Several other studies also suggest no significant impact of PROGRESA on adult labor supply (Skoufias and di Maro 2006; Skoufias and Parker 2001). Gertler, Martinez, and Rubio-Codina (2012) analyze the impact of PROGRESA on long-term consumption, considering its indirect impact on productive investments in rural Mexico. Controlling for baseline agricultural assets, they find that treatment households were more likely to acquire agricultural investment goods and diversify incomes. Four years after the initiation of the program, consumption had increased for initial treatment households by 5.6 percent (after the control group was also brought into the program).

Our study complements these studies in various ways. First, we are using an *ex ante* evaluation technique at the micro level that allows us to explore the impact of potential changes to the program design, which would not be possible with an *ex post* technique. Second, in linking the BFL and IFPRI models bidirectionally, we fully take into account the effects of the conditional transfers on children's time allocation and household income, the subsequent effects on the factor and commodity markets, and the continuous feedback from the countrywide markets to households' behavior and incomes. In our model, the child and adult labor markets are interlinked. Child labor is only imperfectly substitutable with other factors, so potential changes in the program design significantly affect the child labor market-clearing wage without substantially altering the total production of the economy, given the small contribution of child labor to national income. As illustrated in Figure 3.1, we link the IFPRI and BFL models iteratively in the following way:

1. Changes in the design of the *Oportunidades* transfers are transmitted to both the macroeconomic CGE and the microsimulation model—the former at the representative household level and the latter at the sampled individual level.
2. The microsimulation model generates a childwise time allocation between school and work and communicates it in an aggregated way, as a percentage change in the supply of child labor, to the CGE model, where the child labor supply is treated as exogenous.
3. The CGE model generates a new general equilibrium solution and transmits the percentage changes in the average wage of the children (w_{CHILD}) and in other household incomes (Y_{-i}), to the microsimulation model, where these variables are exogenous.
4. Steps 2 and 3 are repeated iteratively in a loop until the two models converge on a joint solution and the economy reaches a new equilibrium in all its factor and commodity markets.

Figure 3.1—Modeling *Oportunidades* conditional cash transfers (CCTs): Our macro-micro modeling approach

Source: Authors' elaboration based on transmission channels in the macro-micro model.

Microsimulation Model

We adapt the methodology of BFL to the case of *Oportunidades*. In this model, each child i chooses among the following occupational alternatives (j): work ($j = 0$), work and attend school ($j = 1$), and attend school ($j = 2$). Child i will take occupational choice k if and only if the utility of alternative k exceeds that of the other alternatives j :

$$O_i = k \text{ iff } U_i(k) > U_i(j) \text{ for } j \neq k. (1)$$

Following the additive random utility model, the utility of each alternative is composed of a deterministic ($F_j(\cdot)$) and a random component (v_{ij}) that reflects unobservable characteristics affecting occupational choice (Amemiya and Shimono 1989). The deterministic component of occupational choice depends on child-specific characteristics (C_i), such as age, and household-specific characteristics (H_i), as well as the sum of the choice-specific income of the child (y_{ij}) and other income of the household (Y_{-i}):

$$U_i(j) = F_j(C_i, H_i; y_{ij} + Y_{-i}) + v_{ij}. (2)$$

Linearizing the utility function and collecting all nonincome covariates into a single vector (Z_i), we can rewrite the latent utility function of choice j as

$$U_i(j) = Z_i' \gamma_j + (Y_{-i} + y_{ij}) \alpha_j + v_{ij}. (3)$$

The child's contribution to overall household income, y_{ij} , is a function of the market wage, w_i . For children in alternative 0 who work in the market and help at home—for example, by helping in the preparation of goods to be sold in a family business or on domestic tasks that may release time other household members can spend on income-generating activities— w_i would underestimate the children's contribution to overall household income y_{i0} . A way to account for the child's domestic contribution to

overall household income is to multiply the market income by a constant (K), so that $y_{i0} = Kw_i$. If $K > 1$, the child's contribution to overall household income exceeds the market income. Given the absence of relevant data to proceed otherwise, we assume that children working in the market and not attending school do not contribute to domestic activities and that their contribution to overall household income is equal to their market wage (that is, $K = 1$), so that

$$y_{i0} = w_i. \quad (4)$$

For a child working and going to school, his remuneration in the labor market is likely to be below what he would receive if he were only to work, because he spends less time working in the market. To capture how child-specific characteristics and occupational choices affect market wages, we assume that the wage is a log-linear function of child-specific characteristics X_i , of a binary variable that takes the value of 1 if the child is working and attending school, $O_{i1} = 1$, and of unobservable child or household specific characteristics (u_i):

$$\ln w_i = X_i' \delta + mO_{ij} + u_i, \quad (5)$$

with $j = 0, 1$. The coefficient m captures the effect on market earnings of children working less than full-time. Accordingly, $M = e^m$ captures the fraction of the market income that the child receives after this reduction. The income contribution of choosing alternative 1 is thus defined as

$$y_{i1} = My_{i0} = Mw_i. \quad (6)$$

A child only going to school is likely to contribute only a fraction (D) of the income she could earn in the market working full-time, as attending school does not yield any immediate economic returns to the household and she can only help at home when not attending school:

$$y_{i2} = Dy_{i0} = Dw_i. \quad (7)$$

Rewriting the utility function in terms of the market wage (w_i) to allow the determinants of occupational choice to be common to the available occupational choices:

$$U_i(j) = Z_i' \gamma_j + Y_{-i} \alpha_j + w_i \beta_j + v_{ij}, \quad (8)$$

Where

$$\beta_0 = \alpha_0, \quad (9)$$

$$\beta_1 = \alpha_1 M, \text{ and} \quad (10)$$

$$\beta_2 = \alpha_2 D. \quad (11)$$

Data and Parameter Estimation

The data we use come from the Mexican *Encuesta Nacional de Ingresos y Gastos de los Hogares* (ENIGH, the National Household Income and Expenditure Survey) 2008, provided by the *Instituto Nacional de Estadística y Geografía* (INEGI, the National Institute of Statistics and Geography). ENIGH 2008 is a national representative household survey that includes information on labor and other factor earnings, transfers, and consumption and allows the identification of households that participate in *Oportunidades*. The survey asks household members about their nonlabor income sources, including *Oportunidades* transfers, and it notes whether any child receives a scholarship from the program. This allows us to construct a measure of the scholarship component of the program using the program rules described in Table 3.1.

Table 3.1—*Oportunidades* scholarship by education level and gender, Mexican pesos per month, July–December 2008

Primary	Male	Female
Third grade	\$ 130	
Fourth grade	\$ 155	
Fifth grade	\$ 195	
Sixth grade	\$ 265	
Secondary		
First grade	\$ 385	\$ 405
Second grade	\$ 405	\$ 450
Third grade	\$ 430	\$ 495
High school		
First grade	\$ 645	\$ 740
Second grade	\$ 695	\$ 790
Third grade	\$ 735	\$ 840

Source: Secretaría de Desarrollo Social, Diario Oficial, December 29, 2008. 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 attending school we classify her into occupational alternative 0. In the analysis that follows, we also refer to this category as “Work.” We group children who attend school but also report a wage into category 1 (“Work and School”) and children who only attend school into category 2 (“School”). Table 3.2 summarizes the sample distribution of children by occupational choice. The table shows that most of the children study and do not work, but Figure 3.2 illustrates that the occupational composition varies by age group. Around age 12, the choice composition shifts toward increased labor market participation, and the percentage of children who do not attend school increases (see also Azevedo and Robles 2010). Table 3.3 shows selected characteristics of the children and their households by occupational choice. It highlights that children who are not studying tend to be older, have a higher probability of living in a rural area, and live in households where the head has fewer years of schooling.

Table 3.2—Distribution of children by occupational choice

Distribution of children by occupational choice		
Choice	Number of Children	Percentage
Not Studying	3,176,218	11.8
Work and School	1,431,794	5.3
School Only	22,316,774	82.9
Total	26,924,786	100.0

Source: Population-weighted statistics calculated by authors based on ENIGH 2008.

Figure 3.2—Occupational choice of children by age

Source: Authors' calculations based on ENIGH 2008.

Table 3.3—Summary statistics by occupational choice of children, sample averages

	Not Studying	Work and School	School Only
Wage (Mexican pesos per year)	7,275	6,189	0
Total household income (Mexican pesos per year)	109,709	133,661	140,243
Rural	0.40	0.26	0.28
Age (years)	15.11	12.49	10.98
Male	0.53	0.65	0.50
Years of schooling	6.74	6.01	4.68
No. children $0 \leq \text{age} \leq 5$	0.57	0.50	0.52
No. children $6 \leq \text{age} \leq 12$	1.06	1.33	1.48
No. children $13 \leq \text{age} \leq 17$	1.68	1.14	0.94
No. people age ≥ 18	2.94	2.56	2.63
Education head (years)	4.77	6.92	7.59
Education spouse of head (years)	3.50	5.37	5.96
Age head (years)	45.93	43.34	43.61
Age spouse of head (years)	32.51	30.38	32.10
Female-headed household	0.24	0.26	0.21
Rank ^a	2.04	2.02	2.12
Observations	3,543	1,702	25,086

Source: Authors' calculations based on ENIGH 2008.

Note: ^a Position in the household.

For the microsimulation model, we need to estimate potential wages for those who do not report a wage. Prior to estimation, we convert all the income figures into monthly thousands of Mexican pesos. Table 3.4 summarizes the results of the estimation of Equation (5) by ordinary least squares (OLS). Column 1 reports the results for all children and Column 2 for those aged 12 and above. We find that, controlling for observable characteristics, children who go to school and work earn 64 percent less income than those who only work. Accordingly, our parameter estimate of M is $M = \exp(-0.644) = 0.525$. The results also show that local labor market conditions (proxied by the average wage in the rural or urban part of the state the household is located in) affect child earnings, that boys earn more than girls, that children in female-headed households earn more than those in male-headed households, and that *ceteris paribus* living in the Noroeste region increases earnings relative to living in the Suroeste region. We impute wages for those not declaring income using the predictions from the wage regression and its root mean square error to inform randomly drawn error terms from a normal distribution.

Table 3.4—Ordinary least squares (OLS) child earnings estimates

Dependent variable: log wage		
	(1)	(2)
	6 to 17 years old	12 to 17 years old
Work and school	-0.644*** (0.060)	-0.593*** (0.058)
Years of schooling	0.009 (0.044)	0.153*** (0.047)
Years of schooling^2	-0.001 (0.003)	-0.012*** (0.003)
Age	0.389*** (0.090)	0.366 (0.334)
Age^2	0.001 (0.003)	-0.001 (0.011)
Male	0.214*** (0.048)	0.213*** (0.053)
Female head	0.135*** (0.052)	0.127** (0.056)
Rural	-0.243*** (0.051)	-0.326*** (0.054)
Log state wages	0.346*** (0.064)	0.438*** (0.072)
Noreste region	0.219 (0.152)	0.096 (0.166)
Noroeste region	0.306*** (0.100)	0.337*** (0.108)
Occidente region	0.151 (0.103)	0.167 (0.111)
Oriente region	-0.062 (0.112)	0.053 (0.115)
Centronorte region	0.122 (0.099)	0.110 (0.104)
Centrosur region	0.178* (0.101)	0.206** (0.105)
Sureste region	-0.023 (0.100)	0.141 (0.107)
Constant	-5.882*** (0.528)	-5.086** (2.484)
Observations	3,021	2,285
R-squared	0.596	0.262

Source: Authors' estimation based on ENIGH 2008.

Notes: Standard errors in parentheses. *: $p < 0.1$, **: $p < 0.05$, ***: $p < 0.01$.

In the next step, we estimate a multinomial logit model (MNL) to explain children's occupational choice. We choose "Work" as the base category in the analysis that follows. The results of the MNL are summarized in Table 3.5 for all children and in Table 3.6 for children aged 12 and above. The signs of the estimates are as expected. Increasing household income increases the likelihood of studying, as it increases the probability of choosing alternative 1 or 2 relative to alternative 0. The table also shows that girls are more likely than boys to study only; increasing average state-level wages, reflecting high local returns in the labor market, as well as living in a rural area, increase the likelihood of working. We also find intrahousehold difficulties, as captured by a divorce of the household head, to decrease the probability of studying and that increasing (potential) wages reduces the likelihood of studying relative to working. The rank of the child, measured by the (descending) rank order from the oldest to the youngest child among siblings, increases the likelihood of studying. This means that, controlling for the number of household members, having older siblings increases the likelihood of attending school.

Table 3.5—Multinomial logit regression of children's time allocation, all children

	(1) Coefficients		(3) Work	(4) Marginal effects	
	Work & School	School only		Work & School	School only
Potential wage	-0.416*** (0.035)	-0.062*** (0.008)	0.005*** (0.000)	-0.016*** (0.001)	0.011*** (0.001)
Years of schooling	0.000 (0.037)	-0.093*** (0.025)	0.006*** (0.002)	0.004*** (0.001)	-0.010*** (0.002)
Years of schooling^2	0.008** (0.003)	-0.002 (0.002)	0.000 (0.000)	0.000*** (0.000)	-0.000*** (0.000)
No. children 0≤age≤5	-0.058 (0.042)	-0.122*** (0.026)	0.008*** (0.002)	0.002 (0.002)	-0.010*** (0.002)
No. children 6≤age≤12	0.297*** (0.034)	0.289*** (0.022)	-0.018*** (0.001)	0.001 (0.001)	0.017*** (0.002)
No. children 13≤age≤17	-0.613*** (0.043)	-0.705*** (0.025)	0.044*** (0.002)	0.002 (0.002)	-0.046*** (0.002)
No. people age≥18	-0.278*** (0.034)	-0.240*** (0.019)	0.015*** (0.001)	-0.002* (0.001)	-0.013*** (0.002)
Male	0.493*** (0.063)	-0.206*** (0.040)	0.011*** (0.003)	0.031*** (0.002)	-0.042*** (0.003)
Rank of child	0.355*** (0.036)	0.396*** (0.022)	-0.025*** (0.001)	-0.001 (0.001)	0.026*** (0.002)
Other household income	0.019*** (0.004)	0.022*** (0.003)	-0.001*** (0.000)	-0.000 (0.000)	0.001*** (0.000)
Educatio head	0.101*** (0.009)	0.169*** (0.006)	-0.011*** (0.000)	-0.002*** (0.000)	0.013*** (0.001)
Age head	0.006* (0.003)	0.019*** (0.002)	-0.001*** (0.000)	-0.001*** (0.000)	0.002*** (0.000)
Head divorced	-0.137 (0.108)	-0.321*** (0.071)	0.022*** (0.006)	0.008* (0.005)	-0.030*** (0.007)
Rural	-0.412*** (0.073)	-0.211*** (0.045)	0.015*** (0.003)	-0.009*** (0.003)	-0.005 (0.004)
Log state wages	0.411*** (0.089)	-0.157*** (0.054)	0.008** (0.003)	0.025*** (0.003)	-0.033*** (0.005)
Noreste region	-0.160 (0.205)	-0.289** (0.115)	0.020** (0.009)	0.005 (0.009)	-0.025** (0.012)
Noroeste region	0.618*** (0.135)	0.076 (0.082)	-0.007 (0.005)	0.029*** (0.007)	-0.023*** (0.009)
Occidente region	0.371*** (0.144)	-0.153* (0.087)	0.008 (0.006)	0.027*** (0.008)	-0.035*** (0.010)
Oriente region	0.253 (0.154)	0.171* (0.090)	-0.010** (0.005)	0.004 (0.006)	0.006 (0.008)
Centronorte region	0.112 (0.138)	-0.068 (0.080)	0.004 (0.005)	0.008 (0.006)	-0.012 (0.008)
Centrosur region	0.042 (0.140)	0.153* (0.080)	-0.009* (0.005)	-0.004 (0.005)	0.013* (0.007)
Sureste region	0.631*** (0.136)	0.108 (0.081)	-0.008* (0.005)	0.029*** (0.008)	-0.020** (0.009)
Constant	-0.736** (0.332)	0.821*** (0.205)			
Observations	30,331	30,331	30,331	30,331	30,331

Source: Authors' estimation based on ENIGH 2008.

Notes: Standard errors in parentheses. *: p < 0.1, **: p < 0.05, ***: p < 0.01.

Table 3.6—Multinomial logit regression of children's time allocation, 12 years old and above

	(1) Multinomial logit estimates Work & School	(2) School only	(3) Not studying	(4) Marginal effects Work & School	(5) School only
Potential wage	-0.405*** (0.036)	-0.057*** (0.008)	0.011*** (0.001)	-0.017*** (0.002)	0.006*** (0.002)
Years of schooling	0.554*** (0.110)	0.770*** (0.049)	-0.109*** (0.007)	-0.004 (0.005)	0.112*** (0.009)
Years of schooling^2	-0.018** (0.007)	-0.048*** (0.003)	0.007*** (0.000)	0.001*** (0.000)	-0.008*** (0.001)
No. children 0≤age≤5	-0.068 (0.056)	-0.154*** (0.030)	0.021*** (0.004)	0.003 (0.002)	-0.024*** (0.005)
No. children 6≤age≤12	0.184*** (0.042)	0.265*** (0.024)	-0.037*** (0.003)	-0.002 (0.002)	0.039*** (0.004)
No. children 13≤age≤17	-0.302*** (0.051)	-0.530*** (0.028)	0.074*** (0.004)	0.006*** (0.002)	-0.080*** (0.005)
No. people age≥18	-0.306*** (0.046)	-0.321*** (0.024)	0.046*** (0.003)	-0.002 (0.002)	-0.044*** (0.004)
Male	0.749*** (0.079)	-0.186*** (0.044)	0.018*** (0.006)	0.044*** (0.004)	-0.062*** (0.007)
Rank of child	0.343*** (0.051)	0.440*** (0.027)	-0.062*** (0.004)	-0.001 (0.002)	0.063*** (0.004)
Other household income	0.013*** (0.005)	0.022*** (0.004)	-0.003*** (0.000)	-0.000 (0.000)	0.003*** (0.001)
Education head	0.074*** (0.011)	0.156*** (0.007)	-0.022*** (0.001)	-0.003*** (0.000)	0.024*** (0.001)
Age head	0.010** (0.004)	0.024*** (0.002)	-0.003*** (0.000)	-0.000** (0.000)	0.004*** (0.000)
Head divorced	-0.200 (0.133)	-0.297*** (0.078)	0.045*** (0.013)	0.002 (0.006)	-0.047*** (0.014)
Rural	-0.557*** (0.092)	-0.258*** (0.050)	0.041*** (0.008)	-0.016*** (0.004)	-0.025*** (0.008)
Log state wage	0.614*** (0.113)	-0.129** (0.060)	0.012 (0.008)	0.035*** (0.005)	-0.047*** (0.009)
Noreste	-0.739*** (0.273)	-0.471*** (0.127)	0.080*** (0.023)	-0.015* (0.009)	-0.065*** (0.024)
Noroeste	0.163 (0.167)	-0.028 (0.091)	0.002 (0.013)	0.009 (0.008)	-0.012 (0.015)
Occidente	-0.004 (0.176)	-0.300*** (0.098)	0.043*** (0.016)	0.012 (0.009)	-0.055*** (0.017)
Oriente	0.151 (0.183)	0.011 (0.100)	-0.003 (0.014)	0.007 (0.009)	-0.004 (0.016)
Centronorte	-0.246 (0.167)	-0.285*** (0.090)	0.043*** (0.014)	-0.001 (0.007)	-0.042*** (0.015)
Centrosur	-0.199 (0.166)	-0.108 (0.089)	0.017 (0.013)	-0.005 (0.007)	-0.012 (0.014)
Sureste	0.347** (0.167)	0.094 (0.092)	-0.016 (0.012)	0.014 (0.009)	0.001 (0.014)
Constant	-3.211*** (0.590)	-3.192*** (0.281)			
Observations	15,357	15,357	15,357	15,357	15,357

Source: Authors' estimation based on ENIGH 2008.

Note: Standard errors in parentheses. *: $p < 0.1$, **: $p < 0.05$, ***: $p < 0.01$.

Once the wage and the occupational choice equations have been estimated, the parameters and initial values of the microsimulation model can be determined. The conditional cash transfer, CCT_{ij} , raises other household income Y_{-i} of school attendants (alternatives 1 and 2). Assuming that children not attending school receive no transfer, and each school attendant receives a transfer (T_i) that varies by age and gender, then $CCT_{i0} = 0$ and $CCT_{i1} = CCT_{i2} = T_i$, Equation (8) can be rewritten as

$$U_i(j) = Z_i\gamma_j + (Y_{-i} + CCT_{ij})\alpha_j + w_i\beta_j + v_{ij} \text{ with } CCT_{i0} = 0 \text{ and } CCT_{i1} = CCT_{i2} = T_i. \quad (12)$$

The MNL allows identifying $(\gamma_j - \gamma_0), (\alpha_j - \alpha_0), (\beta_j - \beta_0)$ for nonalternative specific covariates. Following BFL, and using the OLS parameter estimate of M and Equations (9) to (11), we can recover α_j, β_j , and γ_j for $j = 0, 1, 2$. Our parameter estimates of household income Y_{-i} in alternatives 1 and 2 are $a_1 = \alpha_1 - \alpha_0 = 0.019$ and $a_2 = \alpha_2 - \alpha_0 = 0.022$, respectively. $M = 0.5254$, and our estimates of potential wages in alternatives 1 and 2 are $b_1 = \beta_1 - \beta_0 = -0.416$ and $b_2 = \beta_2 - \beta_0 = -0.062$, respectively. Solving for the parameters of interest yields

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

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

$$\alpha_0 = \alpha_2 - a_2 = 0.8968, \text{ and}$$

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

Once all the elements in the deterministic part of the utility function have been identified, and assuming for convenience that $U_i(0) = 0$, the unobservables $v_{ij} - v_{i0}$ are randomly drawn from an MNL distribution assuring consistency with the observed child's occupational choices.

The determinants of the latent utility are identified for each child and occupational choice, and the utility function allows the simulation of child labor supply responses to changes in the design of CCTs or changes in other determinants of utility such as children's wages or other household income.

Interpretation of the Parameter Estimates $\alpha_0, \alpha_1, \alpha_2, b_1$, and b_2

Using Equation (12), we determine the benchmark utility level of each nonzero alternative for each child (U_{1i}^b, U_{2i}^b). Then we microsimulate the changes in these utility levels after each proposed policy scenario. The child-specific simulated change in the utility level of alternative 1 (2) $-\Delta U_{1i}^s$ (ΔU_{2i}^s)- is linearly determined by the simulated changes in the CCT (ΔCCT_i^s) and the wage (Δw_i^s) and the other household income (ΔY_{-i}^s) that can be received in each alternative. In our notation, this implies $\Delta U_{1i}^s = b_1 \Delta w_i^s + \alpha_1 \Delta CCT_i^s + (\alpha_1 - \alpha_0) \Delta Y_{-i}^s$ and $\Delta U_{2i}^s = b_2 \Delta w_i^s + \alpha_2 \Delta CCT_i^s + (\alpha_2 - \alpha_0) \Delta Y_{-i}^s$. Finally, the simulated utility levels can be generated adding the simulated changes to the original levels: $U_{1i}^s = U_{1i}^b + \Delta U_{1i}^s$ and $U_{2i}^s = U_{2i}^b + \Delta U_{2i}^s$, which enables child-specific comparisons of the utility of each alternative and associated occupational choice.

Offering a CCT of amount T_i changes household incomes for those alternatives where the child attends school (1 and 2) and alters the utility of those alternatives by $\alpha_1 T_i$ (alternative 1) and $\alpha_2 T_i$ (alternative 2). Given that the estimated parameter $\alpha_2 > \alpha_1 > 0$, the conditional transfer increases the utility of alternatives 1 and (even more) of alternative 2. This makes the school alternatives more desirable than originally and increases the utility of choosing to attend school relative to the work-and-school alternative.

Similarly, increasing the wage by an absolute amount of Δw_i raises child and household income in the work-including alternatives (0 and 1). Given that $b_1 < b_2 < 0$, the utility of alternative 0 ("Work") rises relative to alternative 1 ("Work and School") and 2 ("School"), making alternative 0 ("Work") relatively more desirable than before and alternative 1 ("Work and School") less desirable than before the

wage rise. Presumably due to counteracting income and substitution effects, the utility of the “Work and School” alternative falls relative to the utility generated by the other alternatives, shifting some children in the direction of school only and some in the direction of work only. As a consequence, the effect of changes in the wage on the total supply of child labor cannot be determined prior to conducting the simulations.

There are several limitations to our microsimulation model, as pointed out by BFL. First, whether the children can be taken as decisionmakers—whether their parents decide or parents and children decide together about the children’s occupational choices—depends on whether children can be modeled as household production goods, consumption goods, or decisionmakers within the household. In addition, the model assumes that intrahousehold labor supply decisions are made independently by each individual within the household and ignores issues of simultaneity of labor supply responses among siblings. In all of the above, we assumed that the children or their households are solely responsible for their occupational choices, for the sake of simplifying the illustration. We are aware that in doing so, we ignore existing intrahousehold decisionmaking 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 these potential wages determine the occupational choice. Third, the children’s labor supply decision in the model is taken considering only the opportunity cost of schooling in terms of contemporaneous forgone income, abstracting from the effect of the expected skill premium on the schooling decision, as derivable from the Separation Theorem for human capital investments (Acemoglu and Autor n.d.).⁵

Having described the specification and the calibration of the microsimulation model located at the bottom of our combined macro-micro model, we next describe the macrosimulation model located at the top of the model.

Computable General Equilibrium Model

Following general equilibrium theory, representative consumers (households) and producers in our model are treated as individual economic agents. Households maximize a Stone-Geary utility function, such that their consumer behavior is driven by a linear expenditure system (LES) taking income and commodity prices as given. Sector-specific producers have a CES value-added function with arguments given by child labor, other labor, capital, and land, and choose factor inputs to maximize their expected profits assuming wages and prices are given.

Import and export world prices are given for domestic agents. 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 producers’ profit 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 nonfactor (*Oportunidades* and other transfer) income.

Regarding macroeconomic closures, the model has (1) savings-driven investment with exogenous marginal propensities to save for the households and endogenous investment, (2) exogenous public expenditures and tax rates with endogenous public savings, and (3) exogenous foreign savings with an endogenous real exchange rate. The numeraire of the model is given by the consumer price index (CPI). The model is described in detail in Appendix A.

The Mexican CGE model includes 14 sector-specific producers, 15 production factors, 16 representative household groups, and 10 other accounts (including the *Oportunidades* program), as listed in Box 3.1. Child labor is a specific production factor, and the rest of labor is categorized into production factors according to gender, skill level, and formal or informal status. Households are classified according to poverty status, urban status, gender of the household head, and whether they initially benefit from the *Oportunidades* program.

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⁵ Note that for the Separation Theorem to hold, perfect capital markets would need to be assumed.

Box 3.1—Accounts in Mexican CGE model

Activity Sectors (14)

Agriculture, livestock, forestry, fishing, and hunting; mining; electricity, water, and gas provision by pipe to final consumer; construction; manufacturing; trade; transport, mail, and stocking; information in mass 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 semiskilled informal; male skilled formal; male unskilled formal; male semiskilled formal; female skilled informal; female unskilled informal; female semiskilled informal; female skilled formal; female unskilled formal; female semiskilled formal; child labor

Other (2): Capital; land

Representative Household Groups (16)

Nonrecipient nonpoor urban male; nonrecipient nonpoor urban female; recipient nonpoor urban male; recipient nonpoor urban female; recipient poor urban male; recipient poor urban female; recipient poor rural male; recipient poor rural female; recipient nonpoor rural male; recipient nonpoor rural female; nonrecipient poor urban male; nonrecipient poor urban female; nonrecipient poor rural male; nonrecipient poor rural female; nonrecipient nonpoor rural male; nonrecipient nonpoor rural female

Other Accounts (10)

Government; income tax; import tax; activity tax; *Oportunidades*; rest of transfers from government to households; change in stock; savings investment; rest of the world

Source: Authors' creation.

The parameters of the model are calibrated in light of factor use informed by analysis of ENIGH microdata; the social accounting matrix (SAM) specially prepared for the *Oportunidades* project;⁶ and production, trade, and consumption elasticities present in previous CGE analysis of PROGRESA CCTs in Mexico by Coady and Harris (2001). This meant that the factor demand is assumed to be inelastic, with a CES factor substitution elasticity of 0.6, for which we conduct sensitivity analysis given its centrality for the analysis at stake. Imports and exports are elastic, with Armington and CET elasticities taking values between 2 and 4 (4 for agriculture, livestock, forestry, fishing, and hunting; 3 for mining, electricity, water and gas provision, construction, manufacturing, trade, transport, mail, and storage; and 2 for the remaining activities). The income elasticity in the LES household consumption of commodities is lower for primary goods (0.8) than for industrial goods (1.0) and even lower than for services (1.2), and the Frisch parameter is unitary.

⁶ Available with full documentation at www.ifpri.org/dataset/2008-social-accounting-matrix-mexico.

4. COUNTERFACTUAL SCENARIOS TO ANALYZE THE PROGRAM EFFECTS ON SCHOOLING, INCOME DISTRIBUTION, AND POVERTY

To evaluate the short- and long-term effects of the *Oportunidades* program, starting from a base scenario in which we observe *Oportunidades* transfers received by households in the ENIGH 2008 household survey, we analyze the following three counterfactual scenarios.

In the first scenario (“No Program”), we simulate the absence of all *Oportunidades* (conditional and unconditional) transfers. In comparison to the benchmark scenario, in which the program is in operation under the present rules, this scenario allows us to estimate the effects that the actual program is having on schooling, income distribution, and poverty.

In the second scenario (“Program Expansion”), we extend the coverage of the conditional transfers to all the moderately poor children, applying the existent rule for the amount transferred as a function of grade and gender, as summarized in Table 3.1. This means that any existent transfer is left unchanged, but the coverage of the available CCT is further expanded, with $CCT_i = f(\text{school grade, gender})$ for the moderately poor who initially are not CCT recipients. For children who are not attending school, we design the CCT according to their gender and the school grade they would be attending if they were to attend school, given their latest schooling level and grade completed.

The third and final scenario (“Program Skilling”) accounts for the lagged human capital effect of the existing transfers. In particular, we model that *Oportunidades* increases the average years of schooling of the child population and contributes to increasing the skills of the future workforce, particularly of the households benefitting from the program. We model the lagged human capital effect of the program in a very simple way, assuming that the closest child projection into the future is, where available, the child’s same-gender parent (see McKee and Todd [2009] for a more elaborate application with a different dataset). The program has been found to increase the years of schooling by an additional 0.72 and 0.64 years for girls and boys, respectively (Skoufias 2005). Building on this finding, we add the assumed increment in schooling to the observed years of schooling of each matched parent and round it to a new integer level, generating an adult labor force with a new education structure. We use the resulting measure of schooling to reclassify adults by skill category (unskilled, semiskilled, and skilled). We then simulate the general equilibrium effects of the change in the education structure of the adult labor force. For this, we use the associated percentage changes in gender-specific adult labor supply by skill level to inform the exogenous labor supply parameter of our static CGE model and compare a simulated snapshot using the new adult labor force with the initially observed one. We account for the changes in child and adult wages, and the changed incentives of going to school once the postschool wage has fallen for more educated workers given the increase in their supply due to the program.

For each of the three counterfactual scenarios, we translate the simulated changes in the *Oportunidades* transfer and lagged human capital, and the resulting changes in earnings, into changes in income at the level of the observed households, and compute population-weighted changes in school attendance, household income, Foster-Greer-Thorbecke poverty indicators, and the Gini index considering both partial equilibrium (for the first two simulations) and general equilibrium (for all simulations) effects.

There are several limitations to analyzing poverty and inequality in this way. What seems to matter most are the effects of the program on the lifetime incomes of Mexican households, but our model can only provide a measure of income at given points in time. While the first two simulations focus on the contemporaneous partial and general equilibrium distributional effects, the last simulation focuses on the distributional effects that the existing program may have at some point in the future where the effects of the program on the skill composition of the adult labor force have been fully developed, and the program remains in operation with the existing characteristics, albeit not in a dynamic way.

In principle, there could be significant program effects in the short term on the level of social production and the fiscal balance. Given the small share of child labor income in national income, and the

small share of *Oportunidades* transfers in the total expenditure of the Mexican government, these effects turn out not to be first-order effects. If the *Oportunidades* program leads more children to attend school, the government will probably need to increase spending on public education to maintain educational quality. Our model can only capture public expenditure increments that are directly linked to the program.

School Attendance

Table 4.1 reports changes in the time allocation of children associated with the different counterfactual scenarios. The table is organized as a transition matrix: the columns depict the original occupational choices and the rows the simulated choices generated by the partial equilibrium (first three columns) and general equilibrium (last three columns) effects. Each cell shows the total number of children who take a simulated (row) choice, as a share of the population of children originally in a given (column) choice. For example, if the matrix corresponding to a simulation turned out to be a diagonal one, with 100 in each cell of the main diagonal and 0 in all the other cells, this would mean that the simulation did not alter children's time allocation choices.

Table 4.1—Transition matrix for time allocation of children by simulation and type of equilibrium

No Program:	Partial Equilibrium			General Equilibrium		
	Base Choice			Base Choice		
	Not Studying	Work and School	School Only	Not Studying	Work and School	School Only
Simulated Choice						
Not Studying	100.0	0.3	0.1	100.0	0.0	0.0
Work and School	0.0	99.7	0.0	0.0	99.9	0.0
School Only	0.0	0.0	99.9	0.0	0.1	100.0
Program Expansion:	Partial Equilibrium			General Equilibrium		
	Base Choice			Base Choice		
	Not Studying	Work and School	School Only	Not Studying	Work and School	School Only
Simulated Choice						
Not Studying	87.4	0.0	0.0	87.9	0.5	0.1
Work and School	0.8	100.0	0.0	0.5	96.4	0.0
School Only	11.8	0.0	100.0	11.6	3.1	99.9
Program Skilling:	Partial Equilibrium			General Equilibrium		
	Base Choice			Base Choice		
	Not Studying	Work and School	School Only	Not Studying	Work and School	School Only
Simulated Choice						
Not Studying	--	--	--	99.8	0.0	0.0
Work and School	--	--	--	0.0	99.9	0.0
School Only	--	--	--	0.2	0.1	100.0

Source: Authors' calculation based on ENIGH 2008 and model results.

The table shows that the effect on time allocation of withdrawing all *Oportunidades* transfers (“No Program”) is very small, both ignoring and factoring in the general equilibrium effects of the program. Ignoring general equilibrium effects, only 0.1 percent of those initially only attending school, and 0.3 percent of those originally combining work with school, drop out of school. Incorporating general equilibrium effects, the additional child labor supply allows the economy to increase its output marginally in the short run,⁷ lifting some households' income, and so some households (0.1 percent of those originally combining work and school—in other words, an insignificant 0.003 percent of the total children) stop sending their children to work.

⁷ The effect on the child labor wage proves to be negligible.

In partial equilibrium, extending the program to all the children in moderately poor households (“Program Expansion”) does lead to a substantial increase in school enrollment: 12.6 percent of the children who initially were out of school enroll, and 11.8 percent leave the labor market. The significant change in child labor supply generated by the expansion of the program is not inconsistent with the small change in labor supply generated by the withdrawal of the program, as a significant number of children are in the benchmark only marginally included in the “Work” alternative; in other words, their observable and unobservable characteristics are such that a slight increase in the attractiveness of the school alternative make them enter school. This translates into a 1.5 percentage point increase in the overall school attendance rate, given that the initial figure of children out of school is 11.8 percent (Table 3.2). The effect varies by gender (not tabulated): 1.1 percent of boys who were initially working now also go to school and 11.1 percent go to school only; only 0.3 percent of girls initially working now also go to school and 12.7 percent stop working to attend school.

When we account for the general equilibrium effects of the program, the extension of the coverage has two conceptually different effects. As in partial equilibrium, some children return to school, attracted by the CCT. On top of this schooling effect, more children attending school implies a measurable reduction in child labor supply—of around 12 percent—(occupational effect), which, in turn, leads to an equilibrating rise in the average earnings of children, of 17.8 percent (wage effect). These results are robust to a range of different substitution elasticities among factors in the production functions of the CGE model (see Appendix B). By raising the opportunity cost of schooling, increases in wages ultimately make attending school unintentionally less attractive. The results of the combined macro-micro model on time allocation—summarized in the central part of the table—indicate the presence of two competing forces. First, the transfer increases the attractiveness to households of sending the children to school (given $\alpha_2 > \alpha_1 > \alpha_0 > 0$). Second, a wage effect indirectly generated by the program works in the opposite direction, driving households to send children to work (as $b_1, b_2 < 0$).

While we find that the wage effect leads some children to drop out of school, the magnitude turns out to be insignificant, generating *ceteris paribus* a drop in the attendance rate of less than 0.1 percent, as 0.5 percent of those originally working and studying and 0.1 percent of those originally only studying leave school. For most of the children, the direct occupational effect of *Oportunidades* on time allocation more than offsets the indirect wage effect: 12.1 percent of those initially not studying start going to school, and 3.1 percent of those originally combining work with school stop working to only study. Overall, we find that in general equilibrium an eventual expansion of the coverage of the program would increase the attendance rate by 1.4 percentage points. This finding is only slightly below the 1.5 percentage point increase in school attendance predicted by the partial equilibrium model.

The lagged skilling effect of the *Oportunidades* program (“Program Skilling”) operates through changes in the productivity of the labor force and changes in the real wage in the adult labor market, reducing the adult skill premium but increasing the wages of those who acquire skills, discussed in more detail below. The transition matrix is close to an identity matrix, reflecting that the future change in the skill composition of the adult labor force is not expected to affect the future time allocation of the children in a significant way.

Poverty and Income Distribution

Given the progressive design of the program, the contemporaneous and lagged impacts of the program on income distribution are also progressive, as illustrated in Figures 4.1 and 4.2. The figures show the percentage changes in household income for each centile of adult equivalent income due to the program. In the figures, we order households from poor to rich in terms of adult equivalent income. The different lines in the figure illustrate the simulated impacts on each centile of the income distribution. If a line were to coincide with the horizontal axis, the simulation is not estimated to alter the income distribution. The shape of the depicted lines suggests that the effect on income is substantial for the poorest households but converges towards zero for households at the top of the income distribution. Dropping the program reduces the average income of the poorest households by 23 percent, while extending the program to all

the moderately poor increases incomes by 34 percent, a result of the combination of the increase in the number of poor households receiving the transfer and the positive wage effect benefitting those who keep their children at work. By increasing the future human capital stock of beneficiary households (“Program Skilling”), poor households benefit in two ways. The poor households that increase their human capital benefit directly (given the positive skill premium in the new equilibrium), and the poor household members who remain unskilled also benefit due to the increase in the relative scarcity of unskilled labor in the new equilibrium due to the program. Combining these effects, the program raises the average income of the poorest households by around 23 percent.

Figure 4.1—Change in household per adult equivalent income by centile, no-program and program-expansion simulations, partial and general equilibrium.

Source: Authors’ calculation based on model results.

Figure 4.2—Change in household per adult equivalent income by percentile, program-skilling simulation, general equilibrium

Source: Authors’ calculation based on model results.

Figure 4.1 suggests that the simulated program effects are more pronounced when accounting for the general equilibrium effects of the program. The figure shows that the lines generated by the general equilibrium model are further away from the horizontal axis than those in the partial equilibrium model. An extension of the coverage of the program not only increases the income of beneficiary households but indirectly also increases the marginal productivity and the real wage of child labor in Mexico (wage effect), raising the incomes of the households who keep their children at work. Withdrawing the program would not only generate a direct reduction in household incomes, but by increasing child labor supply and reducing the equilibrium child wages (negative wage effect), it would further reduce the incomes of the poor.

Table 4.2 summarizes the effect of the program on different poverty measures using the national moderate and extreme poverty lines provided by the *Consejo Nacional de Evaluación de la Política del Desarrollo Social* (CONEVAL, the National Council for Evaluation of Social Development Policy) for rural and urban areas, and household adult equivalent incomes (Teruel, Rubalcava, and Santana 2005). The table also summarizes poverty in terms of poverty lines set at US\$1.25 and US\$2 per day. We use the purchasing power parity (PPP) conversion factor provided by the World Bank (2011) to convert the national figures into international terms. While international poverty measures using the US\$1.25- and US\$2-a-day poverty lines are close to our base estimates (World Bank 2011), the national figures deviate. This may be because of differences in the aggregation methodology, for instance, or the use of consumption as opposed to income. Our average quarterly incomes are, however, very close to those reported in official documents using ENIGH 2008, at 36,325 Mexican pesos compared to 36,694 (INEGI 2009).

Table 4.2—Simulated poverty and inequality indicators by simulation and type of equilibrium

Indicator	Base	No Program		Program Expansion		Program Skilling
		Partial	General	Partial	General	General
FGT(0)						
National extreme poverty line	6.7	8.3	8.9	5.7	5.3	5.8
National moderate poverty line	29.2	30.3	31.1	27.4	26.5	27.8
US\$1.25-a-day line	1.7	2.8	3.1	1.2	1.1	1.2
US\$2-a-day line	5.2	6.6	7.0	4.4	4.0	4.4
FGT(1)						
National extreme poverty line	1.9	2.7	2.9	1.5	1.3	1.5
National moderate poverty line	9.9	11.0	11.5	9.0	8.5	9.0
US\$1.25-a-day line	0.4	0.9	1.0	0.3	0.3	0.3
US\$2-a-day line	1.5	2.3	2.5	1.2	1.1	1.2
FGT(2)						
National extreme poverty line	0.8	1.3	1.4	0.6	0.5	0.6
National moderate poverty line	4.8	5.7	6.0	4.2	3.9	4.2
US\$1.25-a-day line	0.2	0.4	0.5	0.1	0.1	0.1
US\$2-a-day line	0.6	1.1	1.3	0.5	0.4	0.5
Gini	0.512	0.520	0.521	0.506	0.501	0.504

Source: Authors' calculation based on ENIGH 2008 and model results.

The results are consistent with our previous findings and also suggest larger effects in general equilibrium than in partial equilibrium: withdrawing the program increases the poverty rate by 1.1 (US\$1.25-a-day poverty line) to 1.6 (national extreme poverty line) percentage points in partial equilibrium, and by 1.8 to 2.2 percentage points in general equilibrium. Expanding the program to all the moderately poor is estimated to significantly reduce the poverty rate, by 1.8 (partial equilibrium) or 2.7 (general equilibrium) percentage points in the case of the national moderate poverty line. Accounting for the lagged human capital effect of the program yields a lagged reduction in the poverty rate of an

additional 1.4 percentage points. The table also suggests that poverty incidence, poverty severity, and inequality also decrease significantly with the program, both in the present and in the future, independently of the measure chosen. Finally, withdrawing the program increases the Gini coefficient from 0.512 to 0.520 (partial equilibrium) or 0.521 (general equilibrium), while increasing the availability of the program to all the moderately poor allows it to drop to 0.506 (partial equilibrium) or 0.501 (general equilibrium). Increasing the skills of the future workforce reduces inequality to 0.504.

The progressivity of the *Oportunidades* transfers has a direct effect at the regional level. In the absence of the program, the average national per capita household income is close to 4,100 Mexican pesos per capita per month, and it is estimated to decrease by 0.6 percent (partial equilibrium) or 1.2 percent (general equilibrium). In the case of the Suroeste region, which has a per capita income of only 2,420 pesos per capita per month, the drop in income reaches 2.7 or 3.5 percentage points, respectively. Similarly, in the Suroeste region the impact of increasing the coverage of the program and capturing the lagged effect on human capital exceeds the national effects, as shown in Figure 4.3.

Figure 4.3—Changes in simulated average per capita monthly incomes relative to the base by region

Source: Authors' calculation based on model results.

5. CONCLUSIONS

National-scale CCT programs in support of the poor can have significant indirect general equilibrium effects. Only a combined macro-micro modeling approach is able to take these effects fully into account when estimating the economic impact of this type of program. This paper combines a microsimulation model with a general equilibrium model, both of which are well established, and solves for an equilibrium that jointly satisfies the utility-maximizing decisions regarding children's time allocation and the equilibrium of the countrywide factor and commodity markets.

Applying the combined model to the *Oportunidades* CCTs in Mexico, we find that the program improves household income distribution and poverty indicators in Mexico, and that an extension of the coverage of the program to all moderately poor households could improve these indicators further. Partial equilibrium analysis alone, which is typically used in program evaluation, may significantly underestimate the distributional effects of the program. In particular, we find that by raising the opportunity cost of work through the provision of transfers conditional on school attendance, expansion of the *Oportunidades* educational transfers to all the moderately poor could reduce the child labor supply and increase the wages earned by children at work, by a double-digit magnitude. The incremental increase in child earnings indirectly benefits poor households that keep their children at work and thus improves contemporaneous poverty and income distribution indicators to a greater extent than partial equilibrium analysis suggests. While a partial equilibrium analysis suggests that the program extension would lead to a 1.8 percentage point contemporaneous decrease in poverty, the poverty-reducing effect of *Oportunidades* reaches 2.7 percentage points once the general equilibrium effects are also taken into account. Our estimates imply that if the Mexican government is able to afford the fiscal cost of extending the program to all the moderately poor and the associated increase in public education expenditure, school attendance would increase by 1.4 percentage points, and the poverty rate would fall by 2.7 percentage points. We also find that an increase in the skills of the future workforce, generated by lagged human capital acquisition through the existing *Oportunidades* program, could increase the future incomes of poor households, reducing the poverty rate by approximately 1.4 percentage points in the long term.

Appropriate recalibration of the parameters of the model we presented allows its application to other national-level CCT programs in developing countries. While advantageous in various ways, the combined model has two serious limitations that future research could overcome. First, the model is static and, as such, does not allow us to trace the time path of the income changes triggered by the program and the corresponding changes in lifetime income. Second, the microsimulation model does not capture existing intrahousehold decisionmaking mechanisms that are potentially important in the determination of children's time allocation and indirectly in determining the distributional effects of the program.

APPENDIX A: THE COMPUTABLE GENERAL EQUILIBRIUM (CGE) MODEL

We describe the model below. We use capital characters for endogenous variables and lowercase 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 (for example, $\overline{FSAV}$ stands for the endogenous variable foreign saving that is kept fixed in the chosen closure).

Production and Consumption Behavior

Following general equilibrium theory, representative consumers (that is, 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:

$$\begin{aligned} \text{Max}_i U_h &= \prod_i (C_{hi} - \gamma_{hi})^{\beta_{hi}} \\ \text{subject to } \sum_i (P_i \cdot C_{hi}) &= (1 - s_h - ty_h)Y_h. \end{aligned}$$

This leads us to generate the linear expenditure system (LES) of demand, that is, the set of demand functions:

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

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 household's 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:

$$X_i = \Lambda_i \left(\sum_f \alpha_{if} \cdot V_{if}^{-\rho_i} \right)^{-1/\rho_i}, \quad (\text{A.2})$$

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 (that is, 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 $\rho_i > 0$ (that is, $\sigma_i = 1/(1+\rho_i)$). Sector-specific profits π_i are defined as the difference between value added and total factor payments:

$$\pi_i = PV_i \cdot X_i - \sum_f (W_f \cdot V_{if}),$$

where PV_i is the value-added component of the producer price, and W_f are factor prices (that is, 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:

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

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_{ij} 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 :

$$PP_i = PV_i + \sum_{i'} P_{i'} io_{i'i}. \quad (A.4)$$

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 (that is, CES function) (Armington 1969) is used to define the relationship between domestically produced and imported goods:

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

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

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

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 import 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 an analogous way:

$$PM_i = EXR(1 + tm_i)pwm_i \text{ and} \quad (A.7)$$

$$PE_i = EXR(1 - te_i)pwe_i, \quad (A.8)$$

with te_i being the export tax rates and pwe_i the world export price 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:

$$(1 - tc_i)P_i \cdot Q_i = PD_i \cdot D_i + PM_i \cdot M_i \text{ and} \quad (A.9)$$

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

Maximizing $P_i Q_i - PD_i D_i - PM_i M_i$ subject to the Armington equation and rearranging the resulting first-order condition gives the following sector-specific equation defining the ratio of domestic production and imports:

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

Similarly, minimizing $PP_i X_i - PD_i D_i - PE_i E_i$ subject to the CET equation gives the ratio of domestic production and exports:

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

Equilibrium Conditions

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

$$\sum_i V_{if} = \overline{VS_f}, \quad (\text{A.13})$$

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.⁸ Also, we allow the supply of child labor to change, with its percentage changes informed by the microsimulation model.

Assuming all factors are owned by households,⁹ the income of each representative household Y_h is determined by the sum of factor income and transfers received by the household from other institutions:

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

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 (for example, corporate taxes imposed on capital profits), and TR_{hn} are net transfers received by household groups from other institutions.

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

$$Q_i = \sum_h C_{ih} + N_i + \bar{G}_i + \sum_{i'} (io_{i'i} \cdot X_{i'}), \quad (\text{A.15})$$

where N_i is investment demand and G_i is government recurrent consumption spending, and where the equilibrating variables of the equations are the relative prices of the goods (that is, 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 revenue GR is the summation of all individual taxes plus transfers received from other agents (for example, foreign transfers):

$$\begin{aligned} GR = & \sum_i (tc_i \cdot P_i \cdot Q_i + tm_i \cdot PM_i \cdot M_i + te_i \cdot PE_i \cdot E_i) \\ & + \sum_h (ty_h \cdot Y_h) + \sum_f (tf_f \cdot W_f \cdot \bar{V}_f) + \sum_n tr_{Gn}. \end{aligned} \quad (\text{A.16})$$

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 (that is, recurrent consumption spending), to transfer to other economic agents, and to save (that is, finance public capital investment), as shown below:

$$GR = \sum_i (P_i \cdot \bar{G}_i) + \sum_n tr_{nG} + GB, \quad (\text{A.17})$$

⁸ To keep the description of the model simple, we focus on the case of fully mobile factors.

⁹ In reality, some factor incomes, for example, 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 nonhousehold factor ownership in order to simplify our discussion.

where G_i is consumption spending from Equation (A.13), TR_{ng} is 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—that is, N_i from Equation (A.13). The total value of all investment spending must equal the total amount of investible funds I in the economy. We therefore assume that the value of N for each good i is in fixed proportion to the total value of investment, as seen below:

$$I \theta_i = P_i \cdot N_i, \quad (\text{A.18})$$

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 (A.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 as 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 :

$$CA = \sum_i (pwe_i \cdot E_i) - \sum_i (pwm_i \cdot M_i) + NFI = S - I = \Delta NFA = -\overline{FSAV}. \quad (\text{A.19})$$

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 nonresidents 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 (1) national savings exceed national investment, (2) there are negative foreign savings, and (3) 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:

$$S = \sum_h (s_h \cdot Y_h) + FB. \quad (\text{A.20})$$

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 (that is, $I = S - \Delta NFA$). Consistent with Equation (A.1) in which s is a fixed parameter, public savings are determined by Equation (A.17), 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 (for example, gross domestic product), 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 (A.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 GR . 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—that is, analogous to investment demand in Equation (A.16).

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

$$\overline{CPI} = \sum_{i,h} P_i c_{ih}^0. \quad (\text{A.21})$$

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

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

APPENDIX B: SENSITIVITY ANALYSIS OF THE ELASTICITY PARAMETER IN PRODUCTION FUNCTIONS

Different econometric estimates of the elasticity of substitution among factors have been found for the Mexican economy. While Fukuchi and Hosono (1972) found an elasticity of 0.09, more recently, though focusing on agriculture, Howitt and Msangi (2006) estimated factor substitution elasticities in the 0.40–0.76 range, with values depending on production size unit and commodity, and Dinopoulos et al. (2011), focusing only on the elasticity of labor production factors at the national level, found an estimate of 0.29.

There seems to be no agreement on the elasticity of substitution among factors in Mexico. Given that a main transmission channel in the generation of the general equilibrium income changes is given by the significant change in the wage of child labor, which depends to some extent on the assumed elasticity of substitution in the constant elasticity of substitution (CES) production function, we evaluate how the results would change if this elasticity were not the one assumed through the main part of the analysis (0.6), but either smaller (0.4) or larger (0.8) for a given simulation (extension of the coverage of *Oportunidades*).

The results do not hinge on the elasticity of substitution among factor inputs assumed in the computable general equilibrium (CGE) model for Mexico. Illustrating this, Table B.1 compares simulated time allocation, Figure B1 changes in income by income centile, Table B.2 the simulated poverty and inequality indicators, and Table B.3 summarizes inequality results by region for the mentioned factor substitution parameter values. The figures illustrate very robust results under different elasticity parameters.

Table B.1—Transition matrix for time allocation of children in program-expansion simulation with different elasticity parameters of the constant elasticity of substitution (CES) production functions

Simulated Choice	Elasticity								
	$\sigma=0.4$			$\sigma=0.6$			$\sigma=0.8$		
	Base Choice								
	Work	Work and School	School	Work	Work and School	School	Work	Work and School	School
Work	88.1	0.6	0.1	87.9	0.5	0.0	87.9	0.5	0.0
Work and School	0.5	95.5	0.0	0.5	96.4	0.0	0.5	97.4	0.0
School	11.4	3.9	99.9	11.6	3.1	100.0	11.6	2.2	100.0
Total	100.0	100.0	100.0	88.4	100.0	100.0	100.0	100.1	100.0

Source: Authors' calculation based on ENIGH 2008 and model results.

Figure B.1—Changes in household per adult equivalent income by percentile with different elasticity parameters in CES production function, program-expansion simulation

Source: Authors' calculation based on model results.

Table B.2—Poverty and inequality indicators for program-expansion simulation with different elasticity parameters of the constant elasticity of substitution (CES) production functions

Indicator	Elasticity		
	$\sigma=0.4$	$\sigma=0.6$	$\sigma=0.8$
FGT0			
National extreme poverty line	5.26	5.28	5.29
National moderate poverty line	26.37	26.46	26.54
US\$1.25-a-day line	1.06	1.06	1.07
US\$2-a-day line	4.03	4.04	4.04
FGT1			
National extreme poverty line	1.34	1.35	1.35
National moderate poverty line	8.47	8.50	8.52
US\$1.25-a-day line	0.25	0.25	0.25
US\$2-a-day line	1.05	1.05	1.06
FGT2			
National extreme poverty line	0.52	0.52	0.52
National moderate poverty line	3.88	3.90	3.91
US\$1.25-a-day line	0.09	0.09	0.09
US\$2-a-day line	0.42	0.42	0.42
Gini	0.501	0.501	0.502

Source: Authors' calculation based on ENIGH 2008 and model results.

Table B.3—Gini index by region and elasticity of substitution for program expansion simulation

Region	Elasticity		
	$\sigma=0.4$	$\sigma=0.6$	$\sigma=0.8$
Noreste	0.462	0.463	0.463
Noroeste	0.525	0.525	0.525
Occidente	0.473	0.473	0.474
Oriente	0.464	0.464	0.464
Centronorte	0.481	0.481	0.481
Centrosur	0.495	0.496	0.496
Sureste	0.497	0.498	0.498
Suroeste	0.506	0.506	0.507
National	0.501	0.501	0.502

Source: Authors' calculation based on model results.

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