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Journal of Development Economics 82 (2007) 448–463

JOURNAL OF Development ECONOMICS

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Coffee production effects on child labor and schooling in rural Brazil

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Received 12 August 2004; received in revised form 1 September 2005; accepted 4 April 2006

Abstract

I use variation in coffee production to measure changes in local economic conditions, which proxy for the value of children's time. I test how this short-term variation affects child labor and schooling in Brazilian coffee regions using seven rounds of household surveys. Increases in the county-level value of coffee production led to more work among middle-income boys and girls, poorer children were withdrawn from school, while richer children were not affected. Thus, during periods of economic growth, education of the poor may be adversely affected.

JEL classification: D13; I20; J22; O10; O12
Keywords: Child labor; School enrollment; Brazil; Time allocation; Coffee production

1. Introduction

Economists and policy makers of developing countries–where the vast majority of child laborers live–are concerned with the effects of employment on educational attainment and poverty. Since empirical findings reveal a positive relationship between education quantity and income, then it is possible that working as a child, if it displaces school, may be an important negative determinant of a person's future earnings. And if it is the poor who send their children to work out of economic necessity, then the most vulnerable get stuck in an intergenerational poverty trap: poor parents send their children to work today, who obtain less schooling and find low productivity, low wage jobs in the future.

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0304-3878/$ - see front matter
doi:10.1016/j.jdeveco.2006.04.003

Basu and Van (1999) develop a multiple equilibrium model where child labor is due to poverty; in the "good" equilibrium, income levels are sufficiently high and parents choose not to send their children to work, whereas in the "bad" equilibrium of low parental wages, parents send children into the workforce. Indeed, empirical studies confirm a negative relationship between income and wealth levels and child labor,[1] and a positive relationship between income/wealth and schooling.

While the previous literature focuses on changes or differences in permanent income or wealth, more recent studies have focused on the effects of short-run or temporary fluctuations in household incomes on children's employment and schooling outcomes. What happens to children's outcomes when temporary incomes change? The theoretical implications of the effects of child wages on schooling and child labor are not clear because changes in labor earnings have income and substitution effects, and while they are a source of income that make schooling affordable (specially in poor families), work diverts some–and often all–available time away from educational activities. Recent evidence includes Beegle et al. (in press) who find that agricultural crop shocks increase the number of hours worked by children in Tanzania, while various recent empirical studies using Latin American data find that child labor is pro-cyclical with economic cycles and incomes. In urban Brazil, Duryea and Arends-Kuenning (2003) found that child labor was higher and short-run education outcomes were worse when average wages increased, while Barros et al. (1994) and Neri and Thomas (2001) support the positive relationship between economic activity and child labor. Kruger (in press) finds that children living in Nicaraguan coffee regions were more likely to work during a coffee boom. All these recent studies analyze the effects of *temporary* fluctuations in income on children's outcomes, and they suggest that the substitution effects of temporary income changes are greater than income effects: unexpected, temporary improvements in economic conditions may increase children's employment and deter schooling. In this paper, I follow these more recent empirical questions by analyzing whether and how temporary changes in the value of children's time in Brazil's coffee producing regions affect child labor and school enrollment rates.[2]

Brazil is divided into a Federal District and 26 states, which are further divided into 5507 counties of which about 1900 produce coffee. I use the value of county coffee production as a proxy for local economic conditions–and thus the opportunity cost of children's time–and explore the effects of short-term fluctuations in coffee production on children's labor and schooling outcomes. It is reasonable to predict that in regions where coffee is a relevant source of employment and income, developments in the coffee sector spillover into other productive sectors and thus affect local economic conditions, which in turn affect time allocation decisions of families—those that work directly in coffee and those that do not.

I find that when short-term fluctuations in the county-level value of coffee production were positive, low- and middle-income boys living in regions where coffee is economically important were less likely to be in school, and the likelihood of work increased for boys from middle-income families. Middle-income girls enter the workforce when local economic opportunities improve, while low- and middle-income girls are withdrawn from school. Richer children were not affected by changes in local economic conditions. These findings suggest that during periods

[1] A noteworthy exception is Bhalotra and Heady (2003).

[2] Schultz (1985) used commodity prices as instruments for the opportunity cost of time of women, and Black et al. (2003) used the price of coal as an instrument for the value of men's wages.

of temporary economic fluctuations, children's human capital accumulation may be negatively affected, and that special attention needs to be given to children of poorer households.

This study is a contribution to the child labor and time allocation literature in at least two dimensions. Firstly, while much research using Brazilian data has focused on urban areas, the focus here is on (mostly) rural coffee regions where agriculture plays an important role in the local economy, thus focusing on decisions by poorer families.[3] And secondly, by inter-acting the variable of interest–value of coffee production–with parental education levels, I am able to distinguish the effects of temporary changes in the value of children's time on child employment and schooling by household income levels.

The paper is organized as follows. In Section 2, I present the theoretical backbone that motivates the empirical analysis, followed by a section on the empirical strategy. Section 4 provides background information on Brazil's coffee sector and the nature of its fluctuations, as well as a description of the data used and variables constructed. The results from the empirical estimations are found in Section 5, and I conclude in Section 6.

2. Theoretical underpinnings

Households are comprised of two members, a parent and a child. The parent makes all decisions in order to maximize the family's utility of two goods, consumption (C) and child's human capital (HC). The parent is paternalistic in the sense that she wishes to maximize the level of human capital of the child, which is a function of the time spent by children on schooling activities t_s:

$$\mathrm{HC} = h(t_s) \tag{1}$$

This function has the usual properties: $h' > 0$ and $h'' < 0$.

Parents and children can sell their labor in the market.[4] Children who work $t_l >$ zero hour in the labor market earn market wage w. Thus, households face the following income constraint:

$$C = \kappa + w \cdot t_l = y \tag{2}$$

where C is total household consumption of market goods,[5] κ is constant parental earned income, $w_a t_a$, and $w \cdot t_l$ represents child income. Eq. (2) states that household consumption C must equal household income y. Children's time is allocated to either the labor market or to schooling, giving rise to the following time constraint:[6]

$$T = t_l + t_s \tag{3}$$

[3] In Brazil, approximately 41% of the rural population is poor, compared to 14% in urban areas, and the poor are concentrated in rural areas: although rural residents make up 21% of the total population, 43% of the poor live in rural areas (World Bank, 2001a,b).

[4] To simplify the discussion, I assume that adult labor supply, t_a, is inelastic and that the adult wage w_a is constant, so that the only labor decision analyzed here is children's labor, since I am not interested in the substitution between adult and child labor.

[5] Since I will not analyze the effect of market prices on children's outcomes, I assume that the price of market goods is 1.

[6] Leisure is left out of the analysis for simplification. The results hold if leisure is included.

I assume utility is separable in C and HC, the household's maximize utility

$$\psi = \underset{C,t_s}{\text{Max}}\, U(C) + V(\text{HC}(t_s))$$

subject to (1), (2) and (3). First-order conditions reveal that the opportunity cost of obtaining an additional unit of human capital equals the child market wage.

The effect of the child wage on labor has substitution and income effects:

$$\frac{dt_l^*}{dw} \equiv \frac{d\tilde{t}_l}{dw}\bigg|_{\tilde{\Psi}} + \frac{dt_l^*}{d\tilde{E}} \cdot \tilde{t}_l\left(w; \bar{\psi}, T\right) \tag{4}$$

The first term on the right-hand side of the identity in Eq. (4) is the substitution effect, which is positive, while the second term–the income effect–is negative. The total effect of a wage increase on child's labor and education outcomes depends on the relative strength of these two effects.

The utility derived from consumption and human capital also depends on environmental parameter Σ reflecting household, child, and community environmental characteristics, so the optimal time dedicated to schooling and child labor become $t_s^*(w;\kappa,T,\Sigma)$ and $t_l^*(w;\kappa,T,\Sigma)$, respectively. The observed outcomes are whether children are in school and whether they work—that is, whether time dedicated to school and labor are greater than zero. These discrete choices may be summarized as:

$$\Pr(t_l^* > 0) = l(w;\kappa,T,\Sigma) \tag{5}$$

$$\Pr(t_s^* > 0) = s(w;\kappa,T,\Sigma) \tag{6}$$

These time allocation decisions are functions of the child market wage, parental income, the child's time constraint, and environmental variables. I include the value of county-level coffee production as a measure of local economic conditions (which include wages and demand for labor) as a proxy for the value of children's time.[7] As measures for the other variables in the model, I include various household, child-specific, and community-level variables such as parental education, family demographic composition, child's gender, and age, among others.

3. Empirical strategy

The effects of changes in the local economy are captured by Eq. (4): more and better employment opportunities and higher income reduce child labor and increase schooling if the income effect dominates. Alternatively, improved local economic conditions pull children into the labor force if the substitution outweighs the income effect.

The dependent variables described in Eqs. (5) and (6) face data limitations, as it is usually possible to study only the extensive margins of school enrollment and child work–i.e., the enrollment or work decision–and not the intensive margins, or hours spent going to school and working.

[7] Child wages are almost always missing in survey data.

Thus, I estimate Probit regressions for the following probability model, with state-year effects and county fixed-effects:[8]

$$\Pr(l_{ijt}=1)=\alpha_1+\beta_1\mathrm{ValCof}_{jt}+\boldsymbol{X}'_{ijt}\gamma_1+\sum_{t=1}^{T}\sum_{k=1}^{K}S_kY_t\lambda_{1kt}+\sum_{j=1}^{J}C_j\delta_{1j}+\varepsilon_{1ijt}$$

$$\Pr(s_{ijt}=1)=\alpha_2+\beta_2\mathrm{ValCof}_{jt}+\boldsymbol{X}'_{ijt}\gamma_2+\sum_{t=1}^{T}\sum_{k=1}^{K}S_kY_t\lambda_{2kt}+\sum_{j=1}^{J}C_j\delta_{2j}+\varepsilon_{2ijt} \quad (7)$$

where i is an index for a child living in county j in state k, and t is an index for the year of the survey. The dependent variable l_{ijt} reflects the child's labor status and is equal to 1 if she is reported as working during the last 12 months, either in employment outside the home or as a family worker. The dependent variable s_{ijt} equals 1 if the child was enrolled in school during the previous year. ValCof_{jt} is the variable of interest (discussed below), which measures the value of coffee production in county j in year t and is a proxy for the opportunity cost of children's time; $\boldsymbol{X}_{ijt}$ is a vector of household and individual control variables. I control for state-level trends with state-year interaction terms S_kY_t, which capture any general economic conditions at the state level during each year of the sample that may have affected child labor and schooling; ε_{ijt} is an i.i.d. error term.

C_j are the county fixed effects, so that δ_{1j} and δ_{2j} capture the effects that time-invariant, county-specific characteristics have on child labor and schooling. Should all such characteristics be time-invariant, β_1 and β_2 are unbiased estimates of the effects of the value of coffee production on child labor and school enrollment, respectively.

I also test whether the effects of changes in local economic opportunities have different effects due to a family's income level, using three categories of parental education as proxies for permanent income: *Low* are those households where the highest level of education obtained by one of the parents is primary (4 years of schooling) or less; *Middle* refers to households where one of the parents obtained more than primary but less than a high school degree (between 5 and 10 years of schooling), and *High* refers to families where one of the parents obtained at least a high school degree (11 or more years of schooling). I incorporate households' permanent income into the model by inter-acting these categories with the value of coffee production to capture differences in slopes, and estimate the following regressions:

$$\begin{aligned}\Pr(l_{ijt}=1)=\alpha_3+\pi_3(\mathrm{ValCof}_{jt}\times\mathrm{Low}_{ijt})+\phi_3(\mathrm{ValCof}_{jt}\times\mathrm{Middle}_{ijt})+\mu_3(\mathrm{ValCof}_{jt}\\ \times\mathrm{High}_{ijt})+\boldsymbol{X}'_{ijt}\gamma_3+\sum_{t=1}^{T}\sum_{k=1}^{K}S_kY_t\lambda_{3kt}+\sum_{j=1}^{J}C_j\delta_{3j}+\varepsilon_{3ijt}\end{aligned}$$

$$\begin{aligned}\Pr(s_{ijt}=1)=\alpha_4+\pi_4(\mathrm{ValCof}_{jt}\times\mathrm{Low}_{ijt})+\phi_4(\mathrm{ValCof}_{jt}\times\mathrm{Middle}_{ijt})\\ +\mu_4(\mathrm{ValCof}_{jt}\times\mathrm{High}_{ijt})+\boldsymbol{X}_{ijt}{}'\gamma_4+\sum_{t=1}^{T}\sum_{k=1}^{K}S_kY_t\lambda_{4kt}+\sum_{j=1}^{J}C_j\delta_{4j}\\ +\varepsilon_{4ijt}\end{aligned} \quad (8)$$

[8] Probit estimations with fixed effects give rise to inconsistent coefficients of the fixed effects (the "incidental parameters problem"); however, Heckman (1981) demonstrates that Probit estimations with fixed effects perform as well as consistent estimators when the number of observations per fixed effect is at least 8. My data has at least 14 observations per county and 87 on average; therefore I am confident that this model is consistently estimated. Furthermore, Fernandez-Val (2005) proves that even when there is a bias in the coefficient of the fixed effect (in which we are not interested), the other coefficients and average marginal effects are consistently estimated.

Thus, the effect of a change in the county-level value of coffee production on the probability that a child works equals π_3, ϕ_3, and μ_3 if parents have a low, medium or high education level, respectively.

I performed an *F*-test to see if model (7) is nested in (8) and confirmed that it is. Thus, I discuss only empirical results for (8) in the following sections.

4. Background

Coffee production has played an important role in Brazil's development. From 1850 to 1960, earnings from coffee exports represented approximately 55% of all export revenue, and at the end of the 19th Century coffee producers, who were a strong political force, successfully lobbied for the construction of export infrastructure in the Southeastern coffee states, which included

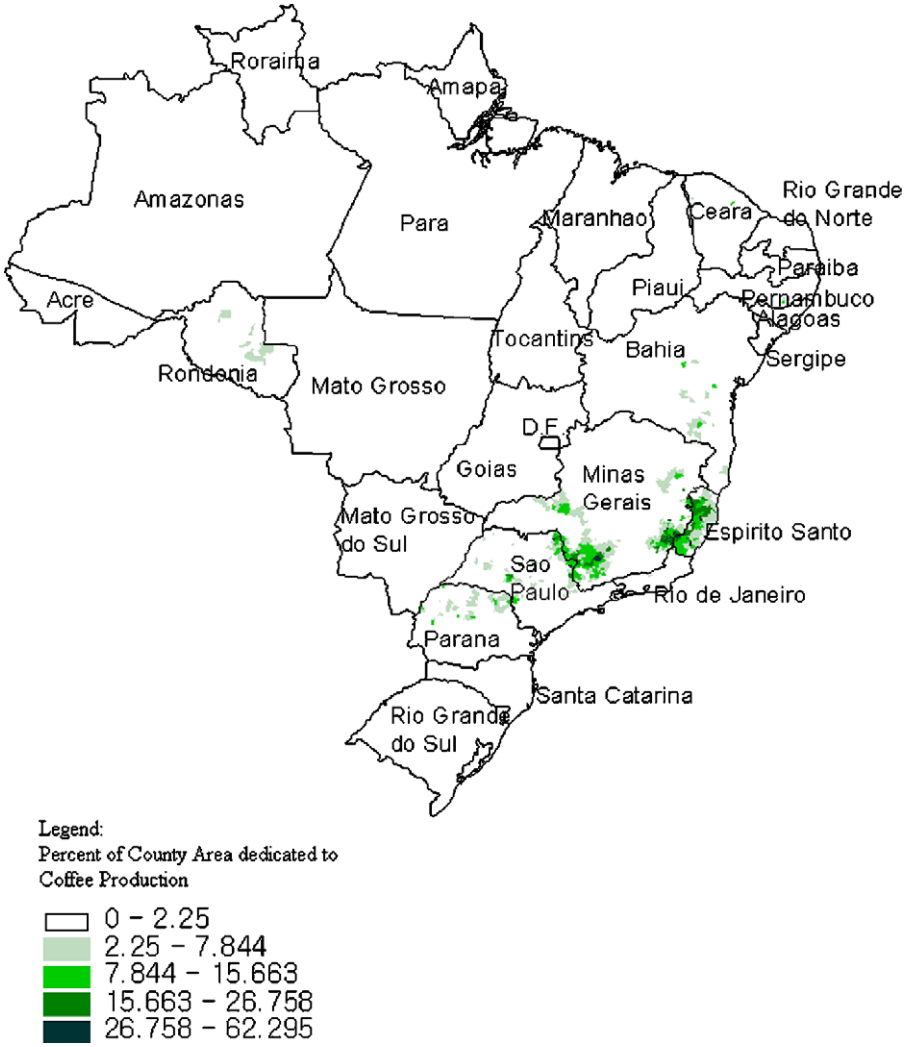

Fig. 1. Geographic location of coffee-producing counties.

railways, public services (ports, shipping, etc.) and roads. These investments later facilitated the development of the industrial sector in the same region (Abreu and Bevilaqua, 2000).

Agriculture's share in GDP has declined steadily as a result of industrialization: from 28% to 7.5% between 1930 and 2000; furthermore, the share of total employment in the agricultural sector declined from 66% to 30% between 1930 and 1980, and by 1980 the value of coffee production represented only 2% of total exports. Brazil has industrialized, but some local economies remain highly dependent on agriculture, and specifically coffee production, which represents more than 50% of GDP in some counties.

The specific climatic conditions required by coffee plants generate regional concentration of coffee production (Fig. 1). Coffee production is concentrated in a few of Brazil's counties: 50% of the total coffee crop in the year 2000 was grown in 86 of the 2008 coffee-producing counties. Although climate leads to geographic concentration of coffee production, its economic role depends on other factors. Many of the states located in Southeastern Brazil, where climate is optimal for coffee, are also very industrialized so that although the region is the largest producer in absolute volume, the economic importance of coffee is not limited to that part of the country (Fig. 2).

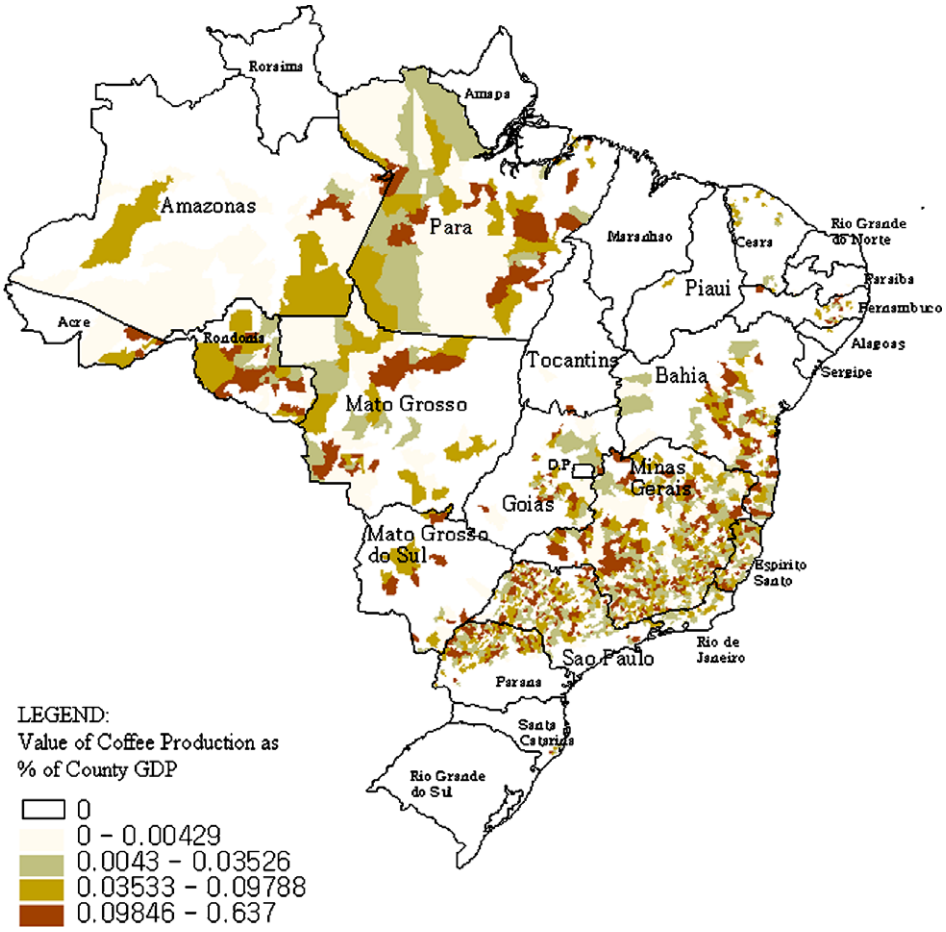

Fig. 2. Economic concentration of value of county coffee production.

I propose that in counties where coffee is economically important, the value of coffee production–"coffee GDP"–is a good proxy for local economic conditions and that fluctuations in the coffee sector have spillover effects on other economic sectors. The value of coffee production contains two effects: coffee quantity and coffee price. Distinguishing between these effects would be appropriate if we were analyzing outcomes of children whose family is directly employed by the coffee sector, which is not the case here (less than 2% of my sample is employed directly in agriculture and an even lower proportion in coffee). To families living in coffee regions and who do not work directly in the coffee sector, it is irrelevant whether the increased (or decreased) economic activity in the county is due to an increase in the price of coffee or an increase in quantity produced: the evolution of coffee GDP would be driving the spillover effects that affect their decisions regarding their children's employment and schooling. Thus, in this paper I use variations in the value of coffee production as a proxy for changes in the opportunity cost of children's time.[9]

Counties where coffee is economically important are vulnerable to coffee production shocks: they are adversely affected by negative shocks and benefit greatly with production booms, which lead to increases in labor demand in all sectors. If these production shocks are due to climatic events and not to producers' decisions, then short-term fluctuations of the coffee sector can be considered exogenous. Coffee area planted in Brazil reveals producers' longer-term decisions, while short-term fluctuations in the quantity of coffee production reflects, among other things, unexpected climatic changes.

Table 1 and Fig. 3 reveal that in Brazil, coffee area planted exhibited stable, smooth trends during the period analyzed—a slight negative trend from 1990 to 1996 and positive trend between 1996 and 2003. The quantity of coffee produced, on the other hand, displayed volatile behavior from one year to the next, and the sharp drops in production have been documented to be caused by specific climatic shocks.[10] As Table 1 reveals, the average acreage of coffee land planted varied by an average of 5% from one year to the next during the 1990–2003 period, while the quantity of coffee produced faced average yearly variations of 17%. The longer-term decisions are captured by the year and state-year effects, while the coffee variable captures the short-term, exogenous fluctuations that we are interested in identifying.

Since the model includes terms that control for state-year and county fixed-effects, a possible concern is that these eliminate all the variation that the temporary fluctuations in the value of coffee production may provide in the estimations. To assess this possibility, I estimated a fixed county effects regression of value of coffee production on state-year effects. The R^2 of this regression is 0.2044, revealing that the fixed effects do not explain a significant portion of the variation in the value of coffee production, and that there is a lot of room for identification from the coffee variable. These exogenous, short-term fluctuations serve as a proxy for the opportunity cost of children's time, and the following sections describe the strategy used to estimate its effect on child labor and school enrollment rates.

[9] To verify that the measure of coffee production I constructed is a good proxy for economic activity, I estimated a county fixed-effects regression of county-level employment between 1996 and 2001, on ValCof_{jt} and dummy variables for year, using employment data from surveys conducted by Brazil's *Central Registry of Enterprises*. The coefficient on ValCof_{jt} is positive and significant at the 5% level, indicating that county-level employment is positively affected by changes in ValCof_{jt}.

[10] The sharp decline in production in the 1994/1995 harvest was due to severe frosts and droughts, while the declines in 2000/2001 and 2001/2002 were due to severe droughts. Source: International Coffee Organization.

Table 1
Brazil: short-term fluctuations in coffee production (all counties where coffee is produced)
Area planted and production, 1990–2003

Year	Area planted	% Change	Production	% Change
1990	2,937,804		2,888,912	
1991	2,777,492	−5.5	3,061,560	6.0
1992	2,514,680	−9.5	2,582,684	−15.6
1993	2,273,874	−9.6	2,602,252	0.8
1994	2,109,995	−7.2	2,577,310	−1.0
1995	1,980,133	−6.2	1,860,269	−27.8
1996	1,929,894	−2.5	2,705,446	45.4
1997	2,000,766	3.7	2,424,494	−10.4
1998	2,077,593	3.8	3,365,585	38.8
1999	2,233,986	7.5	3,235,238	−3.9
2000	2,292,165	2.6	3,829,257	18.4
2001	2,394,133	4.4	3,635,822	−5.1
2002	2,441,980	2.0	2,648,580	−27.2
2003	2,442,804	0.03	1,987,074	−25.0
Average [a]	2,266,884	5.0	2,808,890	17.3

Source: IBGE. Area planted in thousands of hectares; production in thousands of tons.
[a] The average percentage changes are estimated for absolute values, to capture magnitude of the change regardless of its direction.

4.1. The data and variables

The household and individual-level data used in this study comes from Brazil's national household surveys (PNADs) for the years 1992–1999,[11] administered by Brazil's census bureau, IBGE, during the third week of September of each year. Households were selected via stratified random sampling, and I kept observations of children living in counties represented in all the years of the data. The PNAD questionnaires contain sections that gather household and individual-level data, including gender, age, education levels, current education enrollment status, a detailed employment section on all jobs held during the previous year and income earned.

Coffee production data is from county-level surveys of agricultural production administered each year by the IBGE in all counties. Researchers, credit institutions, cooperatives, large producers, and commercial agents in each town generate the measures of agricultural production, and the surveys provide annual data of area planted, area harvested, quantity produced and values of agricultural production in Brazil, including coffee. Coffee fluctuations are likely to impact local economies where agriculture is an important activity, which occurs in rural areas and small cities, so I estimate regressions only in cities with a population of 206,000 persons or less, which corresponds to cities in the lower 3 quintiles of city size. I further limit the analysis to children who live in counties where coffee is economically important, which I defined as counties where the share of coffee in local GDP was at least 2% in any survey year.[12] Of the sample's 790 counties, 236 meet these criteria.

The International Labor Organization defines a "child" for employment purposes as anyone aged 14 years or younger. Since only persons aged 10 and older answer the employment section

[11] Except 1994, when the survey wasn't taken.
[12] As suggested by an anonymous referee, I check for sensitivity of this criterion by estimating regressions for children living in counties where coffee was at least 5% and 10% of local GDP in any given year. Focusing on regions where coffee is a more important activity economically reduces the sample size and variation, presenting a tradeoff between regions where coffee is more important, and sample size. Results for children living in regions where coffee was 10% of GDP were not statistically significant; I discuss results from the 5% sample where appropriate in the following section.

of the PNADs, the sample includes children aged 10 to 14, and a child worker is anyone aged 14 or younger who was employed at least one hour during the previous week, or who held employment during the last 12 months, including self-employment in a family-owned business or farm, either for a wage or as un-paid family workers. Children are "in school" according to the survey response, and those enrolled are assumed to attend.

Child labor and school enrollment rates were about 37% higher and 3% lower in coffee producing counties than the average population. I am ultimately interested in whether–and how strongly–child labor and schooling respond to changes in coffee production. In years where the value of coffee production decreased (as it did between 1994–1995 and 1995–1996), average child labor also decreased, but it did so at a faster rate in coffee counties. When the value of coffee production rebounded, as it did each year between 1996 and 1999, child labor also increased, with stronger responses in coffee counties in almost all years, which suggests that the response of child labor in coffee counties, at least for some periods, was greater than average responses.

In the regressions, I control for household-level demographic characteristics that may affect the outcomes under study, which include: number of infants aged 0–5 in the household, number of other children aged 10–14 in the home, number of elderly persons aged 65 and older, and the maximum level of education obtained by an adult in the household (as defined in Section 3). I include a dummy variable for whether household members live on and/or own a farm, and a dummy variable for whether household members own a business to capture the effects of home employment possibilities. I also include a dummy variable for rural location. Individual child-specific controls include the child's age, a dummy variable for whether the child is black, and dummy variables for whether he or she is the oldest child.[13] Descriptive statistics of all variables for all children are found in Table 2.

5. Econometric results

I estimate equations in (8) with Probit regressions using data for all children aged 10–14 who live in counties where the population is less than 206,000 and where the value of coffee production is at least 2% of local GDP. The sample consists of 23,545 boys and 22,785 girls.

Even though they had similar enrollment rates of about 90%, 34% of boys were employed compared to 17% of girls aged 10 to 14 years, which is similar to other countries in Latin America (King and Hill, 1993). Because the child labor literature has found that boys and girls respond differently to changes in economic conditions, I ran separate regressions by gender and present results in Table 3. Results in Table 4 correspond to children living in counties where coffee represents 5% of local GDP in any given year.

5.1. Boys

As Table 3 reveals, improvements in local economic opportunities, proxied by the county value of coffee production, increase the probability of employment for middle-income boys: an increase of 10% in the value of coffee production increases these boys' employment probability

[13] Emerson and Portela (2003) find that father's characteristics affect labor outcome of boys more than girls, and mothers' characteristics have a greater effect on girls' labor status; Emerson and Portela (2001) find that first-born boys are less likely to attend school, last-born boys are less likely to work, and first-born girls are less likely to go to school than their younger siblings.

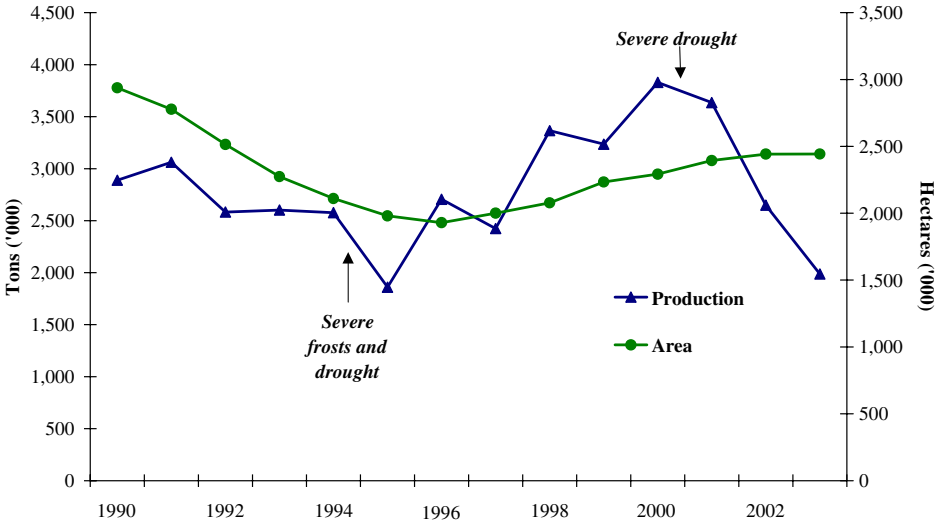

Fig. 3. Brazil: coffee production (tons) and area planted, 1990–2003.

by 4%. The probabilities of employment for low- and high-income boys are not affected. Since a high proportion of low-income boys (42.9%) work, and since the dependent variable measures the extensive margin of outcomes, it is feasible that as economic conditions improve, poor boys increase the number of hours worked (intensity of labor) but not necessarily the likelihood of employment. Coffee production does not significantly affect the probabilities of schooling of

Table 2
Summary statistics

Variable	Boys (N=23,598)				Girls (N=22,804)			
	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Child works	0.340	0.474	0	1	0.175	0.380	0	1
Attends school	0.879	0.326	0	1	0.898	0.303	0	1
Adult income (Reais)	40,396	171,972	0.3	4,300,527	40,962	161,862	1	3,467,815
Adult income (log)	5.7	3.1	−1.4	15.3	5.8	3.1	0.0	15.1
Rural	0.378	0.485	0	1	0.354	0.478	0	1
Number of infants aged 0–5	0.465	0.830	0	6	0.491	0.849	0	6
Number of children aged 6–14	0.731	0.797	0	5	0.728	0.792	0	5
Number of persons aged 65+	0.094	0.321	0	3	0.094	0.327	0	3
Low Educ.Household	0.369	0.483	0	1	0.357	0.479	0	1
Middle Educ.Household	0.460	0.498	0	1	0.463	0.499	0	1
High Educ.Household	0.170	0.376	0	1	0.180	0.384	0	1
Household owns/is farm	0.209	0.407	0	1	0.201	0.401	0	1
Household owns business	0.225	0.418	0	1	0.228	0.419	0	1
Child is black	0.049	0.216	0	1	0.043	0.203	0	1
Child is oldest	0.327	0.469	0	1	0.317	0.465	0	1
Val. Coffee/capita (Reais)	19,525	125,885	0	2,644,894	19,684	122,630	0	2,644,894
Value of coffee (log)	1.13	5.50	−4.85	14.79	1.13	5.52	−4.85	14.79
Share of coffee in GDP	0.099	0.076	0.020	0.392	0.098	0.075	0.020	0.392

Includes children aged 10 to 14 living in small cities where share of coffee production is at least 2% of GDP (small city=population in 1996 ≤ 206,000).

Table 3
Effect of value of county coffee production on employment and schooling
Counties where value of coffee production = 2% of GDP
Probit regressions (average marginal effects)

Explanatory variable	Boys		Girls	
	(1)	(2)	(3)	(4)
	Employed	In school	Employed	In school
ValCoffee * Low-Education HH	0.00274	−0.00181	0.00100	−0.00156
	(0.00196)	(0.00123)	(0.00167)	(0.00086) *
ValCoffee * Mid-Education HH	0.00474	−0.00127	0.00430	−0.00099
	(0.00181) **	(0.00111)	(0.00163) **	(0.00086)
ValCoffee * High-Education HH	0.00299	−0.00111	0.00173	0.00071
	(0.00241)	(0.00167)	(0.00197)	(0.00121)
Rural	0.18474	−0.03998	0.08524	−0.05025
	(0.01365) **	(0.00702) **	(0.00965) **	(0.00543) **
Ch.aged 0–5 in HH	0.02507	−0.01710	0.01317	−0.01730
	(0.00352) **	(0.00275) **	(0.00295) **	(0.00198) **
Ch.aged 6–14 in HH-excl.self	0.01733	0.00239	0.01605	0.00609
	(0.00407) **	(0.00297)	(0.00320) **	(0.00206) **
HH Persons aged 65+	−0.01830	−0.00716	−0.02035	−0.00346
	(0.00876) ***	(0.00663)	(0.00790) **	(0.00453)
Parents = Middle education	−0.05513	0.08546	−0.04646	0.05212
	(0.00728) **	(0.00579) **	(0.00584) **	(0.00414) **
Parents = High education	−0.13028	0.12901	−0.09136	0.07036
	(0.01116) **	(0.00354) **	(0.00597) **	(0.00238) **
HH owns/is a farm	0.17504	0.01571	0.07131	0.00645
	(0.01281) **	(0.00609) **	(0.00994) **	(0.00452)
HH owns business	0.05525	0.01860	0.04281	0.01891
	(0.00801) **	(0.00620) **	(0.00847) **	(0.00389) **
Black	0.01876	−0.03556	0.03881	−0.01847
	(0.01576)	(0.01209) **	(0.01637) ***	(0.00939) ***
Oldest child	−0.02747	0.05072	−0.02877	0.03201
	(0.00607) **	(0.00460) **	(0.00480) **	(0.00304) **
Number of Observations	23,598	23,328	22,804	22,349
Log likelihood	−11,091.4	−6974.2	−8438.4	−5851.6
Correctly predicted outcome (%)	77.5	88.3	83.8	90.2
Mean of dependent variable				
Low-Education HH	0.429	0.797	0.235	0.829
Middle-Education HH	0.329	0.905	0.167	0.915
High-Education HH	0.174	0.983	0.075	0.981

Average marginal effects are the mean of each individual marginal effect. Robust standard errors in parentheses. Middle education = between 5 and 10 years of schooling; high education = 11 years of education or more. Other control variables (not shown): age of child, year, state-year, and county fixed effects.

* Significant at 10%.
** Significant at 1%.
*** Significant at 5%.

boys, which suggests that the intensity of increased employment of middle-income boys does not displace schooling.

Nonetheless, in regions where coffee is more important economically (regions where coffee is 5% of GDP), an increase of 10% in the value of coffee production reduces low- and middle-income boys' probability of schooling by 4% and 3%, respectively (Table 4), suggesting that in some instances, the increased labor demand resulting from improvements

Table 4
Effect of value of county coffee production on employment and schooling
Counties where value of coffee production = 5% of GDP
Probit regressions (average marginal effects)

Explanatory variable	Boys		Girls	
	(1)	(2)	(3)	(4)
	Employed	In school	Employed	In school
ValCoffee * Low-Education HH	0.00222	−0.00371	0.00038	−0.00325
	(0.00244)	(0.00149) *	(0.00193)	(0.00146) *
ValCoffee * Mid-Education HH	0.00377	−0.00330	0.00346	−0.00265
	(0.00235)	(0.00132) *	(0.00195) **	(0.00150) **
ValCoffee * High-Education HH	0.00170	−0.00243	0.00203	0.00281
	(0.00319)	(0.00233)	(0.00252)	(0.00212)
Rural	0.19755	−0.03982	0.09096	−0.06073
	(0.01616) ***	(0.00830) ***	(0.01116) ***	(0.00727) ***
Ch.aged 0–5 in HH	0.02565	−0.01739	0.01350	−0.02369
	(0.00447) ***	(0.00350) ***	(0.00387) ***	(0.00336) ***
Ch.aged 6–14 in HH-excl.self	0.01308	0.00471	0.01704	0.00963
	(0.00522) *	(0.00372)	(0.00423) ***	(0.00355) ***
HH Persons aged 65+	−0.02078	−0.00947	−0.02786	−0.00355
	(0.01084) **	(0.00804)	(0.01029) ***	(0.00807)
Parents = Middle education	−0.04843	0.08868	−0.05045	0.07183
	(0.00898) ***	(0.00713) ***	(0.00786) ***	(0.00690) ***
Parents = High education	−0.11804	0.13173	−0.10948	0.10439
	(0.01410) ***	(0.00474) ***	(0.00932) ***	(0.00460) ***
HH owns/is a farm	0.17225	0.01659	0.07362	0.00966
	(0.01510) ***	(0.00769) *	(0.01148) ***	(0.00758)
HH owns business	0.05904	0.03039	0.04698	0.03050
	(0.01006) ***	(0.00806) ***	(0.01082) ***	(0.00769) ***
Black	0.03504	−0.04284	0.05721	−0.03531
	(0.01964) **	(0.01498) ***	(0.01985) ***	(0.01442) *
Oldest child	−0.02880	0.04576	−0.03365	0.04851
	(0.00737) ***	(0.00604) ***	(0.00665) ***	(0.00565) ***
Number of observations	15,712	15,562	14,968	14,605
Log likelihood	−7734.3	−4838.1	−5949.1	−4038.4
Correctly predicted outcome (%)	76.0	84.7	81.6	89.6
Mean of dependent variable				
Low-Education HH	0.448	0.792	0.251	0.827
Middle-Education HH	0.376	0.902	0.189	0.909
High-Education HH	0.213	0.982	0.088	0.982

Average marginal effects are the mean of each individual marginal effect. Robust standard errors in parentheses. Middle education = between 5 and 10 years of schooling; high education = 11 years of education or more. Other control variables (not shown): age of child, year, state-year, and county fixed effects.

* Significant at 5%.
** Significant at 10%.
*** Significant at 1%.

in local economic activity may cause children to abandon school, and it is lower-income children who do so.

These findings suggest that in the face of a temporary improvement in local economic conditions the substitution effects of an increase in the value of time dominate income effects, so that boys leave school (at least temporarily) and some boys–from middle-income families–enter

the labor market. Children from better-off socio-economic strata are shielded from the potential negative labor market pull-effects resulting from economic booms.

Boys who live in rural areas are more likely to work and less likely to attend school than urban counterparts, even after controlling for household income variables. This result most likely reflects lower accessibility and school supply in remote areas. Household composition has significant effects on both outcomes: the presence of an additional infant (younger than 6 years of age) in the household leads to a higher probability of employment and lower probability of schooling relative to boys without young siblings, which suggests that in the presence of young siblings, boys aged 10 to 14 may be withdrawn from school to enter the workforce in order to complement adult income.

Having a sibling in the household aged 6 to 14 also leads to higher probability of working, but school enrollment is not affected. The presence of an elderly person in the household–most likely a grandparent–is associated with lower employment probabilities for boys, which is probably a result of additional income generated by pensions received by the elderly, reducing the need for children to work (see Carvalho, 2000). Higher parental education is associated with less child labor and higher schooling of boys.

In line with findings in Kruger and Berthelon (2003), household economic activities significantly affect children's outcomes: boys whose household engages in an agricultural and non-agricultural economic activity are not only more likely to work, but also more likely to be enrolled in school. This finding reflects a permanent wealth-effect, since households that own a business or farm are wealthier than those that do not. Owning land or capital, therefore, has significant income effects for boys, since the higher probability of work does not displace school enrollment.

Race and birth order are also important determinants of the outcomes of interest: black boys are less likely to be in school than white children, while eldest boys benefit most in the household—they are less likely to work and more likely to be in school than younger siblings.

5.2. Girls

Table 3 reveals that the probability of middle-income girls' employment increases by 4% when the value of coffee production increases by 10%, and that and the probability of school enrollment of low-income girls falls by 2% with a similar shock to coffee production,[14] revealing that girls respond similarly to boys when local economic conditions change.

The effects of other control variables on girls' employment and schooling probabilities are similar to those found for boys: girls living in rural areas, and those with greater numbers of infant siblings, are more likely to work and less likely to attend school compared to urban girls and girls with fewer young brothers and sisters. The presence of siblings of a similar age is associated with higher employment and schooling, which suggests that older siblings may help each other with the burdens of household and school obligations, making them more likely to be in school. The presence of a grandparent in the home is associated with a lower probability of employment.

Adult education is positively (negatively) related to girls' schooling (employment) probability. Farming and non-agricultural home employment lead to higher employment probabilities, while non-agricultural home activities are associated higher schooling for girls, which reflect similar wealth effects as those found on boys. Black girls are more likely to work and less likely to be in

[14] In regions where coffee is 5% of GDP, the probability of schooling of middle-income girls also falls.

school than white girls, and eldest girls have advantages over younger siblings, being less likely to work and more likely to be in school.

In sum, coffee production fluctuations affect children differently according to their family income level (proxied by parental education). Boys and girls of low- and middle-income households are adversely affected since they are less likely to be in school and more likely to be employed as a result of higher economic activity, while children of high-income families are not affected from the same economic shock. This reveals that families have different responses to the same exogenous event, and that the human capital accumulation of low- and middle-income children may be at risk when local economic booms occur.

6. Summary of findings

Recent studies question the theory that child labor is the result of poverty, which would imply that improved economic conditions reduce child labor and may increase school enrollment. These wealth effects on child labor have been validated for differences in wealth or permanent income levels and for long-term shocks to household income or wealth, but they are not validated when one analyzes short-term shocks.

It is natural to imagine parents responding differently to changes in income or in economic opportunities that they perceive to be temporary than to those they perceive as permanent. The findings of this paper confirm this proposition, and I furthermore find that it is parents from middle-income households that take advantage of temporary improvements in economic conditions by substituting their children's time from schooling into work activities.

In Brazil's coffee-producing areas, child labor among boys increases during periods of temporary increases in local economic activity driven by positive coffee production shocks; and that the effect on school enrollment is negative. This is consistent with other findings for urban Brazil where child labor increased and education outcomes worsened when average wages increased (Duryea and Arends-Kuenning, 2003). Meanwhile Beegle et al. find that temporary agricultural crop shocks increased the number of hours worked by children in Tanzania.

The findings of this paper contribute to understanding the effects that different shocks to household income have on children's outcomes. Specifically, I find that parents take advantage of improved economic conditions that they deem *temporary* and pull their children out of school and insert them into the workforce. Once the 'boom' in local activity reverses, children are sent back to school.

The effects of temporary fluctuations in income and/or economic opportunities differ by the family's income level: while poorer children are less likely to attend school and more likely to work, those from higher-income families are not negatively affected.

The findings of this line of the child labor literature, i.e., the potential risks from temporary improvements in economic conditions, suggest that economic growth may not be a panacea to all problems related to poverty, since some income-constrained households sacrifice their child's education when the local economy is growing in order to increase household income with child labor. Furthermore, if we consider that the county fixed-effects probably capture part of the variation in the value of coffee production, then the effects of coffee production cycles on children's time allocation decisions that I find in this study are lower bounds. This implies that the variable used to measure fluctuations in the county value of coffee production underestimates the effect of local economic conditions on children's outcomes, and that in fact, the actual impact of these changes may be greater.

It is important to differentiate between different types of shocks, to be aware of the substitution effects, and for any policy designed to alleviate child labor and to improve human capital outcomes, to be well targeted to populations at risk.

Acknowledgements

I thank Matias Berthelon, Roger Betancourt, Seth Sanders, Rodrigo Soares, Mushfiq Mobarak, Jonah Gelbach, and two anonymous referees for useful comments and suggestions. The paper has also benefited from feedback received at seminars at the University of Maryland, the Pontificia Universidad Católica de Chile, the University of Chile, and the Pontificia Universidad Católica de Valparaíso. Data was provided by the Instituto Brasileiro de Geografia e Estatística. Any errors and omissions are my own.

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