Appendix 1: Data

National Federation of Coffee Growers and the International Coffee Organization: Coffee Prices

We initially obtained average annual internal coffee prices paid to Colombian coffee growers for years 1970 to 2006 from two sources: the London-based International Coffee Organization (ICO) and the National Federation of Coffee Growers (NFCG). Internal prices paid to Colombian coffee growers at a given point in time do not vary within the country. The ICO's price data is obtained directly from the NFCG, so we generally use the latter. (The single exception is our analyses using *Familias en Acción* survey data. Because the last wave of the survey was conducted in 2005/2006 – but the NFCG only provided price data through 2004 – we use real ICO price data in US dollars). We then converted the NFCG time series price data (obtained in Colombian pesos per kilogram of "green" coffee) to real 1998 terms using the official consumer price index constructed and published by the Colombian Central Bank (*Banco de la República*). This price index is available on-line at: http://www.banrep.gov.co/estad/dsbb/srea_012.xls.

National Federation of Coffee Growers: Coffee Cultivation

Approximately once per decade, the National Federation of Coffee Growers conducts a complete enumeration of all coffee growers in Colombia for planning and monitoring purposes. The 1970 coffee census combined information collected directly from coffee growers with land use data gathered through aerial photography. Drawing on the experiences of the 1970 census, the 1980-81 coffee census was conducted primarily using aerial photography with field verification for purposes of quality control. The 1997 coffee census was based on a complete enumeration (on the ground) of all coffee growers between 1993 and 1997. In all of our analyses, we use the immediately preceding coffee census conducted prior to a given price shock. (Because new coffee plants require four years to produce their first mature harvest, area dedicated to coffee cultivation cannot respond quickly to changes in world coffee markets.)

The 1970 and 1980 coffee censuses are available only in hard-copy format from the NFCG. With special permission from the NFCG, we digitized county-level indicators of coffee cultivation from each census using these printed volumes. The principle measure relevant to our analyses is hectares of land dedicated to coffee cultivation. The 1997 coffee census is available in electronic format.

100% 1993 Colombian Population Census: Birth Cohort Size

We constructed birth cohort size counts at the county-birth year level using the complete (100%) 1993 Colombian population census obtained from the Colombian National Statistical Agency (*Departamento Administrativo Nacional de Estadística*, or DANE). These birth cohort counts were generated using detailed geographic identifiers that allow all counties to be recognized according to each individual's county of birth, not county of residence in 1993. There were 32,451,229 non-institutionalized individuals in 1060 counties recorded in the 1993 population census. These counties account for all of Colombia in a mutually exclusive and collectively exhaustive manner. Birth cohort counts were then matched to (i.) prevailing real internal coffee prices in each cohort's year of birth and (ii.) the most recent county-level coffee cultivation measures prior to that year in each cohort's county of birth.

Demographic and Health Surveys: Health Investments and Maternal Socio-Economic Status

Our primary measures of health investments and mothers' socio-economic status are obtained from four waves of Colombia's Demographic and Health Surveys (DHS). These are nationally-representative surveys of fertile age women (defined as 15-49) in the year a survey is conducted. We pool the four DHS waves together using variables reported in a comparable manner over time. (The first wave in 1986 was conducted by the Corporación Centro Regional de Población; the 1990, 1995, and 2000 waves were conducted by the Asociación Pro-Bienestar de la Familia Colombiana, or PROFAMILIA.) Public-use DHS data is available for download by registering at: http://www.measuredhs.com/. Using the child recode files matched to maternal characteristics (a pooled sample of 70,695 children), we then match each child to (i.) the prevailing real internal coffee price in his/her year of birth and (ii.) the most recent county-level coffee cultivation measures prior to the child's birth year according to county of residence at the time of the survey (county of birth is not recorded in the DHS data). Individual counties are not identified in the publicly-available Colombian DHS data, but PROFAMILIA and Macro International (the US-based DHS partner) provided keys that match sampling clusters to individual counties.

Available measures of health investments reported consistently across the four waves include: maternal use of prenatal care, prenatal tetanus vaccinations, birth assistance, breastfeeding duration, and a variety of child vaccinations (BCG, polio, DPT, and measles). This mother-reported information can be divided into two categories: birth histories and child health histories. The birth histories are reported for every live birth (regardless of child survival to the survey date) and include prenatal care, prenatal tetanus vaccinations, birth assistance, and breastfeeding duration. The child health histories are reported for all children born within sixty months of the survey date (regardless of child survival to the survey date) up to a maximum of six children per woman and include BCG, polio, DPT, and measles vaccinations. Maternal socio-economic characteristics for each child that are available in all four waves include: age, educational attainment in years, number of preceding births, preceding birth interval, age at first birth, age at first marriage, and number of household members.

Familias en Acción Evaluation Survey: Local Labor Markets, Child Morbidity, and Time Use

Our data on rural labor markets, childhood morbidity, adult time use, and travel time to health care facilities is drawn from three waves of a household panel survey conducted to evaluate the *Familias en Acción* program in Colombia. *Familias en Acción* is a non-randomized conditional cash transfer program similar to Mexico's *Oportunidades* program (formerly known as *Progressa*). The survey was first conducted in 2002 with follow-up surveys repeated in 2003 and 2005/2006. In 2002, the baseline survey was administered to 11,502 households in 122 Colombian counties. Attrition rates for the two follow-up surveys relative to the first wave were 6.3% and 17.1%. Topical survey modules broadly covered household demographic characteristics and composition, consumption, income, school attendance and educational attainment, and labor force participation. In addition, detailed health questions – including adult-reported symptoms of child morbidity and child preventive health care service use – were asked for all children 6 years of age and younger. Although the *Familias en Acción* survey data does not extend back to the three major world coffee price shocks studied by this paper, it collected complementary data relevant to our analyses but not available in any other data source on employment, wages, hours worked, adult time use, and travel time to health care facilities.

WHO Expanded Program on Immunization (EPI) Colombian Vaccination Records

To investigate how infant/child vaccinations move with coffee prices, we obtained county-year vaccination records covering years 1998-2007 for the following vaccines: polio, DPT (diphtheria, pertussis or whooping cough, and tetanus), BCG (*Bacille Calmette-Guerin*, a preventive tuberculosis vaccine), hepatitis B, *haemophilus influenzae* type b (against the variety of Hib disease manifestations, including meningitis and pneumonia), and MMR (measles, mumps, and rubella). The Colombian Ministry of Health is formally responsible for reporting aggregate national vaccination coverage data to the World Health Organization. However, it does not store and maintain disaggregated vaccination data for preceding years. To facilitate the study of vaccination coverage, a private organization (*Fundación Santa Fe de Bogotá)* has therefore conducted a project in conjunction with the Ministry of Health to collect disaggregated vaccination data from each Colombian county. To date, this project has collected retrospective county-level vaccination data for years 1998-2007. The *Fundación* has generously provided this data to us, and we have merged these vaccination records with the 1997 coffee census and annual internal coffee prices.

Contraloria General de la Nación: Colombian Local Public Finance Records

We obtained county-year level date on local public revenue and spending collected by *Contraloria General de la Nación* (the senior accounting branch of the Colombian government). *Contraloria* obtains this data from each county's official balance sheets. This data is available for years 1984-1993 and includes: current income, transfers, capital income, tax income, direct taxes, indirect taxes, industry and commerce taxes, total spending, investment spending, operational spending, water spending, infrastructure spending, housing spending, education spending, and health spending. We merged this data with annual coffee prices and county-level coffee cultivation in 1980.

Because data on alcohol and tobacco tax revenue is also relevant to our analyses but is generally not reported at the county level, we also obtained department-year level alcohol and tobacco tax revenue data for years 1990-2001 as well. We then merged this department-year data with department-level coffee cultivation measures from the 1980s and annual internal coffee prices.

National Federation of Coffee Growers: NFCG Social Contribution Spending

At our request, the NFCG has assembled historical information on its annual social contribution for 16 departments (or states) from 1979 to 2006. This data represents the first time that the NFCG has assembled historical information on social contributions from its archival records. Instead of paying taxes, the NFCG makes these social investments to improve quality of life in rural coffee-growing regions of Colombia. These funds are generally spent on public goods for coffee growers, including agricultural research, business development, and publicity as well as four major areas of infrastructure investment (electrification, school construction, water, and roads).

Total social contribution spending is available at the department by year level with the exception of two instances in which NFCG records report combined information for several of Colombia's most sparsely populated departments (because of the organization of NFCG cooperatives in the most remote areas). These two multi-departmental units are (1) Caquetá, Casanare, Meta and Chocó and (2) Cesar and La Guajira. Our results are insensitive to conducting aggregate regional-level analyses and to excluding these departments. Departments

for which the NFCG reported no social spending are assumed to be missing (rather than reflecting no spending) and are omitted from our analyses. We aggregated our county-level coffee cultivation data to the department level and merged the department-year social contribution data with department-level coffee cultivation (using the immediately preceding coffee census) and annual coffee prices.

Colombian Vital Registry Records: Traffic Fatalities and Violent Deaths

Electronic death records at the individual level are available for years 1979-2002 from the Colombian National Statistical Agency (DANE). These records include deaths by age, sex, cause (ICD classification), place of occurrence, place of residence, month and year, marital status, and certification by a medical professional. We provide graphical evidence of infant mortality over time by degree of coffee cultivation but do not generally otherwise make use of Colombia's mortality statistics because of concerns about data quality and under-reporting (particulary given that the degree of under-reporting thought to be correlated with economic conditions) (Florez and Mendez 1997, Medina and Martinez 1999, Hill 2003). Appendix 2 provides indirect estimates of under-reporting in Colombia's vital registry data that range between 30% and 45%. The exception is that we use DANE's county-year records of traffic fatalities and violent deaths (given that no alternative measure of these deaths is available) in investigating potential alternative explanations for the patterns of procyclical mortality that we observe.

Appendix 2: Indirect Mortality Estimation

To assess the extent of under-reporting in Colombia's mortality statistics, Appendix Table A3 shows indirect estimates of Colombia's infant mortality rate (deaths under age one per 1,000 live births) over time. These calculations, taken from Urdinola (2004), are conducted using Colombia's Demographic and Health Surveys (DHS) and the Brass-Trussell method (United Nations 1990). Specifically, these estimates suggest that under-reporting rates were 31% in 1986, 46% in 1990, 47% in 1995, and 44% in 2000. Similar calculations (not shown) using the Palloni-Helligman (1985) variant of the Brass method yields infant mortality estimates that are roughly equivalent. Appendix Table A3 suggests that the quality of Colombia's vital registration system may have been deteriorating over time. This is consistent with observations made by others assessing the quality of Colombia's vital registration system (Medina and Martinez 1999).

Indirect Estimation of Infant Mortality Rates: the Brass-Trussell Method[1]

The Brass method of indirect mortality estimation is a standard tool used by demographers to calculate the probability that a child has died ($q(x)$) by age x in cross-sectional data (Brass, 1974). These probabilities $q(x)$ can therefore be interpreted as age-specific mortality rates commonly found in standard life tables. At minimum, this method requires information on the proportion of infants and children who have died as a share of children ever born to women at each age. Widespread reliance on the Brass Method in producing indirect estimates of age-specific mortality rates has led the United Nations to place the number of children ever born and the number of surviving children on its list of recommended items for national population censuses (United Nations 1990).

The Brass method essentially utilizes differences in child survival rates across age cohorts of mothers to recover information about age-specific child mortality. It exploits the fact that all else equal, children (both alive and dead) born to older women are observed at older ages. Women at varying ages are therefore assumed to provide information about the experiences of all women in the population at each age. An important limitation of this approach is therefore its assumption that cumulative mortality rates depend on age alone. Nevertheless, a large literature in demography demonstrates its usefulness as an approximation in assessing the extent of under-reporting in vital registries.

Following standard notation used in demography, the number of children dead as a share of children ever born (denoted as D_i) among women in reproductive age groups i (i=1 for women 15-19, i=2 for women 20-24, …, i = 7 for women 45-49) are transformed into probabilities of dying ($q(x)$) between birth and exact age x. For the infant mortality calculations shown in Appendix Table A3, the age x of interest is one. The Brass method's basic equation is:

(3) $q(x)=k_iD_i$,

where k_i is a vector of multipliers derived from fertility measures among women in the population of interest. Through simulations, Brass generated the proportions of children dead, the probabilities of dying, and parity ratios (P_1/P_2, P_2/P_3, etc) linking them. Thus, an estimate of the probability of dying by age 1, $q(1)$, can be derived from the proportion of children dead reported by women aged 15-19, $D(1)$; the probability of dying by age 2, $q(2)$, can be obtained from the proportion of children dead for women aged 20-24, $D(2)$, and so on.

[1] For more details on indirect mortality estimation, see United Nations (1983), United Nations (1990), or Preston, Heuveline, and Guillot (2001).

The original Brass method also assumes that mortality rates are constant over time, making cohort and period mortality probabilities identical. This assumption has subsequently been relaxed – if the rate of change over time as assumed to be constant, the reference date of each *q(x)* can be estimated by making allowances for the age pattern of fertility by means of the parity ratios.

More flexible variants of the Brass method have also been developed. One of the best known is the Trussell (1975) variant, which estimates the multipliers k_i differently. Specifically, the fertility schedule used to produce the ratios P_1/P_2, etc. is taken from the Coale-Demeny (1966) model life tables.[2] The Trussell variant also differs in assuming that both infant mortality and fertility patterns remained constant in preceding periods (specifically, the preceding 15 years). Finally, the Palloni-Heligman variation includes a correction using more precise information on birth timing and employs United Nations model life tables for developing countries.[3] The Coale-Demeny model life table that best fits Colombian vital patterns is the West life table, and the Palloni-Heligman table that best fits Colombian vital patterns is the Latin American variant.

[2] Coale-Demeny model life tables were developed using data from a variety of countries and have for basic regional: North, South, East and West.

[3] United Nations model life tables are also constructed for different regions of the world, with several distinct variants: Chilean, Latin America, South Asia, Far Eastern, and General.

Appendix 3: Informal Validity Tests

In this Appendix we consider threats the internal validity of this paper's main analyses. Any confounding influence must have varied in a very specific way – both over time in the same abrupt manner as birth year coffee prices and across counties in proportion to the intensity of birth county coffee cultivation. The most natural concerns are: (1) that we mistake changes in the composition of births or women giving birth for mortality responses, or (2) that selection into areas with varying coffee-growing intensity biases our main results. This section presents validity tests that investigate – but fail to corroborate – these concerns.

We first consider how coffee price shocks might alter the composition of births or the types of women giving birth. Economic models of fertility predict that changes in economic circumstances should differentially influence the fertility of women with varying opportunity costs of time (as measured by socioeconomic status, for example) (Becker and Lewis 1973, Ben-Porath 1973, Becker 1981, Butz and Ward 1979, Perry 2003, Dehejia and Lleras-Muney 2004). As already described, we address potential changes in the composition of women giving birth by restricting our analyses to children already conceived at the time a price shock occurred (children born in shock years or earlier). However, because we only know children's year of birth, we also investigate the possibility of confounding compositional changes directly. Exploiting detailed information on maternal characteristics available in the Demographic and Health Surveys, we use the pooled DHS sample of children ages 0-2 in price shock years to regress measures of maternal socioeconomic status on the interaction between birth year coffee price and birth county coffee cultivation as in equation 2.

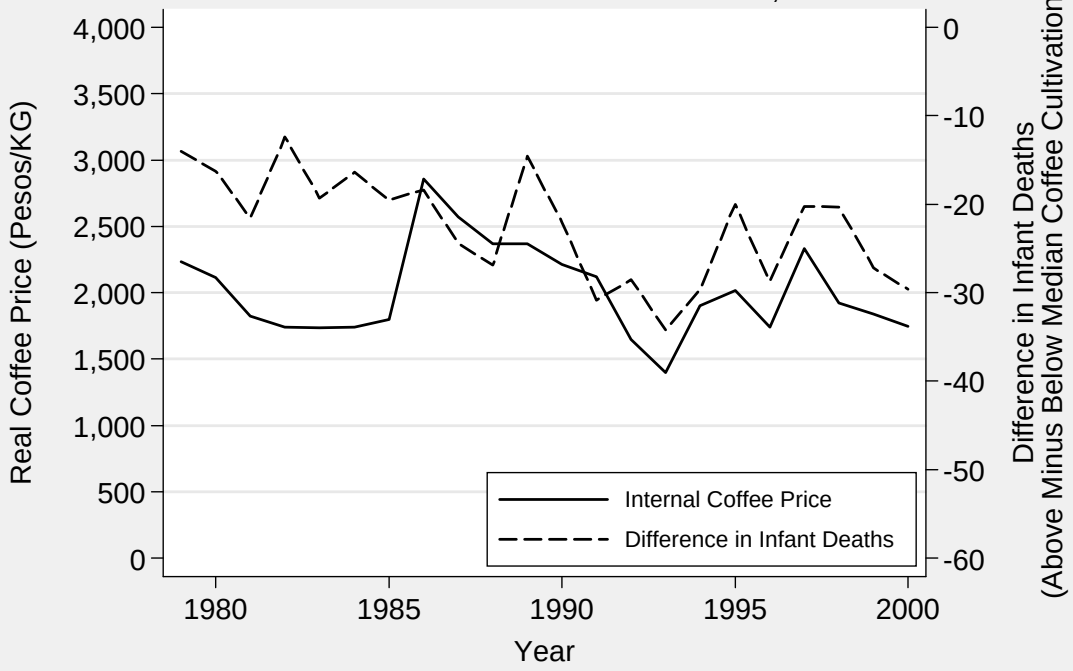
Appendix Table A4 shows coefficient estimates for the interaction between coffee price and intensity. There is no evidence of any change in the composition of mothers' age, education, age at first birth, age at first marriage, preceding number of births, or number of household members. Similarly, estimates for preceding birth intervals – a direct measure of fertility – are statistically indistinguishable from zero. Other confounding compositional changes should be detectable in these analyses as well – including differential migration of pregnant women induced by price shocks and selective mortality among women giving birth – but we find little evidence of them.

We then explore how selection into counties with varying coffee-growing intensity prior to price shocks might bias our cohort size results. Although we are able to condition our estimates on both fixed and time varying differences across counties, Colombians might sort themselves into counties with varying coffee-growing intensity according to unobserved latent characteristics related to price responsiveness and child survival that become manifest in the presence of price shocks. A testable implication of this concern is that if people in counties with varying coffee-growing intensity were subjected to the same price shock (i.e., one whose impact should not vary with coffee-growing intensity), they would respond differently in ways related to infant and child survival.

To test this concern, we replace internal coffee prices with the Colombian CPI and re-estimate equation 1 using stable coffee price years (1968-69, 1982-83, and 1988-89). During these years, Colombian consumer prices changed by 7%, 20%, and 26% (respectively).[4] Appendix Table A5 presents coefficient estimates for the interaction between birth year CPI and coffee-growing intensity. None are statistically distinguishable from zero.

[4] See: http://www.banrep.gov.co/econome/dsbb/i_srea_012.xls

Appendix Figure A1: Coffee Prices Paid to Colombian Growers and the Difference in Infant Mortality between Counties with Above/Below Median Coffee Cultivation, 1979-2000



APPENDIX TABLE A1:
Coffee Price Fluctuations and County-Level Public Finance

	Estimate	Standard Error	N	R^2
Total Local Government Income	0.002	(0.024)	8,020	0.95
Transfer Income	-0.005	(0.006)	8,020	0.90
Capital Income	0.000	(0.001)	8,020	0.71
Total Direct Taxes	-0.001	(0.008)	8,020	0.94
Total Indirect Taxes	0.008	(0.012)	8,020	0.96
Industry and Commerce Taxes	0.005	(0.007)	8,020	0.96
Total Spending	-0.005	(0.039)	8,020	0.92
Investment Spending	-0.013	(0.019)	8,020	0.90
Operational Spending	0.003	(0.017)	8,020	0.94
Water Spending	-0.001	(0.002)	8,020	0.39
Infrastructure Spending	-0.008	(0.006)	8,020	0.68
Housing Spending	-0.001	(0.005)	8,020	0.53
Education Spending	-0.001	(0.003)	8,020	0.77
Health Spending	0.001	(0.002)	8,020	0.75

Notes: County-year public finance data for years 1984-1993 from *Contraloria General de la Nación* ; coffee cultivation data from the National Federation of Coffee Grower's early 1980s coffee census; ann internal coffee price data from the National Federation of Coffee Growers. Estimates and standard erro (in parentheses, clustered by county) shown for the interaction between coffee growing intensity and co price obtained by estimating equation 1 (controlling for county and year fixed effects and county-specif linear trends). Coffee area is in hectares and coffee prices are in pesos per kilogram. *p<0.1, **p<0.05 ***p<0.01.

APPENDIX TABLE A2:
Coffee Price Fluctuations, Traffic Fatalities, and Violent Deaths

	Estimate	Standard Error	N	R^2
Panel A: County-Level Traffic Fatalities and Violent Deaths				
ln(Motor and Other Land Transportation Deaths)	0.015	(0.024)	12,104	0.81
ln(Violent Deaths)	0.012	(0.007)	11,722	0.85
Panel B: Department-Level Alcohol and Tobacco Tax Revenue				
ln(Beer Sales)	-0.006	(0.007)	396	0.99
ln(Liquor Sales)	-0.014	(0.023)	384	0.97
ln(Tobacco Sales)	0.009	(0.011)	394	0.94

Notes: County-year numbers of traffic fatalities and violent deaths for years 1979-2001 from the *Departamento Administrativo Nacional de Estadística* ; department-year beer, liquor, and tobacco sales tax data from *Contraloria General de la Nación* ; coffee cultivation data from the National Federation of Coffee Grower's early 1980s coffee censuses; annual internal coffee price data from the National Federation of Coffee Growers. Estimates and standard errors (in parentheses, clustered by county for Panel A and department for Panel B) shown for the interaction between coffee growing intensity and coffee price obtained by estimating equation 1 (controlling for county and year fixed effects and county-specific linear trends in Panel A, controlling for department and year fixed effects and department-specific time trends in Panel B). Coffee area is in thousands of hectares and coffee prices are in thousands of pesos per kilogram. *p<0.1, **p<0.05, ***p<0.01.

APPENDIX TABLE A3:
Infant Mortality Under-reporting in Colombia: Indirect Brass-Trussell Estimates Vs. Official Figures

Source	Year	Estimated Infant Mortality Rate	Vital Registry Infant Mortality Rate
DHS 1986	1986	40.6	27.9
DHS 1990	1990	37.5	20.0
DHS 1995	1995	33.7	18.0
DHS 2000	2000	30.6	17.1

Notes: Vital registry infant mortality data from the *Departamento Administrativo Nacional de Estadística* ; Indirect Brass-Trussell infant mortality rate estimation procedures using the Demographic and Health Survey waves (1986, 1990, 1995, and 2000) described in Appendix 3. Rates shown are deaths under age one per 1,000 live births.

APPENDIX TABLE A4:
Coffee Price Shocks, Maternal Characteristics, and Birth Timing

	1975 Brazilian Frost	1985 Brazilian Drought	1990 ICA Collapse
Mother's Age	0.020	5.616	-0.004
	(0.016)	(17.600)	(0.011)
Maternal Education	-0.009	0.001	0.004
	(0.008)	(0.009)	(0.009)
Number of Household Members	-0.005	-0.003	-0.009
	(0.006)	(0.010)	(0.009)
Mother's Preceeding Number of Births	0.003	-0.011*	0.001
	(0.008)	(0.006)	(0.006)
Mother's Age at First Birth	0.009	-0.009	-0.013
	(0.007)	(0.010)	(0.016)
Mother's Age at First Marriage	0.007	-0.005	-0.004
	(0.010)	(0.011)	(0.034)
Preceding Birth Interval	-0.026	0.097	-0.230
	(0.074)	(0.180)	(0.204)

Notes: Individual-level maternal characteristics from the pooled 1986, 1990, 1995, and 2000 Colombian Demographic and Health Survey child sample; coffee cultivation data from the National Federation of Coffee Grower's early 1980s coffee census; annual internal coffee price data from the National Federation of Coffee Growers. Estimates and standard errors (in parentheses, clustered by county) shown for the interaction between coffee growing intensity and coffee price in the year that a woman gave birth obtained by estimating equation 2 (controlling for county and year fixed effects and county-specific linear trends). Coffee area is in hundreds of hectares and coffee prices are in hundreds of pesos per kilogram. *p<0.1, **p<0.05, ***p<0.01.

APPENDIX TABLE A5:
CPI Changes and ln(Cohort Size) in Stable Coffee Price Years

	Sample/Specification		
	Ages 0-2	Ages 0-3	Ages 0-3 with Trends
Panel A: 1969 CPI Change	-1.91	-0.04	7.79
	(1.21)	(0.66)	(5.95)
County Fixed Effects	Yes	Yes	Yes
County-Specific Linear Trends	No	No	Yes
N	2207	3314	3314
R^2	0.99	0.99	0.99
Panel B: 1983 CPI Change	-1.10	-0.83	0.07
	(0.70)	(0.53)	(0.05)
County Fixed Effects	Yes	Yes	Yes
County-Specific Linear Trends	No	No	Yes
N	2207	3310	3310
R^2	0.99	0.99	0.99
Panel C: 1989 CPI Change	-0.01	0.00	-0.08
	(0.01)	(0.00)	(0.09)
County Fixed Effects	Yes	Yes	Yes
County-Specific Linear Trends	No	No	Yes
N	2204	3305	3305
R^2	0.99	0.99	0.99

Notes: County-year cohort size data from the complete 1993 Colombian population census; coffee cultivation data from the National Federation of Coffee Grower's early 1970s and early 1980s coffee censuses; annual Consumer Price Index (CPI) data from the Central Bank of Colombia. Estimates and standard errors (in parentheses, clustered by county) shown for the interaction between coffee growing intensity and the CPI in the first year of life obtained by estimating equation 1 (controlling for county and year fixed effects and county-specific linear trends as shown above). Coffee area is in hundreds of hectares and coffee prices are in hundreds of pesos per kilogram. *p<0.1, **p<0.05, ***p<0.01.