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**Industrial Structure and Child Labor:  
Evidence from the Brazilian Population Census**

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## **Abstract**

This paper uses micro data from the 1980, 1991 and 2000 population censuses to investigate the role of changes in the industry mix in accounting for the differential trends in the incidence of child work (ages 10-15) across Brazilian states. We find that exogenous compositional changes account for around 20% of the observed fall in child employment in rural areas.

Keywords: Child labour, shift-share analysis, Brazil

JEL Classifications: J21, J24, O15, O18

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## **INTRODUCTION**

A large amount of literature has been produced on the phenomenon of child labor. We have solid evidence that improvements in living standards are responsible for the secular fall in children's employment typically associated with economic development (for all, see Edmonds 2008, and references therein). Economic progress, with the associated secular increase in the demand for skills, is also likely to reduce the incentives to engage in work at an early age, as the opportunity cost of dropping out of school increases. The same variables are also potentially able to explain cross-sectional differences in the incidence of child labor across countries at different stages of development.

Much of the emphasis in the literature is on the labor supply determinants of child labor. The increasing availability of micro data from household surveys for many developing countries has allowed researchers to investigate decisions regarding children's work in the context of their household labor supply, link work and schooling decisions, investigate the role of credit constraints and poverty (for all see Edmonds 2005, 2008; Baland and Robinson 2000, and Cigno and Rosati 2005 for a discussion of the theory underpinning child labor decisions).

Less attention has been paid to the demand side. Some studies analyze temporary changes in aggregate local labor demand or local economic conditions. There is evidence for both Brazil (Duryea and Arends-Kuenning 2003; Neri and Thomas 2000; Parikh and Sadoulet 2005; Manacorda and Rosati 2007) and other countries (see for example Guarcello et al. 2005 for Ethiopia) that on average child labor tends to increase when local labor demand is stronger. In a similar vein, Kruger (2007) shows that increases in the value of coffee production induce a rise in child labor in coffee producing regions of Brazil, especially among children of less educated

parents, implying that a temporary increase in labor demand tends to increase child labor, despite a potentially counteracting income effect.

Much less is known about how different patterns of industrial specialization affect child labor. To the extent that children enjoy a comparative advantage in specific industries, different industry mixes will lead to different incidence of child labor in the population. This is a potentially relevant - but to our knowledge largely neglected - mechanism behind the secular fall in child labor. If children are concentrated in low productivity industries with obsolete production technologies - because of the unskilled nature of their work or because child labor legislation creates an incentive for them to specialize into informal occupations - changes in the industry mix driven by technological change or shifts in consumers' preferences can potentially be a major force behind the fall in child labor that typically accompanies economic growth.

Obviously, children's occupational choices might readjust, as their opportunities for employment change. This is particularly true if child labor is driven by dire poverty, and children are sent to work (only) to guarantee a subsistence level of consumption to their household (as in Basu and Van 1998), in which case one would not expect changes in the industry mix to lead to changes in child labor.

The only paper we are aware of that attempts to identify the role of industrial specialization on child labor is Edmonds (2003). Using data for Vietnam, this author finds little evidence of an association between children's involvement in economic activity and variation in the (one-digit) industrial mix across communities.

A complementary body of work investigates whether children effectively enjoy an advantage in specific productions. The evidence again is quite mixed. Koutstaal and Schacter (1997) and Sloutsky and Fisher (2004) seem to imply that children have an advantage at work

that requires patterns memorization, although direct evidence in support of the “nimble fingers” hypothesis is weak (Levison et al. 1998, Edmonds 2008).

In this paper we examine more closely the question of whether sector specific labor demand is responsible for the differential variation in the fraction of working children across Brazilian states.

Since the mid 1990s the incidence of child labor in Brazil has been declining rapidly (for all, World Bank 2001a). Despite this clear evidence, there is still no consensus on the determinants of this decline. Improvements in living standards, increasing urbanization, rising public pressure, educational policies and the adoption of local and federal policies aimed specifically at promoting school attendance and curbing child labor have all likely played a role.

A certain number of papers focus specifically on school promotion and child labor eradication policies. Following the success of conditional cash transfer programs (*Bolsa Escola*) in two urban municipalities (the *Distrito Federal* and Campinas), since 1995 other municipalities have adopted similar programs: by 1999, there were 60 (rather heterogeneous) programs in operation in various urban municipalities (out of a total of 5,564 municipalities in the whole of Brazil). Simultaneously a Federal program for the eradication of the worst forms of child labor in rural areas (*PETI*) was launched. This program targeted children in the worst forms of child labor by providing a combination of conditional cash transfers and after-school activities (*jornada ampliada*). By 1999 the program had managed to reach 166 municipalities (World Bank 2001b).

There is some disagreement as to whether these earlier programs were effective in reducing child labor and there is no study that we are aware of attempting to quantify their contribution to the observed fall in child labor. Pianto and Soares (2004) using household survey data and a diff-in-diff estimator across municipalities find that *PETI* was successful in reducing

child labor in Brazil. A similar conclusion is reached by Yap et al. (2009) and World Bank (2001b). Cardoso and Portela (2004), though, using data from the 2000 census and propensity score matching find little evidence of an effect of these income transfer programs on child labor, although their data do not allow to separately identify the effects of *Bolsa Escola* and *PETI*.

Differently from existing work on Brazil that focuses on short term or cyclical changes in child labor (Duryea and Arends-Kuenning 2003; Duryea et al 2007; Krueger 2007, Manacorda and Rosati 2007), our paper investigates long term trends in child labor using data from the 1980, 1991 and 2000 population censuses. There are two major advantages associated to using micro data from the Census compared to the more widely used data from the Brazilian *Pesquisa Nacional por Amostra de Domicílios* (PNAD). First, starting in 1980, the census provides a detailed 3-digit level breakdown for the sectors of economic activity. This allows us to investigate in great detail the contribution of changes in the industrial structure to changes in the incidence of child labor. Second, the very large sample sizes (between 0.8 and 1.3 million children per year) allow us to obtain very precise estimates of child employment by industry and state that could not be obtained using typical household survey data.

The structure of the paper is as follows. In section 1 we show that Brazilian children appear to enjoy a comparative advantage in specific productions, implying that differences in the industrial mix have the potential to explain part of the differential variation in the incidence of child labor across States. Section 2 lays out the methodology that is then used in section 3 to ascertain the role of compositional changes in explaining the incidence of child labor based on Census data. Section 4 finally concludes.

## 1. DATA AND DESCRIPTIVE ANALYSIS

For the purpose of this analysis we use micro data from the IPUMS version of the Brazilian Population census (Minnesota Population Center 2007) for the years 1980, 1991 and 2000.<sup>1</sup> The data provide information on labor market participation for all individuals aged 10 or above.

Sample sizes are very large and increase from around 5.8 million observations in 1980 to more than 10 million observations in 2000, with children - defined as those aged 10 to 15 - accounting for around 12% of the sample.<sup>2</sup> Work activity refers to the week before the census week and includes both paid and unpaid economic work but excludes non-economic activities such as household chores. In the following we refer to children's engagement in economic activities indifferently as "child labor", "work" or "labor force participation". This includes activities inside or outside the child's home.

For those in work, the census ascertains the sector of activity at the three digit level. Because the classification of activities changes over time, we have proceeded to standardize it, resulting into 105 three-digit industrial categories that are consistently defined throughout the period of observation. Details are contained in the Appendix to the paper.

An analysis of census data shows that, between 1980 and 2000, the incidence of child labor nationwide halves, falling from 23% to 11% for boys and from 10% to 6% for girls. This fall is particularly pronounced for rural boys, with larger falls in high-child labor states, implying regional convergence. One cannot observe instead any appreciable change over time in rural girls' propensity to work. This is likely to be the reflection of rural girls' lower propensity to

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<sup>1</sup> IPUMS Census data for Brazil are available since 1970. The problem with the 1970 data, though, is that the classification of industries is too coarse in that year. Around 40% of children would be in fact classified in the "undefined crops" category. To avoid this problem, we restrict our analysis to the period 1980-2000.

<sup>2</sup> We use the upper limit of 15 years of age (as opposed to 14 years, as it is standard in the literature) since, according to Brazilian national legislation, the minimum age for general employment is 16 years. This minimum age was raised from 14 to 16 years in 1998. The Consolidated Labour Act establishes however that younger children can work in family enterprises under the supervision of parents or guardians (except for working at night, in hazardous work and overtime), without specifying a minimum age.

work compared to boys. In urban areas, where child labor is less widespread than in rural areas, we also observe a rapid convergence in child labor across states for both boys and girls.<sup>3</sup>

### **1.a Child intensive industries**

Table 1 lists the top-ten child labor intensive industries, as measured by the ratio of child (ages 10-15) to adult (ages 16-60) workers. The figures are nationwide averages across the three periods and are computed separately for males and females in rural and urban areas. Perhaps unsurprisingly, the most child intensive productions in rural areas are related to agriculture. Cultivation of cotton, followed by tobacco, corn, coffee, manioc root, sugar cane, and rice plus a number of undefined agricultural activities employ disproportionately more children than other sectors of the economy. While the average ratio of male children to male adult workers in rural areas is on the order of 0.11, in the cotton industry this number is 0.16, i.e. 50% higher.

Broadly speaking, the industries in Table 1 are all labor intensive cultivations, where harvesting is done by hand, which explains why children might be disproportionately represented. An analysis of the data (results not reported) shows a positive correlation between child labor intensity and the fraction of adult workers in each industry who are unskilled,<sup>4</sup> suggesting, perhaps unsurprisingly, that children display a comparative advantage in productions with low skills requirements.

The right-hand side panel of Table 1 reports results for girls. If anything, employment of rural girls relative to adult females is higher than what found for boys relative to their adult counterparts (0.14 versus 0.11). This is due to adult women being on average less likely to

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<sup>3</sup> Because Brazil becomes increasingly urbanized over the period of observation (the share of children in urban areas grows from approximately 68% to 80% between 1980 and 2000), this also contributes to a fall in the incidence of child labor.

<sup>4</sup> These are defined as adults with at most completed 4 years of education, accounting for 33% and 10% of total adult employment respectively in rural and urban areas.

participate in the labor market relative to adult men. However, the majority of boys' intensive productions are also intensive in girls' employment, implying that rural boys and girls are highly substitutable in production. One exception is represented by domestic services that constitute a major sector of employment for girls but not for boys. Social norms together with girls' comparative advantage in household chores relative to market activities - and the ensuing accumulation of skills that are valuable for domestic activities - are likely to explain girls' preponderant employment in the paid domestic service sector.

When we turn to urban children in the bottom panel of Table 1, we find that, even in urban areas, the sectors where these children are employed in high proportions relative to adults are linked to agricultural (cotton, tobacco, sugar cane), horticultural, and floricultural production. An analysis of the data reveals that - even if most (80%) child workers in urban areas work for pay - more than 50% of those in agriculture are unpaid, suggesting potentially that these children work on the household's plot of land. Outside of agriculture, the sectors that are particularly child labor intensive in urban Brazil are domestic services, paper trade and footwear. These are highly informal sectors, where child employment is unlikely to be sanctioned. Production in footwear in particular, one of Brazil's major export industries, is often subcontracted and takes places in sweatshops and hazardous conditions (USDOL 1998).

### **1.b Changes in the industrial mix**

We conclude this section by investigating the (nationwide) correlation between changes in child labor intensity and changes in the industry mix. Figure 1 depicts the average change in the fraction of employed adults in each industry between 1980 and 2000 over the 20-year average child labor intensity, defined as the ratio of children to adults in each of the 105 industries. We

present separate graphs for boys and girls in rural and urban areas. Note that the scales of the graphs differ between urban and rural areas. The solid line is the best fit regression line: for rural boys this is clearly negatively sloped (with a negative and statistically significant coefficient of -0.089), implying that over the twenty years of observation the most child labor intensive industries tend to decline.

For legibility, in the picture, we attach labels to those industries whose employment share changes in absolute value by at least 1%. The share of rural men employed in cotton cultivation, for example, declines by around 5 percentage points between 1980 and 2000. This is one of the industries with higher child labor intensity: for every 100 adult men employed in this sector in rural areas, there are 16 male child laborers. The same is true for corn. Expanding sectors, such as construction and food production - where either physical strength is required or capital is intensively used - are instead typically adult intensive. A similar negative relationship, although admittedly less pronounced, can be observed for rural girls: again, for example, we see a large fall in adult female employment in the cultivation of cotton, one of the most child intensive industries.

We see no clear correlation between child labor intensity and changes in the industry mix in urban areas. The reason for this is that, differently from rural areas, children in urban areas are employed in relatively marginal industries, i.e. industries that account for a small and essentially fixed share of adult employment. For example, while the top 10 most intensive child industries in rural areas account for more than 50% of adult employment, the corresponding figure in urban areas is around 14%. That children happen to be more segregated than adults in urban areas compared to rural areas should not be surprising given the higher degree of labor specialization in urban areas.

## 2. DECOMPOSING CHANGES IN CHILD LABOR: METHODOLOGY

The evidence in Figure 1 is suggestive of some role for changes in the industry mix in explaining the fall in child labor in Brazil between 1980 and 2000. In this section we ascertain precisely this contribution using a simple modified version of the traditional shift-share decomposition that is borrowed from Lewis (2004).<sup>5</sup>

Let  $p_{St}$  denote the fraction of children working in state  $S$  at time  $t$ . This by definition equals the ratio of child employment in state  $S$  ( $N_{CS_t}$ ) to child population ( $P_{CS_t}$ ). If the economy is composed of  $K$  different industries, total child employment will be the sum of child employment in these different industries denoted by  $N_{kCS_t}$  ( $k=1, \dots, K$ ). In formulas:

$$p_{St} = \sum_k N_{kCS_t} / P_{CS_t} = \sum_k p_{kSt} = \sum_k (N_{kCS_t} / N_{kUS_t}) (N_{kUS_t} / N_{kAS_t}) (N_{kAS_t} / N_{AS_t}) (N_{AS_t} / P_{AS_t}) (P_{AS_t} / P_{CS_t}) \quad (1)$$

where the subscript  $A$  refers to adults (irrespective of their skills) and the subscript  $U$  refers to unskilled adult workers. (1) says that the incidence of child labor is the sum across industries of the product of different terms. The first term ( $N_{kC}/N_{kU}$ ) is the ratio of children to unskilled workers by industry. The second term ( $N_{kU}/N_{kA}$ ) is the share of adult workers in industry  $k$  who are unskilled. The product between these two terms is the measure of child labor intensity in industry  $k$  ( $N_{kC}/N_{kA}$ ) that is presented in Table 1. The third term ( $N_{kA}/N_A$ ) is the industrial distribution of adult employment. The product of the three first components - once summed over the different industries - is the ratio of child to adult employment ( $N_C/N_A$ ). To obtain the fraction

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<sup>5</sup> Shift share (or variance) decomposition is often used to understand the determinants of changes in the employment (or wage) of specific groups (see for example Bound and Freeman 1992 for an analysis of the employment of blacks in the USA; Card and Lewis 2007 for an analysis of the fortunes of immigrants to the US; and Katz and Autor 1999, for an analysis of changes in the returns to skills in the USA).

of children working we multiply this term by the adult employment to population ratio ( $N_A/P_A$ ) and the ratio of adult to child population ( $P_A/P_C$ ).

One can approximate child labor intensity by letting each term of the decomposition on the right hand side of (1) to vary, while keeping the other terms fixed. If variables without the  $St$  subscript denote averages across time and states, one can in particular define a “between industries” component:

$$B_{St} = \sum_k (N_{kC}/N_{kU})(N_{kU}/N_{kA})(N_{kASt}/N_{ASt})(N_A/P_A)(P_A/P_C) = \sum_k p_k \{ (N_{kASt}/N_{ASt}) / (N_{kA}/N_A) \} = \sum_k B_{kst} \quad (2.1)$$

that is a function only of the differential industrial structure of adult employment ( $N_{kStA}/N_{ASt}$ ) across states and time. Essentially this term reflects compositional changes in child labor across states induced by differences in the adult industry mix. Notice that this term can also be written as the sum of  $K$  terms ( $B_{kst}$ ), each one corresponding to the compositional change attributable to industry  $k$ . We will go back to this point later on in the paper.

Similar to the compositional effect, one can define the following components:

$$W_{St} = \sum_k p_k \{ (N_{kCSt}/N_{kUSt}) / (N_{kC}/N_{kU}) \} \quad (2.2)$$

$$U_{St} = \sum_k p_k \{ (N_{kUSt}/N_{ASt}) / (N_{kU}/N_{kA}) \} \quad (2.3)$$

$$E_{St} = \sum_k p_k \{ (N_{ASt}/P_{ASt}) / (N_A/P_A) \} \quad (2.4)$$

$$P_{St} = \sum_k p_k \{ (P_{ASt}/P_{CSt}) / (P_A/P_C) \} \quad (2.5)$$

and decompose the fraction of children working in state  $S$  at time  $t$  as follows:

$$p_{St} = B_{St} + W_{St} + R_{St} + E_{St} + P_{St} + R_{St} \quad (3)$$

where  $R_{St}$  is defined residually.

The within industry component ( $W$ ) is a function of the differential intensity of child labor relative to unskilled labor across industries ( $N_{kCS_t}/N_{kUS_t}$ ). The term  $U$  is a function of the relative fraction of unskilled workers across industries ( $N_{kUS_t}/N_{kAS_t}$ ). The term  $E$  picks up the aggregate adult employment rate ( $N_{AS_t}/P_{AS_t}$ ), while the term  $P$  picks up the age structure of the population ( $P_{AS_t}/P_{CS_t}$ ). Finally, the term  $R$  is the sum of the cross-products between the different elements of the decomposition.

In order to ascertain the role of these different factors in explaining the incidence of child labor, one can regress each single element of the decomposition in (2) on the variable  $p_{St}$ . In order to abstract from macroeconomic changes that affect all states similarly or permanent differences across states, we include in our regressions state and time fixed effects. In practice, our empirical model is:

$$x_{St} = \alpha_x + \beta_x p_{St} + d_S + d_t + u_{St} \quad x = B, W, U, E, P, R \quad (4)$$

These regressions provide a measure of the average contribution of different factors in explaining the differential evolution of child labor across different states.

Although, by construction, the coefficients from these regressions add up to one, there is no a priori restriction on their sign or magnitude. For example, the coefficient  $\beta_B$  - that is the coefficient of primary interest in this paper - will be positive (negative) if industries that are typically child labor intensive (high  $N_{kC}/N_{kA}$ ) happen to absorb increasing less (more) workers ( $N_{kAS_t}/N_{AS_t}$ ) in states that experience larger falls in the incidence of child labor.

Because, as said, the term  $B_{S_t}$  is the sum of  $K$  different terms, one can run a separate regression for each industry and ascertain the contribution of this industry to changes in child labor.

$$(5) \quad B_{kS_t} = \alpha_k + \beta_{Bk} p_{S_t} + d_S + d_t + e_{S_t} \quad k = 1, \dots, K$$

The coefficient  $\beta_{Bk}$  will be positive (negative) if industry  $k$  declines (grows) more in states that experience the largest fall in child labor. The magnitude of this coefficient will be directly proportional to child intensity in each industry ( $N_{kC}/N_{kA}$ ), so that more child intensive industries will also be expected to display larger coefficients.

As for the other terms, higher labor demand will imply - everything else being equal - higher child labor. For this reason, one would expect  $\beta_E$  to be positive. However, to the extent that higher adult employment is associated with higher living standards and hence lower child labor, one will expect the reverse to be true.

Similarly, while a higher proportion of children in the population, i.e. higher aggregate child labor supply, will - at given demand - decrease the fraction of children in work, the opposite might be true if - for example - a higher fraction of children in the population is

associated to larger household size, and the latter leads to higher child labor supply; hence  $\beta_P$  might be either positive or negative.

Even at fixed industrial composition, the evolution in the fraction of children in work will depend on the evolution of child labor intensity across industries (i.e. within states). If the ratio of children to unskilled adult laborers falls across all industries in a state - say because of an overall fall in child labor supply due to school promotion policies - the fraction of working children will also fall, and hence the coefficient  $\beta_W$  will be positive.

The coefficient  $\beta_U$  will typically be positive if the relative employment of unskilled workers falls across all industries in states that experience a larger fall in child labor. This will be the case, for example, if changes in child labor are driven by skill biased technological change. By the opposite token, an exogenous increase in the supply of unskilled workers might displace child labor, leading to a negative correlation between the fraction of working children and the fraction of unskilled workers in the economy.

Finally a positive  $\beta_R$  coefficient implies that the different elements of the decomposition covary positively and reinforce each other. This might happen for example if child labor intensity falls more in industries that decline more rapidly in states that experience a larger fall in child labor. To the extent that the cross correlation between the different elements on the right hand side of (1) is small, changes in child labor can be approximated by the sum of the between, within, population, relative and total employment components, so that the coefficient on the residual term ( $\beta_R$ ) will be close to zero.

Before presenting the empirical results, it is useful to emphasize that some caution must be exerted in interpreting the OLS estimates of equation (4) as causal. Not different from any other variance decomposition, these estimates only provide a descriptive measure of the average

contribution of different components to changes in child labor across states and time and they do not necessarily carry a causal interpretation. We return to this issue in the last section of the paper.

### 3. EMPIRICAL RESULTS

#### 3.1. Main results

We start by presenting OLS estimates of equation (4) in Table 2, where each column refers to a different dependent variable. Regressions are performed on grouped data (by state and year). Overall we have 78 observations (26 states x 3 years).<sup>6</sup> For the estimation we use GLS with weights given by the number of observations by cell.

We start by assessing the role played by between changes, the component of primary interest in this paper. This term accounts for 21% of the variations in rural boys' employment (row 1, column 1). This says that around one fifth of the differential trends in the fraction of working boys across states is accommodated by differential shifts in their industry mix. In other terms, child intensive industries happen to decline more in states that experienced larger declines in the intensity of child labor.

In order to shed some light on this correlation, we investigate the contribution of changes in the relative employment weight of the top ten child-intensive industries in Table 3. In practice for the first, second, third, etc. top child-intensive industry we run a regression like (5). For rural boys, the associated coefficients are reported in column 1. We also report the cumulative contribution of the top one, two, three etc. child intensive industries in column 2. For example, row 1, column 1 of Table 3 illustrates that the differential trends in the share of adult

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<sup>6</sup> The state of Tocantins was created in 1985 out of a split of the state of Goias. For consistency we consider Tocantins and Goias as single state throughout the period.

employment in the cotton industry across states account for around 20% of the differential trends in child labor. The coefficient though is not statistically significant at conventional levels. Row (2) shows that tobacco accounts for a mere 1%, and column 2, row 2, shows that cotton and tobacco together account for 21% (20% + 1%) of the observed trend. The cumulative contribution of the top 10 child intensive industries - in the last row of the table - is 21%, hence very similar to the overall compositional change in Table 2, and significant at conventional levels. Changes in the share of employment devoted to the cultivation of coffee, in particular, appear to provide a sizeable and statistically significant contribution to the differential trend in boys' labor across rural areas of Brazil over the twenty years of observation: the estimated effect is 14% of the overall change and statistically significant.

Results for rural girls are reported in the right hand side panel of Table 2. Compositional changes display an effect that is not dissimilar to that found for boys, accounting for around 23% of the differences in the incidence of child labor across areas. Again, Table 3 shows that the single most important sector accounting for the fall in girls' labor across Brazil is coffee.

Indeed, coffee production underwent major changes in Brazil over the period considered. Following the end of government control of the coffee market in the late 1980s, production was moved out of the frost-prone southern states to the northern states, while at the same time productivity enhancing technologies were adopted and crops diversified.

This shift is clearly evident in our data as it is the contemporaneous change in child labor. Over the twenty years of analysis, the southern state of Paraná, for example - one of the states with the highest intensity of child labor in 1980 - experiences a very sizeable fall in the share of rural adult employment in the coffee industry (on the order of negative 12 percentage points for males and 9 percentage points for females) while also witnessing some of the largest falls in rural

child labor (on the order of negative 19 percentage points for boys and negative 5 percentage points for girls). By the opposite token, Espirito Santo in the north experiences a fast rise in the share of adult employment in coffee (of around 7 percentage points for males and 20 percentage points for girls) and no change or even a rise in rural child labor (of negative 1 percentage points for boys and positive 7 percentage points for girls).

Table 3 also shows that domestic services appear to have the opposite effect on child labor: in states where adult employment in domestic services grows relative to the national trend, girls' labor declines by more. For example, San Paulo, one of the states with the largest fall in rural child labor (of negative 25 percentage points for boys and negative 13 percentage points for girls), sees the share of adult employment in domestic services grow well above the national average (by around positive 4 percentage points for males and 10 percentage points for women, in the face of substantial stability in the share of adult domestic workers nationwide). One possible explanation for this correlation is that in places where the overall demand for or supply of child labor falls more, because of technical progress or increases in living standards, the demand for domestic services increases by more.

Similar to what found for rural boys, the top 10 girls-intensive-industries account in practice for the entire change in child labor attributable to compositional changes (29% versus 23%).

Consistent with the findings in Figure 1, results in the bottom part of Table 2 show that urban child labor - whether of boys or girls - is essentially unaffected by between industry changes, the effect being between 6% for girls and -2% (but statistically insignificant) for boys. Table 3 also reveals that in urban areas there is no single industry that contributes individually to variations in the incidence of child labor in any appreciable way.

Before investigating in further detail the contribution of between changes to variations in the incidence of child labor, we briefly discuss the role played by other components of the decomposition in (3) in explaining child labor. Within changes, in columns 2 and 8 of Table 2, explain the bulk of changes in child labor. As said, these are changes induced by differential shift in the incidence of child labor relative to unskilled adult labor ( $N_{kCS_t}/N_{kUS_t}$ ) across different industries in any given state.

For rural boys, differences in adult employment in column 4 of Table 2 account for 12% of the differences in trends in child labor incidence across areas of Brazil. The coefficient is positive and significant implying (as found by others) that stronger labor demand is also associated with higher child employment. Finally, columns 5 and 6 show that increases in the ratio of the adult to child population are not systematically associated to lower or higher child labor, and that there is no significant effect of the residual component. This suggests that the approximation induced by evaluating changes at the year and state means does essentially a good job in fitting the data.

Broadly speaking, results are similar for urban boys and for girls, whether in urban or rural areas. A few exceptions are noteworthy: first, rural girls are more responsive to changes in local labor demand, with changes in adult female employment accounting on average for around 31% of female child labor. This is consistent with female labor supply being more responsive to demand shifts than male labor supply, a fact that is known to be true for adults. Second, the role of population changes is small and generally insignificant except for urban boys: here an increase in the share of children in the population (i.e. a fall in the share of adults, the term  $P_{St}$ ) is associated to lower child labor, consistent with the existence of a market for salaried boys' labor in urban areas but not in rural areas. A shift in the labor supply brought about by exogenous

changes in the population depresses wages and reduces the incentives for children to work.

Finally, demand for skills, as proxied by the employment of low education adult workers only affects children's employment in urban areas but not in rural areas.

We have performed a few robustness checks on our data (not reported). These show that results in Table 2 are not sensitive to weighting or a more detailed industrial classification.

### **3.2 Endogeneity concerns**

A concern with the estimates in Tables 2 and 3 is reverse causality, i.e. that changes in industry composition are a result of - rather than a driving force behind - the fall in child labor. Simple economic reasoning suggests that child intensive industries might flourish where there is excess supply of child labor. Precisely in this vein, Goldin and Sokoloff (1982) attribute the industrialization of the American North-East, among other things, to the abundance of child labor.

A related concern is given by omitted variables: if a state becomes more educated, its industry mix might change as will the propensity of children to work. In this case, one would erroneously conclude that changes in child labor are caused by changes in the industry mix, although in fact it is changes in the demand for education to drive this correlation.

As a way to check for the potential endogeneity of compositional changes, in Table 4 we regress the between component on the other - arguably exogenous - determinants of child labor. First, we investigate whether changes in the industry mix are correlated with changes in the ratio of adults to children in the population, the term  $P_S$ . If a higher share of children creates an incentive for child intensive industries to flourish, one would expect the OLS coefficient from this regression to be negative. In column 1 of Table 4 we report OLS coefficients from a

regression similar to equation (4) where the dependent variable is  $B_{St}$  and the independent variable is  $P_{St}$ . Again regressions include state and year fixed effects and are weighted by cell size. The estimated coefficient can never be told apart from zero, lending little support to the notion that the industry mix is endogenous to the population structure.

In column 2 we regress the between term on the term  $U_{St}$ , that measures changes in the employment of unskilled workers. This term arguably proxies for changes in the demand of unskilled labor in a given state, so one would expect the regression coefficient to be positive if omitted demand shifts explain different trends in the industry mix across states. Column 2 again finds little support in favor of this hypothesis. In three cases out of four the regression coefficients are statistically insignificant. It is only for girls in rural areas that the coefficient is significant. Although we have no obvious explanation as to why results for rural girls appear different, we find little evidence that changes in the industry mix do not vary endogenously in response to other underlying forces behind the changes in child labor.

As a final check, we have re-estimated the model in first-differences (as opposed to levels with the inclusion of state fixed effects) and we have allowed the coefficient of interest to vary across decades (1980-1991 and 1991-2000).<sup>7</sup> In this way we test whether the effect of changes in the industry mix manifest predominantly in one decade. This is particularly relevant in the context of Brazil since - as said - the second half of the 1990s saw a vigorous policy effort in the fight against child labor. The concern here is that changes in both child labor and the between term might be driven by policy changes that happened to affect some states but not others.<sup>8</sup> Indeed, the regressions show no evidence of the correlation being stronger in any single decade:

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<sup>7</sup> First differences estimates are almost undistinguishable from estimates in levels with the inclusion of state fixed effects.

<sup>8</sup> A potentially better strategy would be to control explicitly for the spread of *Bolsa Escola* and *PETI* across different states. However, as said, most of these programs were implemented at the municipality level and we have no information on the spread of these programs across areas and time.

the interaction term between changes in child labor and a dummy for the decade of the 1980s (in column 4) is insignificant in all cases. This suggests that the policy efforts of the 1990s - and in particular the rapid expansion of *PETI* and *Bolsa Escola* schemes - are unlikely to be driving our results. This is perhaps not surprising since by 1999 municipal *Bolsa Escola* and *PETI* programs extended to a small minority of Brazilian municipalities. It is only in the early 2000s, so after our period of analysis, that these programs were scaled up to the federal level and when one might expect a sizeable effect.

#### **4. CONCLUSIONS**

Brazil has experienced one of the largest declines in child labor and increases in schooling observed in any country over a 25 year period. Within industry differences in employment are the single most important factor in explaining this fall. These differences subsume changes in the supply of child labor induced by improvements in living standards and policy interventions. The sustained effort of the Brazilian government to increase school attendance and curb child labor through school promotion programs might have played some role in explaining the observed fall in child labor.

Despite this evidence, we find that changes in the industry mix are able to account for a sizeable and significant share of the differential trends in child employment across Brazilian states. As child intensive industries decline, child labor falls, suggesting that households do not fully readjust their children's labor supply through endogenous occupational choices.

We show that around 20% of the differential evolution of rural child labor across states is explained by the spread of different industries. In particular, differential trends across states in coffee production - a sector that sees Brazil as the top world producer and that is characterized

by high child labor intensity - can explain around 16-17% of the differential trends in child labor across Brazilian states. Indeed, the shift in coffee production from the frost-prone southern states to the northern states that took place in the 1990s was accompanied by a modest fall in child labor in the rural north and a much rapid fall in the south.

Results for urban areas show a smaller role of compositional changes in explaining differences in the incidence of child labor across states. This is consistent with our finding that urban children happen to be much more segregated in specific industries than rural children, and that child intensive industries amount for a small and essentially fixed share of adult employment in urban areas.

One potential concern with our analysis is that changes in the industry mix are the response to - rather than the cause of - changes in child labor induced by increased availability of child labor or skill-biased changes in labor demand. In this spirit, Goldin and Sokoloff (1982) for example trace the early industrialization of the American North-East, among other things, to the availability of cheap child (and female) labor that was complementary to capital intensive technologies employed in manufacturing. Our empirical analysis however shows evidence that changes in child labor induced by changes in the industry mix are largely exogenous to changes in the supply of child labor or skilled-biased technological change. Similarly, we find no evidence that the estimated coefficient is explained primarily by changes in child labor over the 1990s, when a number of policy interventions were implemented with the precise scope of combating child labor. This appears to rule out that exogenous economic and policy changes are behind our estimated effect, although, admittedly, we cannot rule out that other unobserved factors (e.g. changes in living standards) might explain the correlation between changes in the adult industry mix and the incidence of child labor.

Changes in the pattern of coffee production across Brazilian states provide additional corroborating evidence in favor of our conclusion, as, by all accounts, these were driven by the liberalization of the coffee market and the contemporaneous replacement of traditional shade grown farming with sun cultivation, rather than local abundance of child labor or demand for education.

Our analysis suggests that sectoral interventions aimed at boosting product demand or expanding production by lowering costs, for example by affecting import or export tariffs or through targeted aid, might have unwanted effects on child labor. We find evidence that the incidence of child work increases as child intensive sectors expand. In this vein, sectoral policies aimed at limiting the spread of child intensive industries or policies that promote the adoption of technologies that are substitutes for children in child intensive industries could have the potential to reduce the incidence of child labor, although admittedly potentially making households worse-off at the same time.

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## **Data Appendix**

The industrial classification changes over time in the Brazilian census. In particular, recent censuses (especially the 2000 census) include more industry items than older ones, corresponding to a lower level of aggregation. In each year, an “undefined” category for each one-digit industry collects workers who are not classified elsewhere. This residual group encompasses different industries at different times. An additional problem is that certain activities which were relevant in the past, such as for example home-based textile production, have lost significance with time and are not included in recent surveys. Such activities are potentially relevant among child laborers. On the other hand, the emergence of “new” activities associated with technological development implies that several sectors are not present in past surveys (for example several services in financial intermediation, communications and several services rendered to companies).

To face these problems and to produce a harmonized industrial classification, the following approach was adopted:

1. The harmonized classification scheme preserved the items that were present in all survey years, while those which were not were assigned to broader categories common to all years were imputed to the existing categories. As a consequence, such categories aggregated a different number of items by year.
2. In several cases, the nomenclature of items was not uniform over time, although the underlying industry activity was presumably the same. The assignment of items to broader categories was carried out referring to the UN ISIC (Revision 3) classification of economic activities.

3. All items which could not be assigned with a reasonable level of confidence to broader categories were grouped under “Other activities”.
4. New activities were assigned to “Other activities” unless they could be assigned unequivocally to existing categories.
5. “Obsolete” activities were treated the same way.

The result of the reclassification exercise was a harmonized taxonomy at a higher level of aggregation relative to all survey years that includes 105 industries.

Table 1: Child intensive industries

<u>Boys – Rural</u>		<u>Girls- Rural</u>	
Herbaceous cotton	0.157	Herbaceous cotton	0.235
Tobacco	0.142	Coffee	0.204
Corn	0.135	Tobacco	0.179
Other activities	0.133	Corn	0.167
Manioc root	0.132	Transf. Non-metallic miner.	0.165
Undefined crops	0.127	Lumber	0.162
Coffee	0.120	Domestic services	0.157
Sugar cane	0.119	Undefined crops	0.148
Rice	0.116	Cocoa beans	0.141
Paper commerce	0.110	Horti/floriculture	0.140
Average	0.110	Average	0.137
<u>Boys – Urban</u>		<u>Girls - Urban</u>	
Herbaceous cotton	0.099	Herbaceous cotton	0.134
Horticulture	0.098	Tobacco	0.114
Domestic services	0.094	Domestic services	0.111
Personal services	0.093	Coffee	0.102
Footwear	0.090	Undefined crops	0.089
Tobacco	0.090	Footwear	0.088
Sugar cane	0.089	Soybeans	0.087
Supermarkets	0.086	Horti/floriculture	0.079
Coffee	0.085	Sugar cane	0.074
Paper commerce	0.085	Manioc root	0.068
Average	0.033	Average	0.041

Notes. The table reports the ratio of children to adults employed in the top ten child intensive industries separately by sex and area. For example, row 1, column 1, shows that in rural areas there are 15.7 male children employed in cotton for every 100 adult males employed in that industry. The bottom row reports the ratio of employed children to adults in the economy as a whole.

Table 2: Decomposing changes in child labor

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Between	Within	Unskilled Emp.ment	Aggregate Emp.ment	Pop.	Residual	Between	Within	Unskilled Emp.ment	Aggregate Emp.ment	Pop.	Residual
<u>Boys – Rural</u>						<u>Girls - Rural</u>					
0.209***	0.600***	-0.006	0.123***	0.043	0.032	0.231***	0.371**	0.049	0.314*	0.024	0.011
(0.069)	(0.142)	(0.056)	(0.030)	(0.104)	(0.150)	(0.047)	(0.102)	(0.036)	(0.129)	(0.108)	(0.226)
<u>Boys – Urban</u>						<u>Girls - Urban</u>					
-0.022	0.489***	0.133***	0.023*	0.071**	0.306***	0.062***	0.512***	0.046**	0.014	0.027	0.339***
(0.019)	(0.065)	(0.022)	(0.012)	(0.028)	(0.050)	(0.019)	(0.107)	(0.019)	(0.021)	(0.021)	(0.065)

Notes. The Table reports OLS estimates of equation (4). Each cell corresponds to a different regression. Standard errors in brackets. All regressions weighted by cell size. Number of observations: 78.

Table 3: Contribution to changes in child labor of most child intensive industries

	(1)		(2)		(3)		(4)		
	Marginal Effect		Cumulative effect		Marginal effect		Cumulative effect		
<u>Boys- Rural</u>				<u>Girls- Rural</u>					
Herbaceous cotton	0.201	(0.172)	0.201	(0.172)	Herbaceous cotton	0.031	(0.045)	0.031	(0.045)
Tobacco	0.014	(0.017)	0.215	(0.174)	Coffee	0.157***	(0.028)	0.188***	(0.050)
Corn	-0.021	(0.075)	0.195	(0.145)	Tobacco	-0.001	(0.009)	0.187***	(0.050)
Other activities	0.011	(0.011)	0.206	(0.147)	Corn	0.105***	(0.036)	0.292***	(0.056)
Manioc root	-0.067*	(0.039)	0.139	(0.157)	Transf. Non-metallic miner.	0.011***	(0.003)	0.303***	(0.056)
Undefined crops	-0.069	(0.080)	0.070	(0.127)	Lumber	-0.001	(0.023)	0.302***	(0.064)
Coffee	0.174***	(0.044)	0.244*	(0.122)	Domestic services	-0.058***	(0.012)	0.244***	(0.062)
Sugar cane	-0.001***	(0.000)	0.244**	(0.122)	Undefined crops	0.045	(0.059)	0.289***	(0.057)
Rice	-0.036	(0.072)	0.208*	(0.105)	Cocoa beans	-0.006	(0.009)	0.283***	(0.056)
Paper commerce	-0.000*	(0.000)	0.207*	(0.105)	Horti/floriculture	0.004	(0.005)	0.287***	(0.055)
<u>Boys- Urban</u>				<u>Girls- Urban</u>					
Herbaceous cotton	-0.006	(0.023)	-0.006	(0.023)	Herbaceous cotton	-0.004	(0.004)	-0.004	(0.004)
Horticulture	0.004*	(0.002)	-0.002	(0.023)	Tobacco	-0.001	(0.001)	-0.005	(0.004)
Domestic services	0.004***	(0.001)	0.002	(0.023)	Domestic services	0.025	(0.020)	0.021	(0.020)
Personal services	-0.004**	(0.002)	-0.001	(0.023)	Coffee	0.006	(0.004)	0.027	(0.019)
Footwear	0.004	(0.004)	0.002	(0.023)	Undefined crops	0.003	(0.005)	0.030	(0.019)
Tobacco	-0.001	(0.001)	0.001	(0.022)	Footwear	0.007**	(0.003)	0.037*	(0.019)
Sugar cane	-0.008	(0.009)	-0.007	(0.025)	Soybeans	0.001	(0.001)	0.038*	(0.019)
Supermarkets	-0.002	(0.003)	-0.010	(0.026)	Horti/floriculture	0.001	(0.001)	0.038*	(0.019)
Coffee	0.018**	(0.008)	0.008	(0.027)	Sugar cane	0.007**	(0.003)	0.045**	(0.020)
Paper commerce	-0.000	(0.001)	0.008	(0.027)	Manioc root	-0.001	(0.001)	0.044**	(0.020)

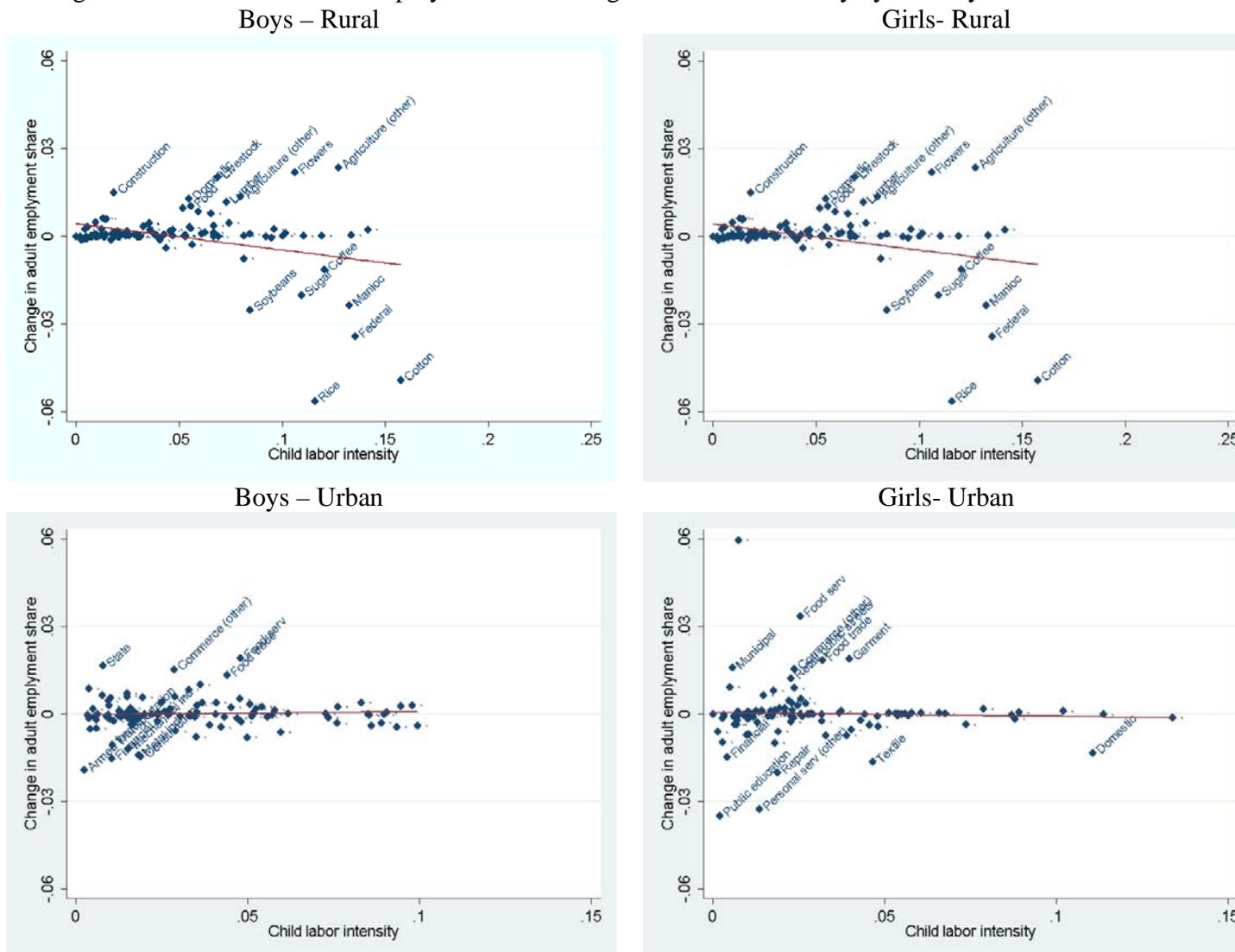
Notes. Columns 1 and 3 report OLS estimates of equation (5) for the top-ten most child intensive industries (in Table 1). Regression coefficients provide an estimate of the marginal contribution of changes in the employment share of the first, second, third, etc. top child-intensive industry to changes in child labor. Columns 2 and 4 report the cumulative contribution of the first one, first two, first three, etc. top child-intensive industries. See also notes to Table 2.

Table 4: Endogeneity checks

	Endogeneity checks			
	(1)	(2)	(3)	(4)
	Independent variable		Heterogeneous effects by decade	
	Population	Unskilled relative employment	Changes in child labor	Changes in child labor X (1980-91)
<u>Boys – Rural</u>	-0.025 (0.0103)	0.280 (0.188)	0.250*** (0.047)	-0.109 (0.047)
<u>Girls – Rural</u>	0.224 (0.134)	-0.094 (0.238)	0.304*** (0.078)	-0.003 (0.003)
<u>Boys – Urban</u>	-0.126 (0.091)	-0.224** (0.090)	-0.031 (0.022)	0.045 (0.052)
<u>Girls – Urban</u>	0.155 (0.139)	0.209 (0.142)	0.120*** (0.026)	-0.079 (0.067)

Notes. Columns 1 and 2 report regressions of the between component on the population and unskilled relative employment components respectively. Columns 3 and 4 report results from the estimation of equation (4) in first differences, where the child labor variable is interacted with a dummy for the decade of the 1980s.

Figure 1 - Changes in adult distribution of employment and average child labor intensity by industry



Notes. The figure reports the change in the share of adult employment between 1980 and 2000 on the vertical axis over the average (between 1980 and 2000) ratio of child to adult employment in each of the 105 industries separately for urban and rural areas and by gender.

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