# Does a Child Labor Kuznets Curve Exist?

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May 1, 2009

**Abstract**

In this paper, I investigate the relationship between a nation's GDP per capita and its rate of child labor incidence. Specifically, I hypothesize that an inverted-U shaped relationship exists, which could be called a "child labor Kuznets curve." I also analyze how, given the existence of such a curve, boycotts and trade sanctions may affect child labor incidence. Furthermore, I examine the effectiveness of international child labor legislation and cooperative agreements. Using fixed-effects and random-effects OLS, I find that logged GDP per capita and its squared value have coefficient estimates statistically significant in difference from zero and with signs consistent with an inverted-U shape; that a country's exports are positively associated with child labor incidence (although this effect is diminished in richer countries); and mixed results regarding legislation's effectiveness. Lowess smoothing fits a Kuznets curve relationship more closely for some geographical regions than others, although the results may not be reliable due to the relatively small sample sizes used. Finally, policy implications based on the aforementioned results are discussed.

Special thanks to Professors John Cadigan, Brendan Cushing-Daniels, Michael Margolis, the Econ 420 seminar and countless others for their helpful comments and suggestions.

## I. INTRODUCTION

According to a recent estimate from the International Labour Organisation's International Programme on the Elimination of Child Labour (ILO-IPEC), there are approximately 218 million children currently employed in some form of child labor[1] (ILO-IPEC 2008b). Many consumers in developed countries boycott firms or countries that employ children (e.g.: Birchall 2008), suggesting such consumers believe that these boycotts will decrease child labor incidence. However, pro-free trade consumers argue that increased trade leads to higher income levels; greater income may allow parents to educate rather than employ their children, suggesting a negative association between a country's exports and its child labor incidence. Yet another argument is that of the "race to the bottom," whereby firms repeatedly cut wages and labor standards in an effort to cut costs and remain competitive. Proponents of this argument advocate the use of international cooperative agreements to stop the downward spiral of labor standards.

The differences in opinion are no trivial matter. Many employed children may not be able to survive without the income they earn or production they contribute, and a boycott or ban alone would not improve child welfare in such cases. Instead, displaced child employees may seek other, more dangerous forms of employment to ensure their survival. Indeed, in anticipation of the Child Labor Deterrence Act becoming law in the United States, (though it never did), garment exporters in Bangladesh fired numerous children from their factories, who then merely

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1 In everyday use, "child labor" may refer to any work done by children. This simplistic definition masks two basic issues that lead to problems when estimating worldwide incidence of child labor: the definitions of "work" and "child." The ILO considers any work that "deprives children of their childhood, their potential and their dignity, and that is harmful to physical and mental development" to be the kind of work referred to when using the negative term "child labor" (ILO-IPEC 2008a). Although adulthood is a relative, culturally defined term, the 1973 ILO Convention 138 establishes a minimum working age of no less than 15 for ratifying countries, so children can be considered to be under the age of 15. In this paper, child labor will be defined following the ILO standards.

proceeded to take employment in more dangerous occupations[2] (Basu & Van 1998). However, if a country's labor market displays multiple equilibria—one where children work and one where they do not—child labor boycotts or legislative bans may be the most effective tactic (Basu & Van 1998, Doepke & Zilibotti 2005).

To determine the most appropriate policy approach, we must first understand the determinants of child labor. I hypothesize that there exists an inverted U-shaped relationship between a nation's income and its child labor incidence, similar to Simon Kuznets's curve relating income and a nation's income inequality (Kuznets 1955). Given that international trade accounts for part of GDP, changes in the level of exports may be associated with parallel changes in total GDP, indicating that boycotts may increase or decrease a country's child labor incidence—depending on that country's location on its Kuznets curve—purely due to exports' effects on income. However, exports may affect child labor somewhat independently of income through labor demand effects. The size of these effects may vary depending on the quality and enforcement of countries' existing child labor legislation Thus, my central research questions may be stated as such: does a child labor Kuznets curve exist, and are boycotts associated with lower child labor incidence?[3] Finally, is anti-child labor legislation effective?

I build from the existing literature to develop a theoretical model of child labor to answer these questions. The empirical results are consistent with my hypothesis of the existence of a Kuznets curve, and indicate that boycotts are associated with lower child labor incidence due to labor demand effects. Certain forms of child labor legislation seem to be more effective than

2 E.g. prostitution or hard labor, such as breaking bricks outdoors (Basu & Van 1998).
3 If a child labor Kuznets curve exists, the second half of the research question will determine whether increasing international trade is an appropriate tactic for raising income in the long-term goal of lowering child labor without sacrificing economic development.

others. This paper expands on the existing theoretical and empirical literature by being the first to directly investigate the existence of a child labor Kuznets curve across countries and time.

This paper is organized as follows: Section II reviews the existing child labor literature; Section III describes the data, Section IV outlines the methodology used; Section V reports the results and Section VI offers policy suggestions and conclusions.

## II. LITERATURE REVIEW

The literature examined for this study comes from numerous branches of the economics literature, including labor economics, international economics, and family and household economics. In this section, I discuss several papers with research goals similar to mine, followed by a discussion of the determinants of child labor incidence as argued in the existing literature.

### 1. Similar Papers

There are three papers that propose the existence of an inverted U-shaped relationship between child labor incidence and an income-related variable. These papers differ from mine in that they use household-level data from a single country as opposed to cross-country data, and they utilize different measures of income (economic growth, wealth, and household income). Thus, none of these papers directly investigate the existence of a child labor Kuznets curve. These papers were written by Kambhampati and Rajan (2006); Basu, Das and Dutta (2007); and Del Carpio (2008).

Of the three papers discussed in this section, Kambhampati's and Rajan's (2006) hypothesis is most directly related to mine. Their paper investigates whether a Kuznets curve (so called by the authors) exists for child labor; however, they stray from the conventional definition of a Kuznets curve and claim that child labor incidence can be plotted as an inverted U-shaped function of economic growth, rather than as a function of income per capita as would be expected for a Kuznets curve. They limit their analysis to India, where they are able to obtain household-level data. Using a probit model to analyze the effect of economic growth on the probability that a child will be employed, the authors find results consistent with their hypothesis.

Basu, Das and Dutta (2007), also utilizing individual-level data from India, hypothesize that an inverted U-shaped relationship exists between child labor incidence and household income. However, they find direct measures of household income problematic. They believe measures of consumption would represent household affluence more accurately than income, but recognize that an endogeneity issue exists between child labor incidence and consumption, since households will be able to consume more when employing their children. To remove the endogeneity problem, the authors instead analyze the relationship between child labor incidence (measured in hours of labor) and wealth. The authors find inverted U-shaped relationships between child labor incidence and both land and livestock ownership.

Focusing on Nicaragua, Del Carpio (2008) hypothesizes that an inverted U-shaped relationship exists between child labor and income. Del Carpio focuses on results from a natural experiment conducted in particularly poor regions of Nicaragua using a conditional cash transfer (CCT) program. Under the CCT program, parents would receive various benefits conditional on sending their children to school. Del Carpio's child labor data, like the other two papers discussed here, contains household-level observations. Results are consistent with her hypothesis when all of the data is pooled, but these results vary depending on gender, age, and participation in physical versus non-physical labor. Furthermore, although the coefficient estimates suggest an inverted U-shape, due to the extreme poverty of the observed regions Del Carpio finds an (mostly upward-sloping) inverted-J shape.

**2. Determinants of Child Labor**

As mentioned above, a country's child labor incidence is colloquially thought to be worsened as its exports rise; typically in developing countries where child labor is already a problem (exports are not thought to create child labor in developed countries). Economic theory provides some merit to this line of thought, as the level of exports from a country may be associated with the demand for child labor (Edmonds & Pavcnik 2006). As a country's exporting firms produce higher levels of output, demand for both adult and child labor increases. The actual proportion of child labor employed will depend on the productivity levels of child and adult labor and the relative need for unskilled labor, the only labor of which children are capable. A child can be expected to produce only a fraction $\lambda$ of what an adult unskilled laborer can produce. Equilibrium child wages should thus be a fraction $\lambda$ of adult unskilled wages (Basu & Van 1998). Firms are expected to hire a profit-maximizing mix of child and adult labor as exports increase, subject to this adult-child wage relationship. Firms may be constrained in the total amount of laborers they may hire due to limited floor space, in which case they will prefer to hire the more productive adult laborers first (Brown & Philips 1992).

Most of the theoretical and empirical models of child labor utilized in the existing literature assume a one-parent, one- or multiple-child household where the parent decides how to allocate her child's time among work and school or leisure (Dehejia & Gatti 2005, Doepke & Zilibotti 2005, Edmonds & Pavcnik 2006, Rogers & Swinnerton 2004, etc.). This model can be expanded to accommodate two-parent households by thinking of parents combining their incomes or distributing children into sub-households. The assumption of parental control over decision-making is especially appropriate for younger age groups, where children typically do not make the majority of their own decisions. The literature universally assumes that parents are altruistic and that children's lifetime utility function is part of their parents' utility function. Although there may be cases where parents employ their children as a form of abuse or neglect, the altruistic model of parents is more likely to be accurate (Basu & Van 1998). A child's utility is determined by his present and future consumption, where his future consumption is an increasing function of his schooling in the current period (human capital development increases earnings potential, providing a higher future income from which to consume). Children and their parents both receive a disutility when the children are employed, so parents will generally prefer not to employ their children if possible. In particular, if lifetime returns to schooling are positive, parents will prefer to send their children to school rather than to work. However, if parental income alone is not enough to maintain a subsistence level of consumption, parents will be forced to send their children to work. Thus, as per capita income increases, we expect more parents to be able to afford to educate their children, causing child labor to decrease. Conversely, for very low levels of income—where returns to human capital investment are likely to be small—rising income per capita may be associated with wages rising above parents' reservation wages for employing their children, which would increase child labor. These income-range specific effects begin to suggest the existence of a child labor Kuznets curve.

Due to the unskilled nature of child labor, not all industries will demand child labor. Child labor is historically most concentrated in the agricultural sector, so countries that depend more heavily on agricultural production may have a higher incidence of child labor (Doepke & Zilibotti 2005). Geographic factors may determine the types of industries that tend to prevail in a country. Specifically, countries with high rural populations will be more inclined toward agricultural production, and therefore will be more likely to have a higher incidence of child labor (Edmonds & Pavcnik 2006).

Educational costs and opportunities also affect parental willingness to supply child labor. As previously mentioned, a child's future income is an increasing function of his current schooling, so better educational opportunities would increase a child's potential future consumption and should be negatively associated with child labor incidence. However, if educational costs are excessively high relative to the quality of the education, the returns to schooling may not outweigh the costs. Additionally, if credit is unavailable, parents simply may not be able to afford to send their children to school when the opportunity cost of schooling is added to the price of tuition (Basu 1999, Dehejia & Samy 2007, Grootaert & Kanbur 1995).

The quantity of children in a family will affect the level of income needed to achieve subsistence consumption, and is a result of irreversible fertility decisions made in reaction to the state of the economy during the parent's early adulthood (Doepke & Zilibotti 2005). These fertility decisions may furthermore be affected by society's moral views toward child labor: if child labor is accepted by society, adults may choose to have larger families to maximize household consumption through child employment. Conversely, if child labor is considered unacceptable, adults may choose to have smaller families that are more affordable when child labor is not a socially acceptable option. These views will also affect parents' reservation wages for employing their children. Interestingly, moral attitudes toward child labor are strongly affected by the status quo: when child labor is widespread, it is frequently not considered an undesirable aberration (Basu & Van 1998).

The modern view of child labor from the developed world is a highly negative one, but child labor has not always been viewed this way. In the 19th century, child labor was common in both the United States and Britain, but was thought of as a healthy part of a child's maturation. Labor was seen as an alternative to idleness and crime, and moral opposition to child labor did not gain momentum until unskilled labor unions, attempting to reduce job competition, began to denounce child labor on moral grounds (Brown et al 1992, Doepke & Zilibotti 2005). Today, the U.S. is strongly opposed to child labor—now that there is relatively little child labor in the U.S. to oppose! This historical shift further suggests that views on child labor may be morally relativistic and based on social norms and the status quo (Basu & Van 1998). Not all contemporary societies view child labor in a negative light, however. For example, some African cultures believe work to be an integral part of a child's social development that provides them with the skills and education necessary for a successful life (Grootaert & Kanbur 1995). In this case, child labor can be thought of as a complement to schooling and thus may be considered less harmful than child labor that serves as a substitute for education. Thus, the social importance of child labor may diminish effects otherwise associated with decreased child labor incidence for such countries.

Child labor laws and regulations can have a range of effects on the incidence of child labor, depending on the country's situation. If a country's child labor market displays multiple equilibria, a child labor ban or regulation can move a country from an equilibrium where children work to an equilibrium where no children work (Basu & Van 1998, Doepke & Zilibotti 2005). The quality of the legislation itself and the extent of enforcement are very important. If the regulation at hand is merely a partial ban (i.e. a ban on child labor in certain industries), children will simply shift to different industries and continue to work (Basu & Van 1998). If regulations are not properly enforced, children will clandestinely continue to work. Government corruption may therefore also affect the incidence of child labor, as firms may be willing to bribe officials in order to avoid compliance with child labor regulations (Brown & Philips 1992).

There are currently two major ILO Conventions regarding child labor. Despite the lack of enforcement or legal repercussions, these Conventions constitute the best existing attempts to legislate child labor on the international level. Convention 138 establishes minimum working ages for various qualitative classifications of labor ranging from light to hazardous work. Generally speaking, children below 13-15 should not perform any work, and only adults (age 18) may perform hazardous work according to the Convention. Some exceptions are made, however, for developing countries. Convention 182 prioritizes the elimination of the worst forms of child labor,[4] while still maintaining the long-term goal of total child labor eradication. Ratification of these Conventions merely indicates a commitment from the country to eradicate child labor, and fails to create any system of enforcement or consequences for noncompliance. Countries may ratify the Conventions earnestly, but there is an incentive for countries with high rates of child labor to ratify Conventions as an attempt to improve their country's global reputation. Furthermore, countries with already low rates of child labor incidence are likely to ratify such Conventions more as an act of condemnation of child labor worldwide than an effort to reduce it in their own nation. Conversely, countries with low child labor incidence may not feel the need to ratify child labor Conventions because they do not have any child labor to eliminate. Therefore it is difficult to draw a clear relationship between Convention ratification and child labor incidence.

4 Slavery and similar practices, child trafficking, debt bondage, forced labor, compulsory military service, prostitution and other sexual occupations, illicit activities such as drug trafficking, and otherwise harmful work.

As Brown & Phillips (1992) argue, firms may choose to employ child labor for motives apart from the fruits of the children's labor. In the United States during the Industrial Revolution, fruit and vegetable cannery work was considered unfit for men, so canneries relied on hiring women. Although children were less productive (and often counterproductive in more industrialized canneries where floor space was precious and machines were too large and complicated to be operated by young children), firms often reluctantly hired them in order to induce the children's mothers into the workforce. Mothers favored this form of child care because they could be with their children all day and benefit from the children's income, as opposed to paying a fee for child care (Brown & Phillips 1992).

The literature can be combined to provide the following argument for an inverted U-shaped relationship between child labor incidence and income. At very low levels of income, opportunities for employment are likely to be low, suggesting a low opportunity cost of schooling or leisure for children. However, at such low levels of income, returns to education may be very low and families stand to benefit greatly from employing children if they could do so. As a nation's income rises, opportunities for child employment increase: demand for both child and adult labor will increase, raising child wages and inducing children into employment. This effect will be especially strong if educational opportunities are weak, lowering the opportunity cost of work with respect to returns to human capital investment. However, parents are altruistic and, in addition to caring about maximizing their children's lifetime consumption, prefer not to employ their children. As national income increases further, household income may rise to a sufficiently high level at which parents can afford to withdraw their children from the workforce. Similar arguments have been proposed by Kambhampati and Rajan (2006), Basu et al (2007) and Del Carpio (2008).

My paper will contribute to the existing literature by: directly testing for the presence of a Kuznets curve-type relationship between income and child labor across countries and time and testing whether similar results may be achieved with a newer measure of child labor from the World Bank.

## III. DATA

For the dependent variable of child labor incidence (*Child*), I use a panel data set from the ILO LABORSTA database measuring the percentage of children between ages 10 and 14 who are employed for 117 countries from 1950-2005[5]. The data collection methods vary by country and include labor force surveys, census data, and official national estimates. The definition of employment varies slightly from survey to survey, but generally includes one or more hours of paid or unpaid work weekly (ILO 2008). Workers may be self-employed or work for someone else, indicating that employment on family farms would be accounted for in the data. Furthermore, work and schooling are not considered to be mutually exclusive, so it is possible that some or all of the children reported to be working in this dataset are also attending school. Due to the relatively small number of observations, I do not conduct random sampling. This may bias the results somewhat due to the non-randomized collection technique utilized by the ILO[6].

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5 The panel is unbalanced: not all 117 countries have observations for every year. In total there are 460 observations.

6 Ideally, the Heckman selection correction would be applied to correct for this possible endogenous selection bias. This correction was not implemented due to time constraints; furthermore, there are many missing observations for the exogenous variables, which suggests that the Heckman correction would not be robust.

The exogenous variables are collected from a variety of sources and are meant to capture the determinants of child labor as discussed in Section II. Some determinants are necessarily omitted due to their unquantifiable nature or lack of prevalent data (e.g. measures of corruption and social views on child labor).

Logged GDP per capita (*Loginc*) is obtained from Penn World Tables 6.2 as a measure of national income. Parental income may be determined by adult wages, but this data is not widely available and GDP per capita is used as a proxy.

The ratio of exports to GDP (*Exports*) is obtained by combining GDP data from the Penn World Tables with exports data from the World Bank's World Development Indicators (WDI). Exports are divided by GDP to control for the importance of trade to a country's economy and to control for scale effects.

The percent of the population that is under the age of 15 (*Chpop*) is obtained from the WDI as a proxy for household size—a larger percentage indicates a higher child-to-adult ratio, suggesting a higher average household size.

ILO Convention ratification dummies (*ILO*138 and *ILO*182 for Conventions 138 and 182, respectively) are codified using information from the ILO's online ratification records. These dummies take on a value of 1 if country *i* had ratified the Convention during or before year *t*, and take on a value of 0 otherwise.

Following the literature, the preprimary enrollment rate (*Educ*) is used as a measurement of educational opportunities, and is obtained from the WDI (Dehejia & Samy 2007).

Regional dummy variables for Africa, Asia, Europe, North America and South America (*Africa*, *Asia*, *Europe*, *Namer* and *Samer*) are codified using the United Nations Statistic Division's classifications, with Oceania as the baseline.

Finally, the proportion of a nation's total population that is rurally located (*Rural*) is obtained from the WDI as a proxy for the relative importance of agriculture.

## IV. METHODOLOGY

First, I wish to estimate the most basic model possible to address my first research question: does an inverted-U shaped relationship exist between child labor and income, and are boycotts associated with lower child labor incidence? Thus, I analyze the following model:

$$Child_{it}=\beta_0+ \beta_1 Loginc_{it}+ \beta_2 Loginc^2_{it}+ \beta_3 Exports_{it}+\beta_4(Exports_{it}*Loginc_{it}) \quad (1)$$

Equation (1) tests for the existence of a child labor Kuznets curve while controlling for the effects of exports on child labor. In keeping with my hypothesis of the existence of a Kuznets curve, I expect *Loginc* to be positively associated with child labor incidence and $Loginc^2$ to be negatively associated with child labor incidence, creating an inverted-U shaped relationship between logged income per capita and child labor incidence.

I expect *Exports* to be positively related to child labor incidence due to trade's effects on labor demand, as discussed in Section II.2. I also interact *Exports* with *Loginc* to control for the fact that exports may affect child labor incidence differently for countries at different levels of income. As previously mentioned, exports are not thought to impact child labor incidence for higher-income or more developed countries; thus, I expect this interaction term to be negatively associated with child labor incidence.

I also wish to control for the major determinants of child labor discussed in the literature and address my second research question: is anti-child labor legislation effective? Thus I estimate the following equation:

$$Child_{it}=\beta_0+ \beta_1 Loginc_{it}+ \beta_2 Loginc^2_{it}+ \beta_3 Exports_{it}+\beta_4(Exports_{it}*Loginc_{it})+\beta_5 Chpop_{it} + \beta_6 Rural_{it}+ \beta_7 Educ_{it} +\beta_8 ILO138_{it} + \beta_9 ILO182_{it} \quad (2)$$

Expectations regarding the signs of the coefficient estimates for the income and exports variables in equation (2) are identical to those discussed for equation (1). *Chpop* is used as a proxy for household size. The explicit costs and opportunity costs of educating children increase with household size; thus, I expect *Chpop* to be positively associated with child labor incidence.

I expect *Rural* to be positively associated with child labor incidence because *Rural* is a proxy for agricultural importance and child labor tends to be concentrated in the agricultural sector.

I expect *Educ* to be negatively related to child labor incidence, as better educational opportunities should increase the opportunity cost to parents associated with employing children, encouraging human capital investment.

As discussed in the literature review, it is difficult to form clear *a priori* expectations regarding the signs of the coefficient estimates of ILO Convention ratification dummies given the lack of enforcement and incentive for dishonesty. With that in mind, I expect *ILO138* and *ILO182* to both be negatively related to child labor incidence, as the effects of honest ratification and implementation may overpower the aforementioned issues.

I also wish to determine whether certain geographical regions are more prone to child labor incidence than others. Following the literature, I only include dummy variables for Africa and Asia, as these regions are typically among the worst offenders with regards to child labor (Edmonds & Pavcnik 2006). Thus I add regional dummies and estimate the following equation:

$$Child_{it}=\beta_0+\beta_1 Loginc_{it}+\beta_2 Loginc^2_{it}+\beta_3 Exports_{it}+\beta_4(Exports_{it}*Loginc_{it})+\beta_5 Chpop_{it}+\beta_6 Rural_{it}+\beta_7 Educ_{it}+\beta_8 ILO138_{it}+\beta_9 ILO182_{it}+\beta_{10} Africa_i+\beta_{11} Asia_i \quad (3)$$

I expect both *Africa* and *Asia* to be positively related to child labor incidence.

Equations (1) through (3) are appropriate for ordinary least squares (OLS) estimation. Although one could argue that income is endogenous to child labor incidence—creating a simultaneity issue and biasing the OLS results—I argue that this endogeneity problem should be slight, as child labor incidence would tend to have a very small effect on national GDP per capita, *ceteris paribus*. Furthermore, correcting for this endogeneity using the two-stage least squares estimation procedure (using trade openness to instrument for income) returns results that are qualitatively similar to OLS.  Thus I conclude that any endogeneity that exists between child labor and income is not problematic in this case.

As discussed in the literature review, I expect cultural factors to be important determinants of child labor incidence, making it implausible to directly estimate equations (1) through (3) without controlling for the complex and largely unobservable factors that distinguish countries from one another. These cultural factors may even cause the ways the exogenous variables relate to the endogenous variables to differ among countries. These cultural factors are likely to be time invariant, suggesting that fixed effects estimation may be appropriate for this model, as opposed to random effects. Conducting the Hausman specification test for the appropriateness of fixed-effects versus random-effects estimation on equations (1) and (2) returns chi-squared statistics of 36.63 and 13.65, respectively. The null hypothesis of a lack of systematic difference in coefficients estimated by fixed effects and random effects is therefore rejected, and fixed effects OLS is the appropriate estimation technique. Thus, fixed effects OLS is used to estimate equations (1) and (2). Equation (3) is estimated using the random effects generalized least squares (GLS) technique due to the inclusion of regional dummy variables, which cannot be estimated by fixed effects OLS estimation[7].

7 GLS is necessitated on this occasion due to the utilization of random effects.

I also wish to provide visual confirmation for the existence of a Kuznets curve. To do so and to provide a nonparametric check of the robustness of the OLS results, I use a locally weighted scatterplot smoothing (Lowess) technique to fit lines through select samples of the data. It would be inappropriate to use Lowess smoothing on the pooled data because this would fail to account for the country fixed effects just discussed. Ideally, Lowess smoothing would be performed on country-by-country subsets of the data. However, no country has more than 19 observations in this data set, which are too few to obtain reliable results from Lowess smoothing. Therefore I group the data by global region (Africa, Asia, Europe, North America and South America) before conducting Lowess smoothing, as a method of obtaining larger sample sizes while retaining some region-specific effects[8]. This is an imperfect method; while grouping by global region may be preferable to pooling all of the data together; such groupings ignore country- or subregion-specific differences within large regions. For example, East Asian culture is vastly different from that of other parts of Asia, and so it may be inappropriate to group all Asian countries together. However, given the limitations of the ILO child labor incidence data, this may still be the best option for utilizing Lowess smoothing.

## V. RESULTS

### 1. Summary Statistics

Table 1 in the Appendix displays summary statistics for select variables. Over the entire sample, child labor incidence ranges from 0% to 69.7% of the population aged 10-14, while

8 The United Nations Statistics Division classifies countries into one of six regions: Africa, Asia, Europe, North America, Oceania and South America. The data set used in this paper contains only four data points in Oceania, and so Lowess smoothing is not conducted for Oceania.

logged per capita income ranges from approximately 6 to 10[9]. Thus a wide range of child labor incidence rates and per capita income are present in the dataset, which suggests that the data is not limited to extremely poor countries or countries with particularly high child labor incidence, which would bias the econometric results.

Of the 182 countries listed in the ILO Conventions ratification documentation, 151 have ratified Convention 138 and 169 have ratified Convention 182 to date. The fact that so many countries have ratified these Conventions yet child labor incidence exists to broadly varying degrees in many countries highlights the difficulty in including ILO Conventions in the analysis, as discussed earlier. However, it is still interesting to note certain regional trends listed in Tables 2 and 3 of the Appendix. Of the four regions classified by the ILO (Africa, the Americas, Asia and Europe), Asia has the lowest ratification rates for both Conventions: 63% for Convention 138 and 81% for Convention 182. Conversely, Europe has the highest ratification rates for both: 96% and 98%. Table 2 of the Appendix shows the mean values of child labor incidence by region for the entire dataset. Asia's mean child labor incidence is not extreme when compared to the other regions', but it does have the second-highest maximum of the four regions. Meanwhile, Europe has the lowest mean and maximum child labor incidence of the four regions. These basic statistics are consistent with the expectation that honest ratification of ILO Conventions 138 and 182 is negatively associated with child labor incidence, as discussed in the literature review.

Of the 460 combinations of countries and years present in the ILO child labor data set, data on preprimary enrollment rates (*Educ*) are available for only 90 observations over 36 countries. The availability of data is much better for the percentage of the population that is

9 Approximately $462 to $21,111 per capita.

under age 15 (*Chpop*, N=432) and that is rurally located (*Rural*, N=441). Income and openness variables are available for 412 observations.

## 2. OLS Regression Results

As mentioned in Section IV, conducting the Hausman specification test on equations (1) and (2) indicates that random effects estimation is inappropriate and that fixed effects estimation is preferable. I therefore estimate equations (1) and (2) using fixed-effects OLS, "absorbing" the country category. I utilize robust standard errors in all estimations. The results from all OLS and GLS regressions in this subsection may be found in Table 4 of the Appendix.

Estimation of equation (1) returns coefficient estimates for *Loginc* and $Loginc^2$ that are statistically significantly different from zero at the 10% level, and that take on signs consistent with the Kuznets curve hypothesis[10]. Furthermore, the coefficient estimates for *Exports* and the interaction term *Loginc*Exports* are statistically significantly different from zero at the 5% level and take on the expected signs.

Maximizing equation (1) with respect to income generates the following equation:

(4)

By inserting the appropriate coefficient estimates obtained by estimating equation (1) for $\beta_1$, $\beta_2$ and $\beta_4$ and inserting the average value of *Exports*, I find that the average child labor-maximizing level of logged income per capita in this model is approximately 7.20[11]. Child labor incidence should be expected to decrease as logged income per capita rises beyond this level, holding *Exports* constant.

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10 Coefficient estimate for *Loginc* is positive; coefficient estimate for $Loginc^2$ is negative.
11 Approximately $1342 per capita.

Equation (2) includes the major determinants of child labor discussed in the literature, and is therefore less likely to suffer from omitted variable bias. Estimation of equation (2) also returns coefficient estimates for *Loginc* and $Loginc^2$ that are statistically significantly different from zero at the 5% level and that take on signs consistent with the Kuznets curve hypothesis, although the magnitude of these coefficient estimates is much larger than those estimated by equation (1). In this regression, the coefficient estimates for *Exports* and the interaction term *Loginc*Exports* are not statistically significantly different from zero, and take on unexpected signs. In fact, no other coefficient estimates are found to be statistically significantly different from zero at even the 10% level in this model. This contradicts the expectations that *Chpop*, *ILO138*, *ILO182*, *Educ* and *Rural* are all important determinants of child labor. Furthermore, the coefficient estimates for *Chpop*, *Educ* and *Rural* take on unexpected signs. The coefficient estimates for *ILO138* and *ILO182* take on the expected signs, but are only statistically significant in difference from zero at the 50% and 70% levels, respectively.

Inserting the appropriate coefficient estimates found from estimating equation (2) into equation (4), I find that the average child labor-maximizing level of logged income per capita in this model is approximately 8.61[12]. The adjusted R-squared value in this model is much higher than that from equation (1), at 0.9479, indicating that controlling for educational opportunities explains approximately 15% of the variation in child labor incidence.

One possible explanation for so few statistically significant results is that there are only 90 observations in the dataset for *Educ*, and all of these observations occur after the year 1991. When equation (2) is estimated, missing observations from other variables truncate the number of observations in the regression to 70, over 31 groups; regressing child labor incidence on 9

12 Approximately $5,477 per capita.

independent variables results in a total of 30 degrees of freedom in the model (as compared to 272 degrees of freedom in equation (1)). This may bias the coefficient estimates, and can have adverse effects on the statistical significance of the coefficient estimates of the independent variables and of the entire model itself. Indeed, the F-statistic for the model is 1.58 (indicating that the null hypothesis that all of the coefficient estimates equal zero can only be rejected at the 10% level of significance), which is smaller than would be ideal. It is possible that expanding the dataset to include observations in more years and countries for *Educ* would produce better significance levels for the coefficient estimates, and cause estimation results to conform to expectations. Furthermore, the preprimary enrollment rate itself is not an ideal measure of the quality or availability of educational opportunities. However, a better and more widely available measure of educational opportunities is not clearly available. Given these issues, it is unclear whether *Exports* should truly be negatively associated with child labor incidence and that equation (1) suffers from omitted variable bias by not including *Educ*, or whether the measurement issues with *Educ* bias the results in equation (2). Given that the results in equation (2) violate *a priori* expectations derived from the literature and economic theory, I conclude that equation (2) is biased by issues with the *Educ* variable. To expand the degrees of freedom in the model, I drop *Educ* from the model and estimate the following:

$$Child_{it}=\beta_0+\beta_1 Loginc_{it}+\beta_2 Loginc^2_{it}+\beta_3 Exports_{it}+\beta_4(Exports_{it}*Loginc_{it})+\beta_5 Chpop_{it}+\beta_6 Rural_{it}+\beta_7 ILO138_{it}+\beta_8 ILO182_{it} \quad (2a)$$

Estimation of equation (2a) also returns coefficient estimates for *Loginc* and $Loginc^2$ that are statistically significantly different from zero at the 5% level and that take on signs consistent with the Kuznets curve hypothesis. The coefficient estimates for *Exports* and the interaction term *Loginc*Exports* are statistically significantly different from zero and take on the expected signs.

Furthermore, the coefficient estimates of the income and exports variables are of similar magnitudes to those from equation (1) ($\beta_1$=57.07, 62.34; $\beta_2$=-3.75, -3.99; $\beta_3$=268.89, 274.67; $\beta_4$=-29.32, -28.76).

As in estimation of equation (2), the coefficient estimate for *Chpop* is not statistically significant in difference from zero, and takes on a negative sign, contrary to *a priori* expectations. One possible interpretation of this result is that household size does not have a significant effect on child participation in the labor force suggesting that, although household size may be associated with the *number* of children employed, parents will choose to employ the same or lower *proportion* of their children as household size increases. In other words, a family that has two children and employs one of them will, if household size doubles, employ either one or two of their four children, but will not employ three or four of them.

The coefficient estimate for *Rural* is statistically significantly different from zero at the 20% level and takes on the expected sign, suggesting that countries with a higher agricultural focus tend to have more child labor, as expected.

As in estimation of equation (2), the coefficient estimate for *ILO138* is not statistically significantly different from zero and takes on an unexpected sign. However, the coefficient estimate for *ILO182* is statistically significantly different from zero at the 5% level and takes on the expected sign, indicating that establishing a minimum working age (Convention 138) is very weakly associated with higher levels of illicit child employment, but that prioritizing eradication of the worst forms of child labor (Convention 182) is strongly associated with lower child labor incidence.  As mentioned in Sections II and IV, it is difficult to draw conclusions regarding the effects of Convention ratifications on child labor incidence due to the incentive to dishonestly ratify and the tendency for countries with already low rates of child labor to ratify such Conventions.

Using equation (4), I find that the average child labor-maximizing level of logged income per capita in this model is approximately 7.44[13]. Recall that equation (1) predicts child labor to be maximized at a logged income of 7.20.

In addition to equations (1) and (2), I wish to estimate a random-effects GLS model that included regional dummy variables for Africa and Asia (equation (3)). Estimation of this model fails to produce any coefficient estimates that are statistically significantly different from zero at any conventional confidence level, with the exception of *Exports*. Furthermore, many of the signs of the coefficient estimates contradict *a priori* expectations: *Exports*, *Loginc*Exports, Chpop, Educ, ILO138,* and *Asia* all have coefficient estimates that take on signs opposite of expectations. Estimating equations (2) and (2a) also returned coefficient estimates for *Chpop, Educ* and *ILO138* that contradicted expectations at times, and interpretations of those results have already been given.

As predicted, the coefficient estimate for the *Africa* dummy is positive, indicating that African countries will tend to have higher child labor incidence than other regions. Contrary to expectations, however, the coefficient estimate for the *Asia* dummy is negative, indicating that Asian countries will tend to have lower child labor incidence than other regions. These results are consistent with Dehejia & Samy's 2007 findings on regional effects, although the authors fail to provide any rationale for the negative coefficient estimate for the *Asia* dummy. I believe that the *Asia* dummy may inappropriately aggregate East and West Asia, grouping countries like Korea and Kazakhstan. Furthermore, Hausman specification tests on equations (1) through (2a)

13 Setting the dummies equal to zero and holding all other independent variables constant at their mean values; approximately $1,701 per capita.

indicated that random effects estimation was inappropriate; it seems that fixed effects estimation is ideal for models of this family of models, and that regional dummies cannot be feasibly included.

Using equation (4), equation (3) predicts that child labor incidence is maximized at an income level of 7.02 logged GDP per capita[14]; despite the lack of statistically significant results in estimating equation (3), its prediction is similar to those of equations (1) through (2a).

Similar to equation (2), equation (3) suffers from a low number of degrees of freedom due to the inclusion of *Educ* in the model, which is missing many observations and may be biasing the results. As in equation (2a), I expand the degrees of freedom by dropping *Educ* from the model and estimating the following:

$$Child_{it}=\beta_0+\beta_1 Loginc_{it}+\beta_2 Loginc^2_{it}+\beta_3 Exports_{it}+\beta_4(Exports_{it}*Loginc_{it})+\beta_5 Chpop_{it}+\beta_6 Rural_{it}+\beta_7 ILO138_{it}+\beta_8 ILO182_{it}+\beta_9 Africa_{it}+\beta_{10} Asia_{it} \quad (3a)$$

Estimation of equation (3a) returns coefficient estimates with signs that are consistent with those found by estimating equation (3). Only *ILO182* and *Asia* have coefficient estimates that are statistically significantly different from zero at the 5% level. The interpretation of these results is similar to those discussed for equation (3).

Using equation (4), equation (3a) predicts that child labor incidence will be maximized at 5.95 logged GDP per capita[15]. This prediction is the most dissimilar of the five models estimated.

Estimation of the equations fails to reject the existence of a Kuznets curve. In all of the equations, the coefficient estimates of the income variable take on the expected signs, and in equations (1), (2) and (2a), the estimates are statistically significant in difference from zero at the 10% level, at least. The Kuznets curve relationship does not appear to be the result of an

14 Approximately $1,120 per capita
15 Approximately $383 per capita

increasingly negative relationship between income and child labor. On the contrary, the data suggest an increasing relationship between child labor and income at levels of income below the predicted child-labor maximizing level of approximately 7 logged GDP per capita. For instance, lower-income countries like Cambodia in 1998 and Tanzania in 1978 displayed lower child labor incidence than higher-income countries like Indonesia in 1961 and Sudan in 1993.

The calculated child labor-maximizing levels of income fluctuate somewhat among equations. Figure 1 in the Appendix graphs child labor incidence as a function of income as predicted by equations (1), (2) and (2a), holding all other variables constant at their mean values and setting the dummies equal to zero[16]. The thin vertical lines represent the minimum, mean and maximum levels of income in the data set, indicating that both upward- and downward-sloping portions of the child labor Kuznets curve are present in the data. This graph highlights the similarities between equations (1) and (2a), and the inadequacies of equation (2). Equation (2) predicts that child labor will exist only over a very narrow, improbably high range of income. Equation (2a) is therefore the preferred model, as it conforms to *a priori* expectations and makes reasonable predictions.

If, holding income constant, a boycott were effective in lowering a country's exports, the results from equations (1) and (2a) suggest that this would be associated with a lower incidence of child labor, due to an associated reduction in demand for child labor. In this sense, it appears that the boycott argument is correct, indicating that encouraging free trade is not an acceptable policy to raise income in countries that utilize child labor, particularly in low-income countries (as the positive association between exports and child labor diminishes as income rises).

16 Due to this method of graphing the models, the y-axis values should be largely ignored, as they are sensitive to the values chosen for the non-income variables.

However, income cannot realistically be held constant as exports change, because income is endogenous to exports. Figure 2 in the Appendix illustrates the three-dimensional relationship between child labor, income and exports, using the coefficient estimates found for equation (2a). This graph highlights the manner in which the level of exports' association with child labor changes at varying levels of income. Figure 3 is a contour plot of Figure 2, which more clearly highlights this relationship. It can be seen from Figure 3 that lowering the level of exports will be associated with lower child labor incidence in most cases, even if the reduction in exports causes income to fall. However, if a country relies heavily on exports and is fairly rich, a reduction in exports should actually be associated with an increase in child labor. Thus, boycotts may be effective in most cases, but are certainly not a foolproof strategy for combating child labor.

### 3. Lowess Smoothing

Lowess smoothing graphs are included in Appendix B. Asia's Lowess line most closely resembles the inverted-U shape expected by the Kuznets curve hypothesis. North America, Africa and Europe all display downward sloping lines that could be the right-hand sides of a Kuznets curve, but may also simply represent a constantly negative relationship. South America's Lowess line is downward sloping until approximately 8.5 logged GDP per capita[17], beyond which the line displays an inverted-U shape. Overall, this nonparametric method fails to visually confirm the existence of a Kuznets curve, with the possible exception of Asia. However, there is no particularly obvious reason that Asia would be more likely than other regions to have a child labor Kuznets curve.

It is particularly difficult to rely on results from Lowess smoothing in this case. As mentioned in Section IV, I pooled the data by geographical region in order to obtain enough data

17 Approximately $4,915 per capita

points for Lowess smoothing to be viable. This is problematic for two reasons. First, there is no way to control for country fixed-effects when pooling by region, whereas the Hausman specification test suggested that fixed-effects analysis was preferable over random effects analysis. Thus, a level of sophistication achievable in OLS analysis is lost in Lowess smoothing. Second, the dataset is not large enough to capture significant economic development over time, and so geographical regions tend to display a relatively narrow range of income levels. Therefore, even though a Kuznets curve may exist for the region, Lowess smoothing may only display a section of the curve (say, part of the left half or right half) and a U-shape will not be visible. This is similar to Del Carpio's (2008) inverted-J shaped findings for Nicaragua. It should be noted that in this dataset, this issue would also be problematic for country-by-country Lowess smoothing.

## VI. CONCLUSION

This paper began by discussing the merits and pitfalls of the boycott and pro-trade arguments concerning child labor, and offering an alternative description of the relationship between international trade and child labor. Specifically, I asked whether a child labor Kuznets curve exits. I also asked whether boycotts are associated with lower child labor incidence, and sought to analyze the effectiveness of child labor legislation. If an inverted U-shaped relationship exists between child labor incidence and income, a country's location on its child labor Kuznets curve would determine whether policies aimed to raise income would be associated with lower child labor incidence in the short run. If boycotts are not associated with lower child labor incidence, encouraging free trade would be an acceptable method of raising income to lower child labor incidence[18]. If, however, boycotts are indeed associated with lower child labor incidence, encouraging free trade may be inappropriate. If international child labor legislation has been effective to date, investing more resources into further legislation may be a worthy cause.

My results are consistent with the child labor Kuznets curve hypothesis: I find coefficient estimates that are positive for the income variable and negative for income squared, and both are statistically significant in difference from zero. Furthermore, my results indicate that, all else held constant, exports are positively associated with child labor incidence (although the effect diminishes with rising income). These results are consistent with similar studies that found inverted U-shaped relationships between child labor and income-related factors (Kambhampati & Rajan 2006, Basu et al 2007, Del Carpio 2008). These results are robust through most specifications of the child labor model with both country fixed-effects OLS and random-effects GLS estimation.

The child labor Kuznets curve suggests that at extremely low levels of income, parents would out of necessity employ their children if they could, but opportunities are few and so child labor incidence is low. As income rises so do opportunities for employment, and child labor incidence rises. However, parents are altruistic and would prefer not to employ their children; thus child labor incidence decreases once a sufficiently high income level is achieved. The econometric results suggest that the best long-term strategy for reducing child labor is to support policies that raise income, as this will eventually be associated with lower child labor incidence and improve children's standard of living. This is a long-term process: in the short run, child labor may need to worsen before it can improve. If, holding income constant, a boycott were

18 $Loginc_{it} = \beta_0 + \beta_1 Exports_{it}$; $\beta_1 = 2.938217$; *z*-stat=8.86, chi-sq stat=78.45

effective in lowering a country's exports, the results suggest that this would be associated with a lower incidence of child labor, due to an associated reduction in demand for child labor. However, income is endogenous to exports. Although demand for child labor may be expected to fall with exports, so will income; if the income effect dominates the demand effect, child labor should actually be expected to rise as exports fall. This is a rare case and is more likely to occur among richer countries where exports are less strongly associated with child labor incidence. Thus, boycotts appear to often be effective, but are not a foolproof method of decreasing child labor incidence. Additionally, even where boycotts may be effective at lowering child labor incidence, they may also lower income and thus children's standard of living. This would be counterproductive to the goal of improving child welfare by means of reducing child labor incidence.

Certain types of international child labor legislation appear to be more effective than others. Specifically, convincing countries to honestly commit to eradicating the worst forms of child labor (ILO Convention 182) is negatively associated with child labor incidence. However, establishing a minimum working age (ILO Convention 138) appears to actually be *positively* associated with child labor incidence, although this result is not statistically significantly different from zero at the conventional confidence levels.

The effects of improving educational opportunities are less clear due to lack of available data and less than adequate measures. However, it may be that improving educational opportunities may help to decrease child labor in the long run through positive effects on income, and these may be policies worth pursuing. Lessening countries' focus on agricultural production should be associated with lower incidence of child labor. Household size appears to have little to no effect on child labor incidence; if anything, increasing household size leads to a lower child labor participation rate.

Future work in this area would benefit from improved data: a larger international child labor data set would produce more reliable results from Lowess smoothing; more prevalent data on educational opportunities would facilitate the estimation and interpretation of equation (2); with more complete data for the independent variables, the Heckman selection correction technique could be utilized to correct for the possible selection bias inherent in the ILO child labor data set. A more precise measure of child labor incidence would also be illuminating; the World Bank records several variables that can be used to generate a measure of the proportion of children in a population who only work and do not attend school. This measure would be more accurate than the ILO measure, which cannot distinguish between an after-school job and work as the child's sole economic activity, but it is only available for 71 developing countries in one year from 1998-2006. Future work should also concentrate on characterizing and isolating some of the cultural characteristics that differ between countries, such as the moral status quo and importance of work in a child's education.

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**APPENDIX A**

**Table 1: Sample Summary Statistics**

| **Variable** | **Obs** | **Mean** | **Std. Dev.** | **Min** | **Max** |
|---|---|---|---|---|---|
| *Year* | 460 | 1987.1 | 12.200 | 1950 | 2005 |
| *Child* | 460 | 11.879 | 12.328 | 0 | 69.7 |
| *Loginc* | 412 | 8.2153 | .79853 | 6.1375 | 9.9576 |
| Exports | 369 | 2.0323 | 1.6341 | -.50073 | 4.3834 |
| *Chpop* | 428 | 37.451 | 7.8922 | 16.056 | 50.664 |
| *Rural* | 440 | 51.614 | 21.972 | 0 | 95.92 |
| *Educ* | 90 | 42.391 | 23.982 | .77364 | 96.032 |
| *ILO138* | 460 | .20435 | .40366 | 0 | 1 |
| *ILO182* | 460 | .07826 | .26887 | 0 | 1 |
| *Africa* | 460 | .17139 | .37756 | 0 | 1 |
| *Asia* | 460 | .26087 | .43959 | 0 | 1 |

**Table 2: ILO Convention Ratifications by Region**

| | Convention 138† | % of Region | Convention 182†† | % of Region |
|---|---|---|---|---|
| *Total of 182* | *151* | *83* | *169* | *93* |
| Africa (53) | 46 | 87 | 50 | 94 |
| Americas (35) | 29 | 83 | 34 | 97 |
| Asia (43) | 27 | 63 | 35 | 81 |
| Europe (51) | 49 | 96 | 50 | 98 |

Source: ILO Ratifications database. Regional classifications defined by the ILO.
†Minimum age Convention
††Worst forms of child labor Convention

**Table 3: Child Labor Incidence Statistics by Region**

| Region | Mean | Min | Max |
|---|---|---|---|
| Total | 11.9 | 0 | 69.7 |
| Africa | 24.5 | 0.3 | 69.7 |
| Americas | 10.2 | 0.4 | 49.4 |
| Asia | 11.4 | 0.1 | 60.9 |
| Europe | 3.6 | 0 | 21.8 |

**Table 4: OLS Estimation Results**

| **Regressor** | **(1)** | **(2)** | **(2a)** | **(3)** | **(3a)** |
|---|---|---|---|---|---|
| *Loginc* | 57.06549<br>(2.14)** | 465.715<br>(1.89)* | 62.33638<br>(2.31)** | 27.44614<br>(0.56) | 19.86835<br>(1.09) |
| *Loginc*$^2$ | -3.74661<br>(-2.33)** | -27.3571<br>(-1.88)* | -3.98555<br>(-2.44)** | -2.25597<br>(-0.73) | -1.742636<br>(-1.58) |
| *Exports* | 267.8971<br>(2.17)** | -460.568<br>(-1.21) | 274.6652<br>(2.19)** | -363.462<br>(-1.67)* | -70.7537<br>(-1.06) |
| *Loginc*Exports* | -29.3182<br>(-2.10)** | 50.00176<br>(1.13) | -28.7587<br>(-2.05)** | 40.05637<br>(1.59) | 8.153481<br>(1.10) |
| *Chpop* | | 0.091325<br>(0.12) | 0.04227<br>(0.25) | -0.22898<br>(-0.61) | -.0784489<br>(-0.73) |
| *Rural* | | -0.4717<br>(-1.04) | 0.118051<br>(1.32) | 0.225233<br>(1.23) | .0729835<br>(1.30) |
| *Educ* | | 0.03117<br>(0.83) | | 0.051843<br>(1.12) | |
| *ILO138* | | -1.81065<br>(-0.76) | 2.044601<br>(1.1) | 0.260436<br>(0.14) | 1.403264<br>(0.86) |
| *ILO182* | | -0.76336<br>(-0.38) | -2.64848<br>(-2.04)** | -0.27256<br>(-0.19) | -2.059769<br>(-1.91)* |
| *Africa* | | | | 8.041558<br>(0.73) | 4.849933<br>(1.63) |
| *Asia* | | | | -7.72741<br>(-1.11) | -4.981091<br>(-2.50)** |
| Constant | -203.953<br>(-1.86) | -1938.14<br>(-1.85)* | 113.706<br>(-2.11)** | -58.1386<br>(-0.3) | -33.60016<br>(-0.44) |
| †Adj. $R^2$ | 0.8013 | 0.9479 | 0.8040 | 0.4842 | 0.4512 |
| Hausman test Chi-sq | 36.63 | 13.65 | 45.25 | | |
| *N* | 350 | 70 | 350 | 70 | 350 |

T-statistics (or z-statistics for equations (3) and (3a), the RE GLS models) in parentheses
*Statistically significantly different from zero at the 10% level
** Statistically significantly different from zero at the 5% level or better
†Overall $R^2$ given for equations (3) and (3a)

**Figure 1**

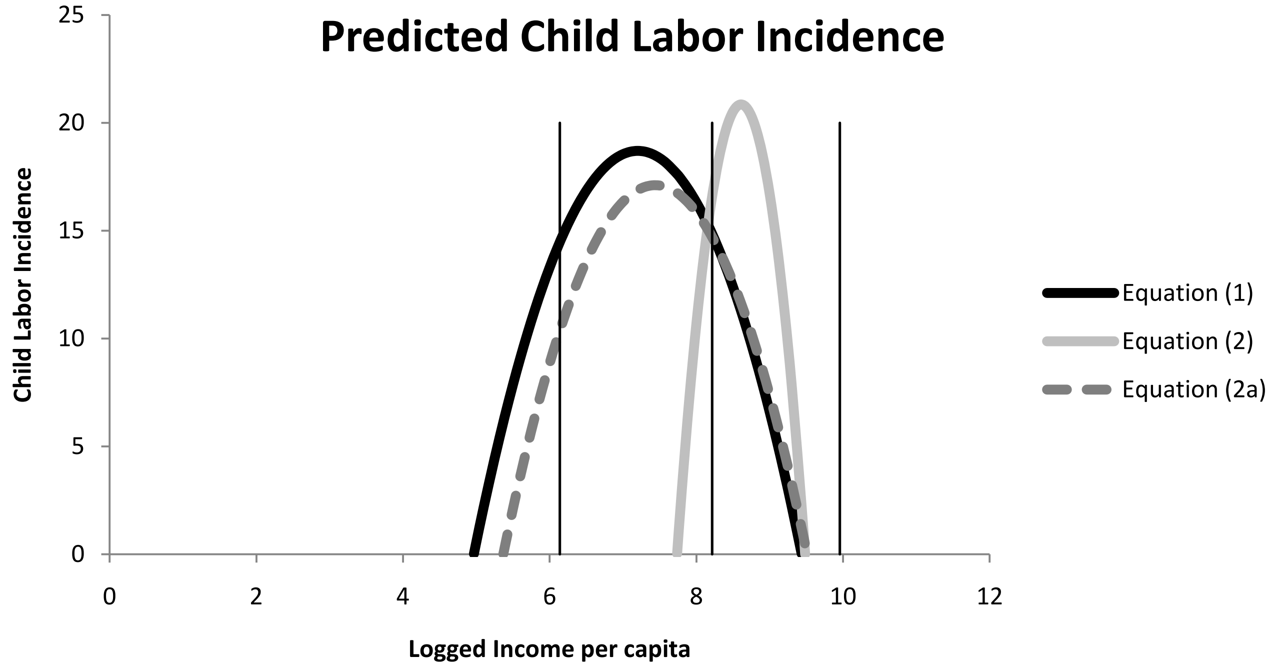



**Figure 2**

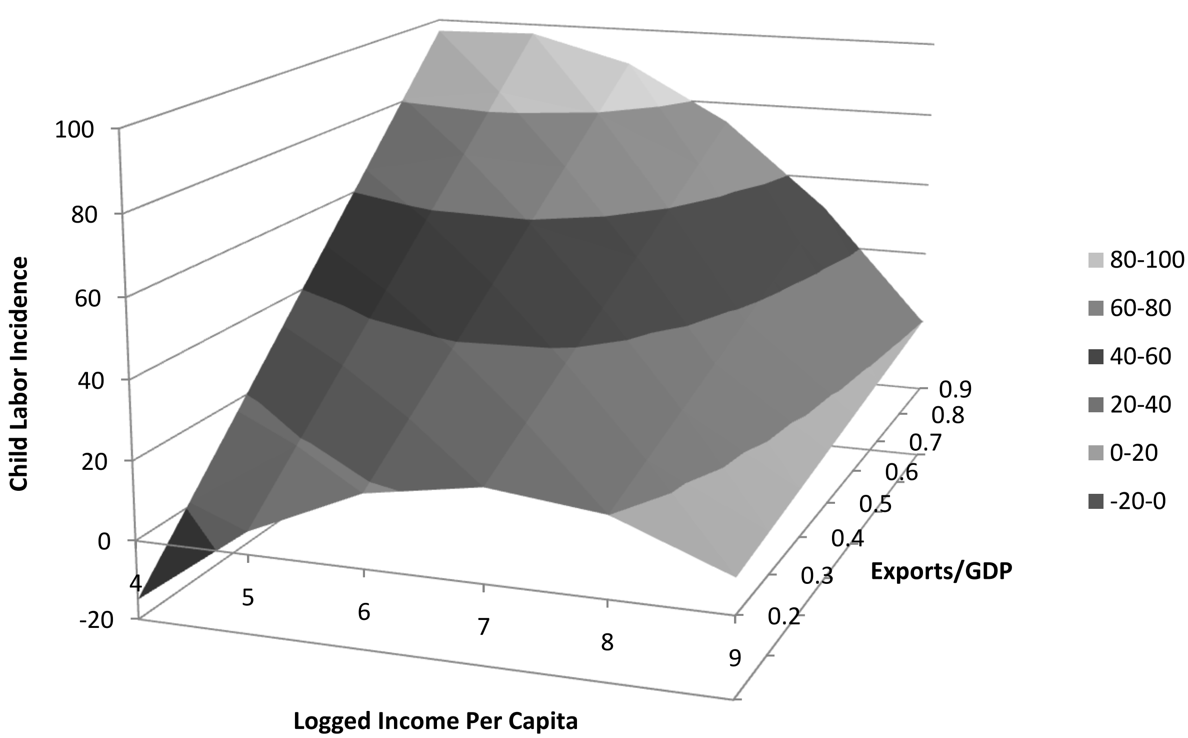
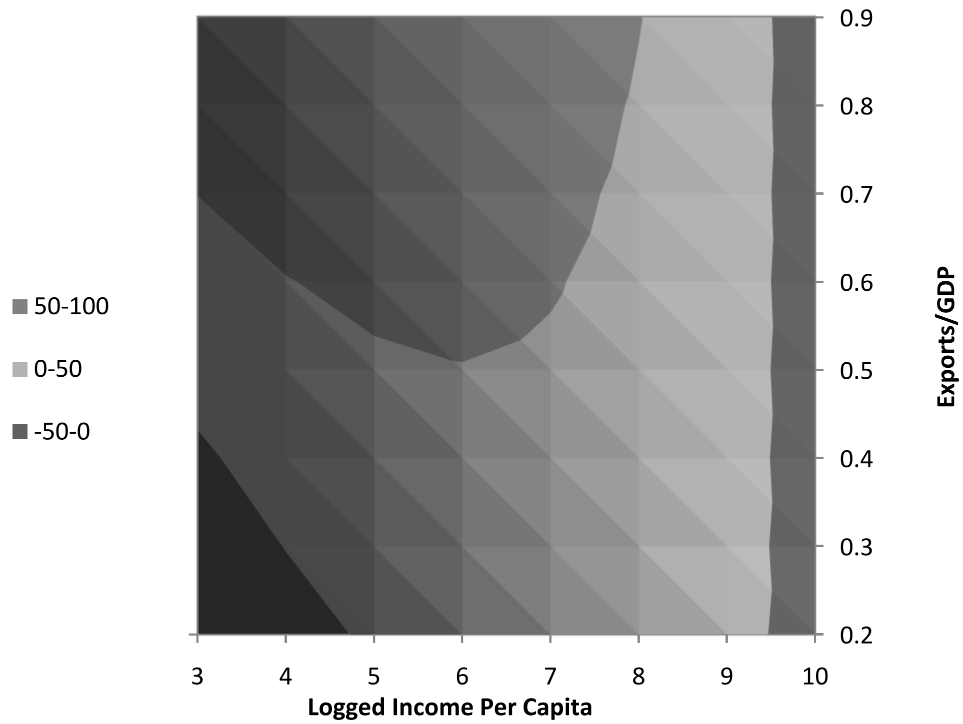
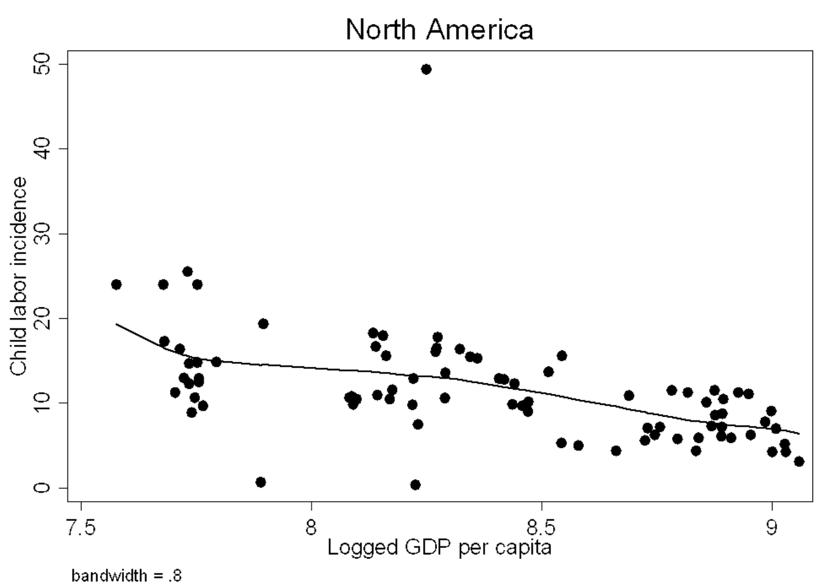
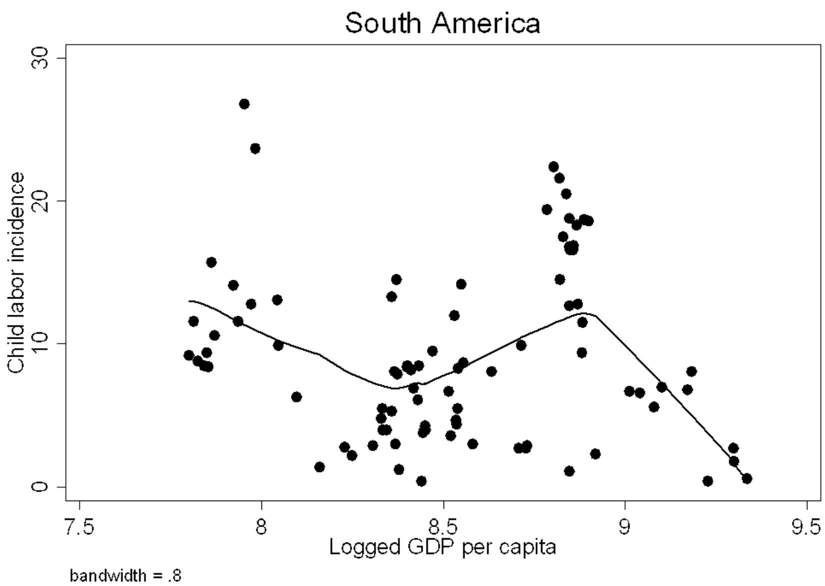


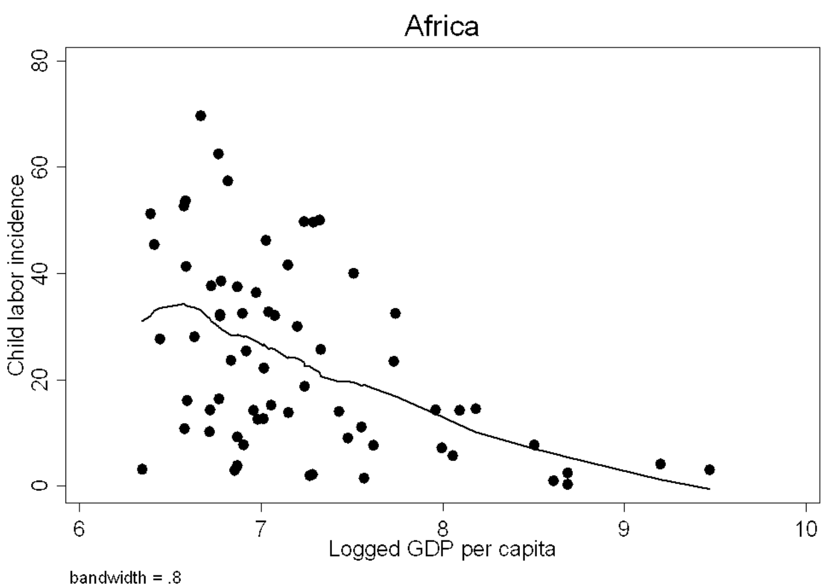
**Figure 3: Contour plot of Figure 2**

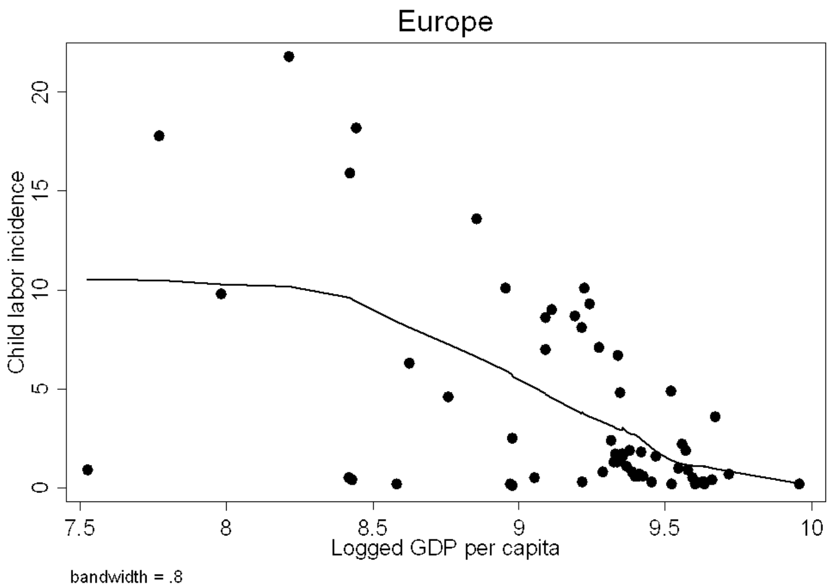


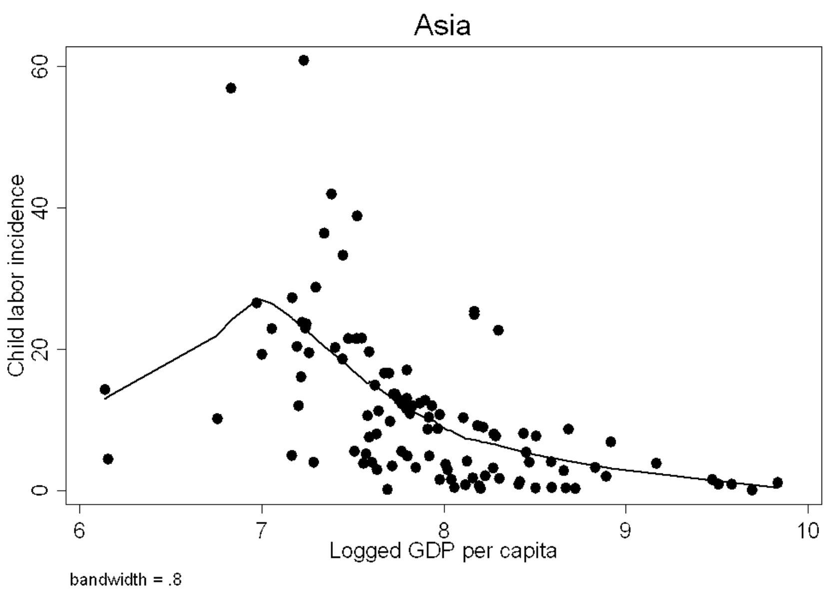

**APPENDIX B: Lowess Smoothing by Region**




South America
Child labor incidence
0
10
20
30
7.5
8
8.5
9
9.5
Logged GDP per capita
bandwidth = .8


Africa
Child labor incidence
0
20
40
60
80
6
7
8
9
10
Logged GDP per capita
bandwidth = .8


Europe
Child labor incidence
0
5
10
15
20
7.5
8
8.5
9
9.5
10
Logged GDP per capita
bandwidth = .8


Asia
Child labor incidence
0
20
40
60
6
7
8
9
10
Logged GDP per capita
bandwidth = .8

## APPENDIX C

### Proof of Equation (4)

The equations estimated in this paper are as follows:

(1) $Child_{it}=\beta_0+ \beta_1 Loginc_{it}+ \beta_2 Loginc^2_{it}+ \beta_3 Exports_{it}+\beta_4(Exports_{it}*Loginc_{it})$

(2) $Child_{it}=\beta_0+ \beta_1 Loginc_{it}+ \beta_2 Loginc^2_{it}+ \beta_3 Exports_{it}+\beta_4(Exports_{it}*Loginc_{it})+\beta_5 Chpop_{it} + \beta_6 Rural_{it}+ \beta_7 Educ_{it} +\beta_8 ILO138_{it} + \beta_9 ILO182_{it}$

(2a) $Child_{it}=\beta_0+ \beta_1 Loginc_{it}+ \beta_2 Loginc^2_{it}+ \beta_3 Exports_{it}+\beta_4(Exports_{it}*Loginc_{it})+\beta_5 Chpop_{it} +\beta_7 Rural_{it} +\beta_8 ILO138_{it} + \beta_9 ILO182_{it}$

(3) $Child_{it}=\beta_0+ \beta_1 Loginc_{it}+ \beta_2 Loginc^2_{it}+ \beta_3 Exports_{it}+\beta_4(Exports_{it}*Loginc_{it})+\beta_5 Chpop_{it} + \beta_6 Rural_{it}+ \beta_7 Educ_{it} +\beta_8 ILO138_{it} + \beta_9 ILO182_{it}+ \beta_{10} Africa_i+ \beta_{11} Asia_i$

(3a) $Child_{it}=\beta_0+ \beta_1 Loginc_{it}+ \beta_2 Loginc^2_{it}+ \beta_3 Exports_{it}+\beta_4(Exports_{it}*Loginc_{it})+\beta_5 Chpop_{it} +\beta_6 Rural_{it} +\beta_7 ILO138_{it} + \beta_8 ILO182_{it} + \beta_9 Africa_{it} + \beta_{10} Asia_{it}$

All five equations differentiate identically with respect to *Loginc* (treating "*Loginc*" not as ln(inc) but as a self-contained variable):

(4)

To maximize the function, set (4) equal to zero and solve for *Loginc*: