ABSTRACT

Title of Dissertation: THE ROLE OF CAPITAL-SKILL COMPLEMENTARITIES IN CHILD LABOR & SCHOOLING

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We explore complementarities between parents' investment in their children's human capital and firms' investment in physical capital as a determinant of child labor and schooling in developing economies. In the first essay, we develop a theoretical model where human and physical capital investments are shown to be decreasing in firms' cost of investing in skill-biased capital, increasing in the quality of education, and decreasing in the cost of education. Our contribution is two-fold. First, when there is a unique equilibrium, there is an unambiguous improvement in the welfare of all agents in response to policies that improve the quality of education or lower the cost of education or skill-biased capital. Second, this welfare improvement can be achieved by policies that target only a proportion of workers or firms.

In the second essay, we test the theoretical proposition that human capital investments respond to changes in the returns to education in India. Using National Sample Survey data, we first estimate the rates of return to primary, middle, high

school, and college education for males and females in each Indian state for four separate years - 1983, 1988, 1993, and 1999. The response of children's participation in child labor and schooling to the rates of return to primary and middle school is then examined. We find that child labor amongst both boys and girls, falls in response to higher rates of return to education. However, only boys' participation in school increases in response to higher rates of return to education.

In the third essay, we first examine changes in relative wages and returns to education in India from 1983 to 1999, which coincides with India's liberalization of trade and investment. We then conduct a simple demand and supply analysis using the non-parametric method proposed by Katz & Murphy (1992) to examine alternative explanations for changes in relative wages in India. We find that relative demand changes contributed significantly to changes in relative wages and that international trade in manufactures predicts increases in the relative demand for both high-skilled men and women.

THE ROLE OF CAPITAL-SKILL COMPLEMENTARITIES
IN CHILD LABOR & SCHOOLING

by

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Dedication

For my family.

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Chapter 1

Introduction

We explore the relationship between capital-skill complementarities, the returns to education, and child labor and schooling in developing economies. In the first essay we develop a theoretical model where parents' human capital investment decisions for their children and firms' physical capital investment decisions respond to changes in three factors - the cost of investing in skill-biased capital for firms, the cost of education, and the quality of education available to children, via the expected returns to education and firms' investment in skill-biased capital.[1]

Policies that lower the cost of skill-biased capital or the cost of education or those that improve the quality of education for just a proportion of agents results in an increase in all agents' investments and expected returns, leading to an unambiguous welfare improvement for all agents. Despite a constant returns to scale production technology, we show that the equilibrium rate of return to human and physical capital

[1]In our model, physical capital *embodies* technology because it is factor biased. We refer to skill-biased technology not as a traditional exogenous technological parameter (A) but instead to the production technology *embodied* in physical capital. A lower level of capital is synonymous with unskill-biased machinery (the use of unskilled-labor-biased production technology) while a higher level of capital represents skill-biased machinery (the use of skilled-labor-biased production technology).

are increasing not only in the average human capital of the workforce but also in the average physical capital of firms, a la Acemoglu (1996). In this sense, there are social increasing returns to investments in human and physical capital which are pecuniary rather than technological in nature. The results are driven by a combination of ex-ante investments in human and physical capital and costly bilateral search in the labor market.

Low levels of human capital investments in developing countries have been attributed primarily to poverty. Poor parents rely critically on their children's incomes in order to survive. The absence of social welfare systems and access to credit in most developing economies further exacerbates the problem. Even though poverty, credit constraints, and the absence of social welfare systems are cited as the major cause of child labor and low levels of education, these are not the only and often not the most significant determinants of these phenomena. There is evidence from several developing countries that often very poor children attend school while relatively better-off children work.[2]

This observation points to other determinants of high child labor and low education in poor countries. The lack of enforcement of anti-child labor and compulsory education laws is often cited as a crucial determinant of child labor and education. The monetary and political costs of enforcing such laws are too high for many governments. Lobbying by employers of child workers and the fear of losing votes from households of displaced children create political pressures that discourage governments from enforcing these laws. Lack of awareness of these laws on the part of employers and parents also contributes to high child labor and low education.

[2] Bhalotra & Heady (2003) find that the daughters of land-rich households are more likely to work than the daughters of land-poor households in both Ghana and Pakistan. They refer to this phenomena as the 'wealth paradox'.

The social dimension is equally important in driving high levels of child labor and low levels of education. Parental attitudes are highly interdependent: what one person thinks about the value of education is strongly influenced by others' views on this within their family, community, or village. Moreover, the custom amongst many families and communities of sending their children to school for only a few years and then to work to learn skills, is a consequence not of poverty but of social norms.

Yet another explanation for low human capital investments is that parents often see no economic benefit from educating their children. The scarcity of jobs and low wages for educated workers results in low economic returns to education.[3]

In addition to low economic returns to education, the returns to child labor may be high. Not only are skilled jobs scarce in developing countries, but also securing a skilled job depends more on economic status and family connections rather than

[3] There is conflicting evidence on the returns to education in LDCs. Some researchers find relatively high returns to education in LDCs while others find no consistent pattern between growth or development and the returns to education. In Psacharopoulos (1994) returns to education (particularly for primary schooling) are found to be highest in Sub-Saharan Africa, followed by Latin America/Caribbean, Asia, and non-OECD Europe/Middle East/North Africa. The returns to education are found to be lowest in OECD countries. The comparison of vastly different educational systems across countries and the choice of countries could affect the estimated returns to education in cross-country studies. Bennell (1996) argues that with chronically internal and external inefficiencies at all education levels in most Sub-Saharan African countries, it seems highly implausible that rates of return to education are higher than in advanced countries. Denny et al. (2001) find that the returns to education are high in some developed countries (Great Britain, Northern Ireland, and The Republic of Ireland) and low in others (Netherlands, Norway, Austria, Germany, and Sweden), but cannot find any pattern for transition or developing countries. There are relatively few studies that estimate the returns to education over time within a single developing country. Nielson & Westergard-Nielson (1998) find extremely low returns to primary education and higher returns to secondary education in Zambia.

academic merit and experience. As a result, poor parents often believe their children are better off working and securing an unskilled job as children since they will never have the opportunity to secure skilled jobs as adults. Many parents believe education to be a worthless endeavor due to a low quality of education and inaccessible schools. This reinforces parents' beliefs that their children are better off acquiring skills through employment rather than via formal education. Many schools that cater to poor children have too few and incapable teachers and lack adequate teaching facilities so that children barely learn to read and write in primary school (grades 1 through 5). Inadequate infrastructure and transport facilities, together with too few and inaccessible schools, further discourages parents from educating their children.

Our argument - that the cost of skill-biased capital, the cost of education, and the quality of education determine the expected returns to education and firms' investment in skill-biased capital - relies on several observations. First, insufficient employment opportunities for educated workers as a result of inadequate investment in skill-biased capital and technology by firms results in low returns to education in many developing countries (Foster & Rosenzweig 1996). Second, in an environment where children's time has an economic value, the opportunity cost of education (foregone wages from child labor) may be high (Rosenzweig 1990). Third, a low quality of education or bad access to schools further discourages education (The Probe Team 1999). Finally, it is risky for firms to invest in skill-biased capital in regions with low human capital (Lucas 1988, 1990).

The interaction between firms' production technology and workers' human capital is an important one that has been insufficiently explored in the existing literature on child labor. Three forms of complementarities are explored in this paper. First, each parent's investment in his child's education is increasing in other parents' investments in their children's education. Second, each firm's investment in skill-biased capital is increasing in other firms' investments in skill-biased capital. Finally, each parent's investment in his child's education is increasing in all firms' investments in skill-biased capital.

The idea that capital-skill complementarities will affect parents' human capital investments in their children and firms' physical capital investments is simple. Parents' and firms' expectations of the returns to their investments in the future affect their present investment decisions. An individual's incentive to forego current income and invest in education depends on the wage differential between better and less educated labor (the returns to education) and on the probability of finding employment that adequately rewards the skills achieved. Similarly, a firm's incentive to forego current profits and invest in technologically superior machinery depends on the differential between the returns to traditional and modern machinery (the returns to skill-biased capital) and on the probability of finding adequately skilled labor that efficiently utilizes modern technology. If parents expect a high return to education as a result of sufficient skill-intensive job opportunities in the future, then they are more likely to educate their children. Similarly, if firms expect a high return to skill-biased capital as a result of a large supply of educated labor in the future, then they are more likely to invest in modern technology.

The existence of capital-skill complementarities, together with ex-ante investments in human and physical capital and costly bilateral search in the labor market, will result in pecuniary social increasing returns to human and physical capital. The intuition is straightforward. If the cost of education falls for a group of children, their parents will invest more in their education. The firms that expect to employ these children in the future (when they are grown workers) will want to invest more in skill-biased capital. However, in a non-Walrasian labor market, it is not known which firms will employ these workers. Many firms that hope to employ the more skilled workers will invest more in skill-biased capital. The group of children for whom the cost of education did not fall will compete for the same jobs in the future and expect to be employed by some of these firms. As a result, many parents of those children for whom the cost of education did not fall will invest more in their children's education, hoping that their children will be employed by the more skill-biased firms.

The effects that the cost and quality of education have on human capital investment decisions have received little attention in the literature on child labor. The cost of education includes the monetary cost (tuition, fees, textbooks and stationery, uniforms, and travel costs) and the opportunity cost (foregone wages from child labor) of education. An important observable measure of the cost of education is access to schools. The scarcity of schools in some regions makes education inaccessible and the cost of education almost prohibitive to the masses. Despite the availability of schools in several remote areas, poor infrastructure and transport facilities discourage parents from educating their children. The poor quality of education in several developing countries contributes to parents' beliefs that education is worthless and a waste of time. In an environment where children's time has an economic value, inaccessibility to schools and inadequate quality of schooling play an important role in parents' decisions to send their children to school or not.

Our theoretical model contributes to the literature on child labor in two ways. When there is a unique equilibrium, there is an unambiguous improvement in the welfare of all agents (households and firms) in response to government policies that improve the quality of education or lower the cost of education or skill-biased capital.[4] Moreover, this welfare improvement can be achieved by government policies that target only a proportion of workers or firms. In the case of multiple equilibria, a ban on child labor or compulsory schooling laws results in the same welfare improvement of all agents. An unambiguous welfare improvement for all agents in response to government policy or regulation that decreases child labor is missing in the existing literature on child labor.[5] In the second essay we empirically test if and how parent's human capital investments in their children respond to rates of return to education. Using individual-level household data from the National Sample Survey Organization (NSSO) and after correcting for selection bias using the method developed by Bourguignon et al. (2001), we first estimate the rates of return to primary, middle, high school, and college education for males and females in each Indian state for four years - 1983, 1988, 1993, and 1999. Using present rates of return to education to capture expected future rates of return to education, we then estimate the impact of the rates of return to primary and middle school on participation in child labor and schooling

[4]The cost to the government of improving the quality of education or lowering the cost of education or skill-biased capital could be substantial. Our model excludes the government and assumes these three policy instruments are exogenous. Incorporating the government and endogenizing these instruments in our model could result in a lower welfare of the government.

[5]In Basu & Van (1998) a total ban on child labor has an ambiguous effect on workers' welfare while a partial ban on child labor unambiguously lowers workers' welfare. In both cases the impact on firms' welfare is not explored. Basu (2002) obtains a similar result. A ban on child labor has an ambiguous effect on workers' welfare while the impact on firms' welfare is not analyzed. Ranjan (1999) shows that a ban on child labor is welfare reducing for poor households because it constrains the choices faced by them. Dessy (2000) shows that compulsory education is welfare improving for workers. Dessy & Pallage (2001) show that eliminating child labor via a child labor ban or compulsory education in combination with investment subsidies to firms can be welfare improving for workers and firms.

for boys and girls. The results indicate that participation in child labor falls for both boys and girls in response to higher rates of return to education. However, schooling only amongst boys increases in response to higher rates of return to education. Our results are robust to several specifications.

In the third and final essay we explore changes in relative wages and the returns to education in India over four years - 1983, 1988, 1993, and 1999 - and the determinants of these changes. In exploring the extent to which changes in relative demand and supply can explain changes in relative wages, we focus on whether or not India's trade and investment liberalization reforms, implemented during the 1980s and 1990s, have played a role via capital- and technology-skill complementarities. We first measure the overall change in relative wages and then determine to what extent these changes are explained by changes in wages by level of education, age, and gender. Next, we examine in more detail the relationship between education and wages by estimating the returns to education, using the selection bias correction method developed by Bourguignon et al. (2001). We then conduct a simple demand and supply analysis using the non-parametric method proposed by Katz & Murphy (1992) to examine alternative explanations for changes in relative wages in India. We find that relative demand changes contributed significantly to changes in relative wages during the period which coincides with India's liberalization of trade and investment. This suggests that a higher demand for skilled labor, brought about by the transfer of skill-biased capital and technology from developed and technologically more advanced countries to India, might be responsible for higher relative wages of skilled labor in India. International trade in manufactures predicts increases in the relative demand for both high-skilled men and women. Further research into foreign direct investment and outsourcing activities in India might shed some light on these critical determinants of firms' relative demand for skilled labor.

Chapter 2

Literature Review

Three pieces of literature provide a background to our research. First, the literature on child labor and education examines the major determinants of child labor, the equilibria existing in a market with child labor, and determinants of education in developing countries. Second, the literature on investment in human and physical capital provides evidence for the existence of complementarities between the two. Third, there is a large body of literature that focuses on the impact of capital- and technology-skill complementarities brought about by trade and investment liberalization on the relative demand for, relative returns to, and productivities of skilled and unskilled labor in both developed and developing countries.

2.1 Literature on Child Labor & Education

2.1.1 Theoretical Literature

The bulk of the theoretical literature on child labor focuses on poverty and credit constraints as the main causes of child labor (Basu & Van 1998, Basu 2002, Ranjan 1999). Another strand of the literature examines the impact of trade on child labor (Jafarey & Lahiri 2002, Edmonds & Pavcnik 2004, Cigno et al. 2002). Yet another strand investigates the impact of technological changes on child schooling and child labor (Foster & Rosenzweig 1996, Dessy & Pallage 2001). The two studies most relevant to our theoretical analysis are Foster & Rosenzweig (1996) and Dessy & Pallage (2001).

Foster & Rosenzweig (1996) develop a general equilibrium model with endogenous school construction and investigate the impact of technological change and school availability on schooling investments in landed and landless households. The Green Revolution in India is used as an exogenous technological change to test their theoretical predictions empirically. Using land prices to capture expected future technologies, the authors find that higher expected future technology and increases in the number of schools raise schooling in landed households. However, even though increases in the number of schools raise schooling in landless households, higher expected future technology decreases schooling in landless households.

Our work differs from Foster & Rosenzweig (1996) in several ways. First, while Foster & Rosenzweig (1996) differentiate between workers on the basis of asset ownership, heterogeneity amongst workers in our model arises because they face different monetary costs of education and receive a different quality of education. Second, in Foster & Rosenzweig (1996) there are two types of agents - landed and landless workers. We incorporate heterogeneity amongst both workers (based on the cost and/or quality of education they receive) and firms (based on their cost of investing in skill-biased capital). Third, in Foster & Rosenzweig (1996) all workers know with certainty what types of jobs they will have in the future. Landed households know their children will perform skill-intensive tasks in the future (make decisions about the adoption and management of new seeds) while landless households know their children will perform manual tasks in the future (weeding or harvesting crops). In our theoretical analysis, workers are uncertain about the type of job they will have in the future and firms are uncertain about the type of workers they will employ in the future. Fourth, in Foster & Rosenzweig (1996) the returns to education for only children from landed households are increasing in the level of technology while children from landless households benefit only indirectly from technological change because the number of schools increase. Here, the returns to all workers and firms are increasing in investment in education and skill-biased technology.

Dessy & Pallage (2001) show how a coordination failure between parents' investment in human capital and firms' investment in skill-biased technology can result in multiple equilibria - a no-education/no-investment equilibrium and a Pareto superior one with both types of investment - in a model where parents and firms have discrete investment choices. The authors show that the Pareto superior outcome is more likely the more patient parents and firms are (agents have a high time discount factor) and the higher is each firm's return to investing in the skill-biased technology. In the discrete version of our theoretical model, we show the existence of multiple equilibria. In addition, we find that the Pareto superior outcome is more likely the higher each firm's return to investing in skill-biased technology is and the higher each parent's return to investing in his child's education is.

2.1.2 Empirical Literature

The relationship between the returns to education and human capital investments is an important one that has been insufficiently explored in the existing literature on child labor and schooling. Several empirical studies provide evidence that child labor and schooling are affected by more general local economic conditions such as openness, globalization, technological innovations, economic growth, and labor markets.

Edmonds & Pavcnik (2004) show that trade liberalization in Vietnam between 1993 and 1998 led to a large increase in the price of rice, Vietnam's principle export and major staple, which was a permanent shock. A higher price of rice resulted in higher unskilled wages that brought about higher income and lower poverty among unskilled households. This caused lower levels of child labor and higher levels of schooling in rural Vietnam. Therefore, the income effect appears to have dominated the substitution effect of a rise in unskilled wages in Vietnam.[1] Cigno et al. (2002) find that countries with greater openness have lower levels of child labor.

Foster & Rosenzweig (1996) examine the impact of agricultural technical changes on schooling in rural India during the peak period of agricultural innovations associated with the Green Revolution (1968–1982). Using land prices to capture expected future technologies, the authors find that higher expected future technology and increases in the number of schools raise schooling levels in landed households. However, although increased school availability increases schooling in landless households, higher expected future technology decreases schooling levels in landless households.

Empirical studies using Latin American data suggest that child labor is procyclical. Barros et al. (1994) find that child labor in Brazil was higher during periods of economic growth than during economic downturns (temporary shocks). Da Silva Leme & Wajnman (2000) find that schooling in Brazil was higher when national unemployment was high, suggesting that children are more likely to attend

[1]When unskilled wages increase, unskilled households are richer. Unskilled parents have less need for their children to work and supplement household income so child labor falls. Education becomes more affordable for unskilled parents so child schooling rises. This is the income effect of an increase in unskilled wages. However, when unskilled wages increase, the opportunity cost of schooling - foregone wages from child labor - increases. Therefore, child labor rises and child schooling falls. This is the substitution effect of an increase in unskilled wages.

school if they cannot find employment. Neri & Thomas (2001) find that child labor in Brazil was above a fitted trend line during periods of economic growth and on the trend line during recessions. Swaminathan (1998) gets similar results for the western Indian state of Gujarat. The author finds that massive economic growth in Gujarat led to a sharp increase in the number of child workers, indicating that economic growth alone is insufficient to eradicate child labor. This result has a direct implication for the analysis in this paper. Economic growth will generate unskilled-labor-intensive jobs and increase the demand for working children, unless it is accompanied by education policies and government incentive schemes that encourage firms to invest in skilled-labor-intensive production technology. In other words, *sustained* growth rather than cyclical expansion is required to improve human capital investments.

Labor market conditions are also shown to affect child labor and schooling. Duryea & Arends-Kuening (2002) find that child labor increases and schooling decreases as the local low skilled wage increases in Brazil. Krueger (2002) shows that child labor increases and schooling decreases when the value of county-level coffee production increases in Brazil. Unlike the study by Edmonds & Pavcnik (2004) where a permanent increase in unskilled wages resulted in the income effect dominating the substitution effect, these studies find that with temporary or cyclical increases in unskilled wages the substitution effect dominates the income effect.

2.2 Literature on Human and Physical Capital Investment

One strand of the literature on human and physical capital investment shows that human capital is attracted to human capital abundant regions. Lucas (1988) shows theoretically that the rate of return on human capital is increasing in the stock of human capital in the workforce. Borjas et al. (1992) show empirically that high skilled workers migrate to regions where such skills are abundant. Bhagwati & Rodriguez (1975) refer to this phenomenon as a 'brain-drain' and show how it hinders the development of many countries. This phenomenon is driven by the idea that in many developing countries, the low stock of human capital, results in low rates of return to both human and physical capital, which further discourage investment in human capital, thus creating a vicious cycle and underdevelopment trap.

Another strand of this literature shows that physical capital (or skill-biased technology) wants to go, as human capital does, to human capital abundant regions. In Lucas (1990), a low stock of human capital restricts capital inflow and the growth of poor countries. International variations in investments and growth rates are also explained by variations in human capital across countries (Barro 1991, Benhabib & Spiegel 1994). The geographical concentration of certain manufacturing industries - for example, the software industries in Silicon Valley, California or Bangalore, India - lends support to the idea that physical capital follows not only human capital but also physical capital itself (Ellison & Glaeser 1994).

Our theoretical model follows Acemoglu (1996) closely. With a one-to-one random matching process between entrepreneurs and adult workers, an exogenous matching function, and exogenous sharing rule, Acemoglu (1996) shows that the returns to human and physical capital are increasing in the average human capital of the workforce and average physical capital of firms. Unlike Acemoglu (1996), our model includes the quality of education as a major determinant of both human and physical capital investments. Therefore, in addition to examining the impact of the cost of education and the cost of skill-biased technology on human and physical capital investments, this model allows for an understanding of human and physical capital investments in response to changes in the quality of education as well as the cost of education and the cost of investing in skill-biased capital.

2.3 Literature on Capital- and Technology-Skill Complementarities

This body of literature focuses on the impact of capital- and technology-skill complementarities brought about by trade and investment liberalization on the relative demand for, relative returns to, and productivities of skilled and unskilled labor in both developed and developing countries.[2]

The theoretical literature in this area establishes the effect of trade and investment liberalization on skilled and unskilled wages in developing countries and shows how widening wage differentials are brought about as a result of skill-biased technology transfer from developed to developing countries (Stokey 1991, Young 1991, Pissarides 1997, Feenstra & Hanson 2001).

There is a vast and rapidly growing empirical literature on the trade-technology-skill and foreign investment-technology-skill links that focuses on the impact of trade and investment liberalization on the demand for, returns to, and productivities of skilled and unskilled labor (Robbins 1996, Coe et al. 1997, Robbins & Gindling 1999, Beyer et al. 1999, Mayer 2001, Gorg & Strobl 2002, Hanson 2003).

Coe et al. (1997) find evidence for a large sample of developing countries, that openness to capital goods imports from technologically advanced countries contribute to an economy's total factor productivity. For Costa Rica, Robbins & Gindling (1999) find evidence that trade liberalization led to an increase in the relative demand for skilled labor. Beyer et al. (1999) find rising wage inequality between skilled and

[2]See O'Connor & Lunati (1999) for a review of the theoretical and empirical literature on how trade and investment liberalization may affect the demand for and returns to skill in developing countries.

unskilled workers after trade liberalization in Chile. Robbins (1996) finds similar evidence for Argentina, Colombia, Malaysia, Mexico, the Philippines, Taiwan, and Uruguay, where trade liberalization brought about rising wage inequality. Mayer (2001) finds that low-income countries as a group have substantially increased the GDP-ratio of technology imports over recent years. However, improved access to technology imports has raised labor productivity and the demand for skilled labor in only some low-income countries, namely India, Pakistan, Sri Lanka, and Zimbabwe. Gorg & Strobl (2002) find an increase in the relative wages of skilled labor in Ghana, brought about by skill-biased technological change induced through imports of technology-intensive capital goods or export activity. For Mexico, Hanson (2003) finds an increase in the returns to skill and in regional wage dispersion during the 1990s, which appears to be explained largely by regional variation in access to foreign trade and investment.

Chapter 3

Complementarities Between Human and Physical Capital: A Theoretical Model

We develop a theoretical model of capital-skill complementarities, where we show that three factors affect parents' investment in their children's education and firms' investment in skill-biased capital, via the returns to education and skill-biased capital. These factors are the cost of investing in capital for firms, the cost of education, and the quality of education available to children.

The layout of this essay is as follows. Section 3.1 sets up the theoretical model. Sections 3.2 and 3.3 examine the Walrasian allocation and decentralized case with search and random matching, respectively. Section 3.4 shows the existence of multiple equilibria in the discrete version of the model and section 3.5 presents concluding remarks.

3.1 Theoretical Model

Consider a two period economy ($t = 0$ and $t = 1$). In the first period agents invest in human and physical capital and in the second period a single good is produced using two factors of production - human capital and physical capital. There are three types of individuals - parents, children, and entrepreneurs. We describe the model below.

3.1.1 Consumers

On the consumption side at $t = 0$, there is a uniform distribution of parents whose mass is normalized to 1. Each parent, p, has one child and a household consists of one parent and one child. At $t = 0$, each parent chooses the proportion of time, e_p, his child spends in school. At $t = 1$, the grown child spends all his time working. The total time available to a child at $t = 0$ and to a grown child at $t = 1$ is normalized to 1.

At $t = 0$, each parent chooses the proportion of time his child spends in school, $e_p \in [\underline{e}, 1]$, where $\underline{e} > 0$. In school, each child receives a given quality of education, h_p. A grown child's human capital level at $t = 1$ depends on both the quantity and quality of education he received at $t = 0$. At $t = 1$ each grown child has human capital level $H_p = e_p h_p$. We assume that at $t = 0$ $H_p = H_o > 0$ to capture the idea that every individual is born with a minimum level of knowledge. Therefore, a grown child's human capital level at $t = 1$ must be positive even if he spent no time in school at $t = 0$, i.e. $H_p = H_o + e_p h_p > 0$.[1]

The total cost of educating child p at $t = 0$ is $C_p = c_p \frac{e_p^{1+\Gamma}}{1+\Gamma}$, where $\Gamma > 0$.[2] C_p captures the monetary cost of education (tuition, fees, textbooks, stationery, uniforms, and travel costs). However, C_p can also be interpreted as including the opportunity cost of education, i.e. the foregone wages from child labor, if there is an informal sector (not modeled here) where children can work. The less time a child spends working at $t = 0$, the more time he spends attending school, e_p. As e_p increases so does the

[1] The assumption that $H_o > 0$ ensures that output and therefore returns to workers and firms are positive even when a parent chooses no education for his child.

[2] This functional form is used to make the total cost of education convex. The cost of education can be linear or convex. An argument can be made for either case. A convex cost of education gives a unique equilibrium while a linear cost of education gives multiple equilibria.

total cost of education, C_p, both as a result of a higher monetary cost of education (due to more time spent at school) and a higher opportunity cost of education (due to less time spent at work and therefore more foregone wages from child labor).[3]

At $t = 0$ parent p chooses e to maximize the household's expected utility over both periods, $E(U_p)$, which is linear in the household's second period income (W_p).[4]:

$$E(U_p) = \delta v(E(W_p)) - C_p = E(W_p) - c_p \frac{e_p^{1+\Gamma}}{1+\Gamma} \tag{3.1a}$$

where δ, the time discount factor common to all workers and firms, is assumed to be 1 for simplicity.

3.1.2 Producers

In the formal market at $t = 0$, there is a uniform distribution of firms whose mass is normalized to 1. A single good is produced using a Cobb-Douglas production technology, where $y_{pf} = y(H_p, k_f) = AH_p^{\alpha} k_f^{1-\alpha} = A(e_p h_p)^{\alpha} k_f^{1-\alpha}$, $0 < \alpha < 1$, is the total output of firm f that employs worker p.

At $t = 0$ each firm invests in physical capital, k_f, the returns of which are only realized at $t = 1$, when parents are retired and children are working adults. We assume that the level of physical capital that firm f chooses, k_f, is directly related to the type of production technology, with the minimum level of physical capital, k_0, representing unskill-biased production technology and higher levels representing a

[3]Including both the monetary and opportunity costs of education in the total cost, C_p, is a simplifying assumption and does not change the main conclusions.

[4]Because the grown child provides for the parent at $t = 1$, a parent is not driven purely by altruism when choosing how much to educate his child, but also by monetary gains for him and his child. This assumption is justified by the practice in many developing economies where grown children, especially sons, are expected to take care of their parents financially

more skill-biased production technology.[5] At $t = 0$ the cost of investing in skill-biased capital for firm f is μ_f.

At $t = 0$ entrepreneur f chooses k to maximize the firm's expected payoff over both periods, $E\left(V_f\right)$, which is linear in the firms' second period income $\left(R_f\right)$:

$$E\left(V_f\right) = \delta E\left(R_f\right) - \mu_f k_f = E\left(R_f\right) - \mu_f k_f \tag{3.2a}$$

3.2 First Best Case: The Walrasian Allocation

We begin with the Walrasian allocation. All agents make their investments at $t = 0$ and production occurs at $t = 1$ in one-worker-one-firm partnerships.[6] In the frictionless Walrasian system, at $t = 0$ the auctioneer calls out schedules of returns to workers and firms, and trade stops when all markets clear. With Walrasian markets, a worker is allocated to a firm where his marginal product is highest, and since human and physical capital are complements, the most skilled worker will be matched with the most skill-biased firm. If all workers and firms are ranked from most skilled or skill-biased to least, then worker p and firm f will be matched together when they have the same ranks in their respective orders.

This allocation is a Walrasian equilibrium if an only if all agents are paid their marginal products in their pairings. The wage and rental rates for all equilibrium

[5] The investment decisions of firms are assumed to be irreversible. These decisions can be thought of as the type of jobs they choose to create or the quality of machinery and equipment they choose to purchase.

[6] The assumption that production occurs in a worker-firm pair is a simplifying one and does not change the main conclusions. Also, because the mass of workers and firms are both normalized to 1, there is no unemployment.

worker-firm pairs (H_p, k_f) are:

$$w_p = w(H_p, k_f) = \alpha A e_p^{\alpha-1} h_p^{\alpha} k_f^{1-\alpha}$$
$$r_f = r(H_p, k_f) = (1-\alpha) A \left(e_p h_p\right)^{\alpha} k_f^{-\alpha}$$

The total equilibrium income of worker p and firm f are $W_p = w(H_p, k_f)H_p$ and $R_f = r(H_p, k_f)k_f$.

The optimal first order conditions for worker p and firm f are:

$$\alpha A e_p^{\alpha-1} h_p^{\alpha} k_f^{1-\alpha} = c_p e_p^{\Gamma} \tag{3.3a}$$
$$(1-\alpha) A \left(e_p h_p\right)^{\alpha} k_f^{-\alpha} = \mu_f \tag{3.3b}$$

Equation 3.3a, the first order condition for type p worker, implies a choice of e_p such that the marginal benefit of an additional unit of education is equal to the marginal cost of an additional unit of education. Equation 3.3b, the first order condition for type f firm, implies a choice of k_f such that the marginal benefit of an additional unit of skill-biased capital is equal to the marginal cost of an additional unit of skill-biased capital. Equations 3.3a and 3.3b give e_p^{FB} and k_f^{FB}, which lead to Proposition 1:

$$e_p^{FB} = \left(\frac{\alpha(1-\alpha)^{(1-\alpha)/\alpha} A^{1/\alpha} h_p \mu_f^{(\alpha-1)/\alpha}}{c_p}\right)^{1/\Gamma} \tag{3.4a}$$
$$k_f^{FB} = \left(\frac{\alpha(1-\alpha)^{1/\theta} A^{(\Gamma+1)/\alpha} h_p^{\Gamma+1} \mu_f^{-1/\theta}}{c_p}\right)^{1/\Gamma} \tag{3.4b}$$

Where $\theta = \frac{\alpha}{\Gamma+1-\alpha}$.

Proposition 1. [7] *In the first best case (the Walrasian allocation),*

[7] Detailed proofs of all propositions are in Appendix A.

1. *There exists a unique socially optimal outcome given by e_p^{FB} and k_f^{FB} for worker p and firm f.*

2. *The socially optimal investments, returns, and welfare of worker p and firm f are increasing in worker p's quality of education and decreasing in worker p's cost of education and in firm f's cost of skill-biased capital.*

3. *The socially optimal investments, returns, and welfare of worker p and firm f are independent of the distribution of workers and firms.*

Proposition 1 is the result of efficient matching. At $t = 0$, worker-firm pairs are known to all agents. As a result, the investment of each agent depends on only those parameters that directly affect his own investment and the investment of the agent he is matched with. The returns and welfare of each agent are increasing in only his investment and the investment of the agent he is matched with. A worker is indifferent about the human capital choices of other workers. Similarly, a firm is indifferent about the physical capital choices of other firms.

3.3 The Decentralized Case with Search and Random Matching

We now turn to a model with costly bilateral search in the labor market where switching partners has a cost of $\epsilon > 0$. As before, all agents make their investments at $t = 0$ and production occurs at $t = 1$ in one-worker-one-firm partnerships with no unemployment. We assume that workers and firms are allocated to each other with a random matching technology. Therefore, at $t = 1$ each worker has an equal probability of meeting each firm, irrespective of the worker's human capital and the firm's physical capital.

Two important features are introduced in this model as a result of replacing the

Walrasian auctioneer with costly bilateral search in the labor market. First, wage and rental rates are no longer equal to agents' marginal products. Instead, as in the standard search models, returns to workers and firms are determined by bargaining. Here, we make the simplifying assumption that workers earn a share β and firms earn the remaining share $1-\beta$ of total output.[8] The total equilibrium income for worker p and firm f is $W_p = \beta y_{pf}$ and $R_f = (1-\beta)y_{pf}$. The second feature that is introduced is anonymity. Workers and firms do not know who their employers or employees will be when they make their investments in human and physical capital. Therefore, there is an incompleteness of contracts because agents cannot write contracts to improve their investment incentives.

3.3.1 Homogenous Agents

We begin with the case of homogeneous agents. All children face the same cost of education ($c_p = c\ \forall p$) and receive the same quality of education ($h_p = h\ \forall p$), and all firms face the same cost of skill-biased capital ($\mu_f = \mu\ \forall f$). The expected returns for workers and firms are:

$$E\left(W_p\right) = W(H_p, \{k_f\}) = \beta A\left(e_p h_p\right)^{\alpha}\left(\int k_f^{1-\alpha}\ df\right)$$
$$E\left(R_f\right) = R(\{H_p\}, k_f) = (1-\beta)A\left(\int \left(e_p h_p\right)^{\alpha}\ dp\right)k_f^{1-\alpha}$$

As a result of random matching, each worker's expected return depends on the whole distribution of physical capital across firms,$\{k_f\}$. Since each worker has an equal probability of being matched with each firm, his expected output is $A\left(e_p h_p\right)^{\alpha}\left(\int k_f^{1-\alpha}\ df\right)$

[8] See Acemoglu (1996) for a derivation of this sharing rule. To understand why agents are paid a share of total output rather than their marginal product, suppose that once a pair is formed both parties must incur a cost ϵ to change partners. Even with very small search frictions, there may be a large wedge between the marginal product of factors of production and their rates of return.

and his expected return is a share β of this. Similarly, each firm's expected return depends on the whole distribution of human capital across workers,$\{H_p\}$. Since each firm has an equal probability of being matched with each worker, its expected output is $A\left(\int (e_p h_p)^\alpha \, dp\right) k_f^{1-\alpha}$ and its expected return is a share $(1-\beta)$ of this.

Since all workers are identical and all firms are identical, all workers will choose the same level of education and all firms will choose the same level of physical capital. The first order conditions for all workers and firms are:

$$\alpha\beta A e^{\alpha-1} h^\alpha k^{1-\alpha} = c e^\Gamma \tag{3.5a}$$

$$(1-\alpha)(1-\beta) A \, (eh)^\alpha \, k^{-\alpha} = \mu \tag{3.5b}$$

The optimal investment levels, e^* and k^*, for each worker and firm are:

$$e^* = \left(\frac{\alpha\beta\left((1-\alpha)(1-\beta)\right)^{(1-\alpha)/\alpha} A^{1/\alpha} h \mu^{(\alpha-1)/\alpha}}{c}\right)^{1/\Gamma} \tag{3.6a}$$

$$k^* = \left(\frac{\alpha\beta\left((1-\alpha)(1-\beta)\right)^{1/\theta} A^{(\Gamma+1)/\alpha} h^{\Gamma+1} \mu^{-1/\theta}}{c}\right)^{1/\Gamma} \tag{3.6b}$$

Where $\theta = \frac{\alpha}{\Gamma+1-\alpha}$.

Proposition 2. *In the decentralized case with random matching, with $W_p = \beta y_{pf}$ and $R_f = (1-\beta) y_{pf}$, and with homogeneous agents,*

1. *There exists a unique equilibrium given by e^* and k^* for each worker and firm.*

2. *The optimal investment levels of workers and firms are inefficient, i.e. $e^* < e^{FB}$ and $k^* < k^{FB}$.*

3. *The investments, returns, and welfare of all workers and firms are increasing in the quality of education for all workers and decreasing in the cost of education for all workers and in the cost of skill-biased capital for all firms.*

Proposition 2 (2) - under-investment in human and physical capital - is the result of incompleteness of contracts. The terms β and $(1-\beta)$ make e^* and k^* inefficient, and these are the terms introduced by the incompleteness of contracts. There is no sharing rule that can restore efficiency in this economy.[9] Proposition 2 (3) shows that there are social increasing returns to investment in human and physical capital in this economy. A lower cost or higher quality of education for children not only increases investments, returns, and welfare of workers, but also increases the investments, returns, and welfare of firms.[10] Proposition 2 (3) also captures complementarities between human and physical capital. Human and physical capital want to go to regions where these factors are already abundant. This explains the geographical concentration of skill-intensive industries, the lack of capital flow to low-skill areas, and higher rates of return to human capital in high average education urban areas.

3.3.2 Heterogeneous Agents

We now turn to the case of heterogeneous agents and show an even stronger form of social increasing returns. We assume that there are two types of children ($i = 1, 2$) two types of firms ($j = 1, 2$). Type 1 children receive quality of education h_1 and face cost of education c_1 whereas type 2 children receive quality of education h_2 and

[9] No value of β can restore efficiency. This is because, as β approaches 1, correct investment incentives are restored for parents but firms' investment incentives are increasingly distorted. Conversely, as β approaches 0, correct investment incentives are restored for firms but parents' investment incentives are increasingly distorted.

[10] This result is driven by the investment response of the other side of the market to a change in a parameter. A change in an exogenous variable must occur before the other side of the market invests and must be known to the other side of the market. For example, if a change in the cost of education for children occurs after firms have made their investment decisions or if it is unknown to firms, then there will be no change in firms' investments.

face cost of education c_2. There is a mass of λ of type 1 children and $(1-\lambda)$ of type 2 children at $t=0$. Type 1 firms face cost of skill-biased capital μ_1 whereas type 2 firms face cost of skill-biased capital μ_2. There is a mass of ρ of type 1 firms and $(1-\rho)$ of type 2 firms at $t=0$.

The expected returns for type i worker and type j firm are:

$$E(W_i) = W(H_i, \{k_j\}) = \beta A (e_i h_i)^{\alpha} \left(\rho k_1^{1-\alpha} + (1-\rho) k_2^{1-\alpha}\right)$$
$$E(R_j) = R(\{H_i\}, k_j) = (1-\beta) A k_j^{1-\alpha} \left(\lambda (e_1 h_1)^{\alpha} + (1-\lambda)(e_2 h_2)^{\alpha}\right)$$

The first order conditions for worker i and firm j are:

$$\alpha\beta A e_i^{\alpha-1} h_i^{\alpha} \left(\rho k_1^{1-\alpha} + (1-\rho) k_2^{1-\alpha}\right) = c_i e_i^{\Gamma} \tag{3.7a}$$
$$(1-\alpha)(1-\beta) A k_j^{-\alpha} \left(\lambda (e_1 h_1)^{\alpha} + (1-\lambda)(e_2 h_2)^{\alpha}\right) = \mu_j \tag{3.7b}$$

The optimal investments for all workers and firms are:

$$e_1^* = \left(\alpha\beta\left((1-\alpha)(1-\beta)\right)^{(1-\alpha)/\alpha} A^{1/\alpha}\right)^{1/\Gamma} \left(\rho (\mu_1)^{(\alpha-1)/\alpha} + (1-\rho)(\mu_2)^{(\alpha-1)/\alpha}\right)^{1/\Gamma}$$
$$\left(\lambda (h_1)^{\alpha/(1-\alpha)} (c_1)^{-\alpha/(1-\alpha)} + (1-\lambda)(h_2)^{\theta(\Gamma+1)} (c_2)^{-\theta} (h_1)^{\theta\Gamma\alpha/(1-\alpha)} (c_1)^{-\theta\Gamma/(1-\alpha)}\right)^{(1-\alpha)/\alpha\Gamma} \tag{3.8a}$$

$$e_2^* = \left(\alpha\beta\left((1-\alpha)(1-\beta)\right)^{(1-\alpha)/\alpha} A^{1/\alpha}\right)^{1/\Gamma} \left(\rho (\mu_1)^{(\alpha-1)/\alpha} + (1-\rho)(\mu_2)^{(\alpha-1)/\alpha}\right)^{1/\Gamma}$$
$$\left(\lambda (h_1)^{\theta(\Gamma+1)} (c_1)^{-\theta} (h_2)^{\theta\Gamma\alpha/(1-\alpha)} (c_2)^{-\theta\Gamma/(1-\alpha)} + (1-\lambda)(h_2)^{\alpha/(1-\alpha)} (c_2)^{-\alpha/(1-\alpha)}\right)^{(1-\alpha)/\alpha\Gamma} \tag{3.8b}$$

$$k_1^* = \left(\alpha\beta\left((1-\alpha)(1-\beta)\right)^{1/\theta} A^{(\Gamma+1)/\alpha}\right)^{1/\Gamma} \left(\rho (\mu_1)^{-1/\theta} + (1-\rho)(\mu_2)^{(\alpha-1)/\alpha} (\mu_1)^{-\Gamma/\alpha}\right)^{1/\Gamma}$$
$$\left(\lambda (h_1)^{\theta(\Gamma+1)} (c_1)^{-\theta} + (1-\lambda)(h_2)^{\theta(\Gamma+1)} (c_2)^{-\theta}\right)^{1/\theta\Gamma} \tag{3.8c}$$

$$k_2^* = \left(\alpha\beta\left((1-\alpha)(1-\beta)\right)^{1/\theta} A^{(\Gamma+1)/\alpha}\right)^{1/\Gamma} \left(\rho (\mu_1)^{(\alpha-1)/\alpha} (\mu_2)^{-\Gamma/\alpha} + (1-\rho)(\mu_2)^{-1/\theta}\right)^{1/\Gamma}$$
$$\left(\lambda (h_1)^{\theta(\Gamma+1)} (c_1)^{-\theta} + (1-\lambda)(h_2)^{\theta(\Gamma+1)} (c_2)^{-\theta}\right)^{1/\theta\Gamma} \tag{3.8d}$$

Where $\theta = \frac{\alpha}{\Gamma+1-\alpha}$.

Proposition 3. *In the decentralized case with random matching, with* $W_p = \beta y_{pf}$ *and* $R_f = (1-\beta)y_{pf}$*, and with homogeneous agents,*

1. *There exists a unique equilibrium given by* e_i^* *and* k_j^* *for type* i *worker and type* j *firm, where* $i = 1, 2$ *and* $j = 1, 2$.

2. *The investments, returns, and welfare of type* i *worker and type* j *firm are increasing in the quality of education for all workers and decreasing in the cost of education for all workers and in the cost of skill-biased capital for all firms.*

3. *The investments, returns, and welfare of type* i *worker and type* j *firm, are increasing in the proportion of high-skilled workers and skill-biased firms.*

Proposition 3 establishes a stronger form of social increasing returns to human and physical capital investment. If agents are heterogeneous in terms of the cost or quality of education or the cost of skill-biased capital that they face, then a change in a parameter for just a proportion of agents will affect the investments, returns, and welfare of all agents in the economy. The intuition is based on the idea that at $t = 0$, before each agent makes his investment decision, parents and firms are unaware of worker-firm matchings at $t = 1$. If type 1 children experience either a lower cost or higher quality of education, these children's parents will invest more in their education. Firms expect there to be more human capital in the workforce and therefore expect a higher return to investment in skill-biased capital. So, firms invest more in skill-biased capital to take advantage of this. Parents of type 2 children expect a higher return to their children's education as a result of more skill-biased capital in the economy and therefore invest more in their children's education.[11]

[11] Similarly, if type 1 firm experiences a lower cost of investing in skill-biased capital, these firms will invest more in skill-biased capital. Workers expect there to be more skill-biased capital in the

In terms of policy to diminish or eradicate child labor, Propositions 2 and 3 provide two striking results. First, this model shows that subsidizing education or improving the quality of education for only a proportion of households is sufficient to increase education and lower child labor in unsubsidized households as well. So a minimal cost policy to eradicate child labor potentially exists, whereby some mechanism allows one to differentiate between various types of workers and target the group that is least costly to subsidize or improve the quality of education for. For example, a group can be cheaper to target if it is smaller than other groups. However, a lower cost policy might be less effective since the other side of the market responds less to a change in a parameter that benefits a smaller group.[12] Second, targeted education policies and skill-biased investment subsidies are shown to be substitutable instruments for increasing education and decreasing child labor in an economy.

Note. The decentralized case with efficient matching is in between the Walrasian allocation and the decentralized case with search and random matching. In the case of homogeneous agents, the allocation described in Proposition 2 is the unique equilibrium. In the case of heterogeneous agents, if type 1 children experience a lower cost

economy and therefore expect a higher return to education. So workers invest more in education to take advantage of this. Type 2 firms expect a higher return to skill-biased capital as a result of more human capital in the workforce and therefore invest more in skill-biased capital. Acemoglu (1996) obtains similar results with respect to the costs of human and physical capital. However, unlike Acemoglu (1996), the results presented here show that human and physical capital investments are also increasing in the quality of education for all or a proportion of children.

[12]For example, if the proportion of low human capital workers, λ, is small and the government subsidizes education for this group, these workers will increase their investments in human capital. However, because λ is small, the probability of meeting each of these workers is low, so firms will increase their skill-biased investments less than if λ was high. So the aggregate effect of a minimal cost policy based on the size of a group of agents may be small.

or higher quality of education, then the investments, returns, and welfare of these grown children and the firms they are matched with will improve. Type 2 children and firms will be unaffected.

The decentralized case with efficient matching is not analyzed here because in reality the matching technology is more random than efficient since an efficient matching technology requires an invisible hand creating the right matches. Although certain labor market institutions, like job advertising and interviewing, play this role, there is still a high degree of randomness. The real world matching technology can therefore be thought of as a combination of random and efficient matching. As a result, social increasing returns will be present in general, though their significance might be limited if the matching technology is closer to an efficient one.

3.4 Multiple Equilibria

The idea that human and physical capital are attracted to regions where these factors are already abundant gives rise to the possibility of multiple equilibria - one equilibrium with low investments in education and skill-biased capital and the other with high investments in both.

In Sections 3.2 and 3.3, with a convex cost of education, the continuous version of the model generates a unique equilibrium. However, with a linear cost of education, the continuous model generates multiple equilibria. Because it is difficult to find closed form solutions for the multiple equilibria generated in the continuous model with a linear cost of education, we use the discrete model with a linear cost of education to illustrate the existence of Pareto-ranked multiple equilibria.

In the discrete model, we assume for simplicity that there is one parent and one firm. At $t = 0$ the parent chooses to either send his child to school full time ($e = 1$)

at cost c or to work full time ($e = \underline{e}$) where he will earn γW_0, $0 < \gamma < 1$, where γ is a parameter that measures the productivity of a child worker and W_0 is the income of an adult worker at $t = 0$.[13] If a parent decides to educate his child, the total cost of education is the sum of the monetary cost of education, c, and the opportunity cost of education, γW_0. While the continuous version of the model includes both the monetary and opportunity cost of education in the total cost of education, C_i (Section 3.1.1), these two costs of education are separable in the discrete version. At $t = 1$ the firm chooses between two levels of capital or two types of technologies, k_0 and k_1, where $k_1 > k_0$. The cost of retaining the traditional or unskill-biased capital is μk_0 while the cost of investing in the modern or skill-biased capital is μk_1.

If both agents invest, their payoff functions are:

$$U_{11} = U(e = 1, k = k_1) = \beta A h^{\alpha} k_1^{1-\alpha} - c \tag{3.9a}$$

$$V_{11} = V(e = 1, k = k_1) = (1 - \beta) A h^{\alpha} k_1^{1-\alpha} - \mu k_1 \tag{3.9b}$$

If the parent invests but the firm does not, their payoff functions are:

$$U_{10} = U(e = 1, k = k_0) = \beta A h^{\alpha} k_0^{1-\alpha} - c \tag{3.10a}$$

$$V_{10} = V(e = 1, k = k_0) = (1 - \beta) A h^{\alpha} k_0^{1-\alpha} - \mu k_0 \tag{3.10b}$$

If the firm invests but the parent does not, their payoff functions are:

$$U_{01} = U(e = \underline{e}, k = k_1) = \gamma W_0 + \beta A \left(\underline{e} h\right)^{\alpha} k_1^{1-\alpha} \tag{3.11a}$$

$$V_{01} = V(e = \underline{e}, k = k_1) = (1 - \beta) A \left(\underline{e} h\right)^{\alpha} k_1^{1-\alpha} - \mu k_1 \tag{3.11b}$$

[13]The income of an adult worker and firm at $t = 0$ is excluded from the analysis in both the continuous and discrete versions of the model because all workers and firms are assumed to be identical in the first period. Therefore, the income of all workers and all firms are identical at $t = 0$, and do not affect their investment decisions.

If neither agent invests, their payoff functions are:

$$U_{00} = U(e = \underline{e}, k = k_0) = \gamma W_0 + \beta A \left(\underline{e}h\right)^{\alpha} k_0^{1-\alpha} \tag{3.12a}$$

$$V_{00} = V(e = \underline{e}, k = k_0) = (1-\beta) A \left(\underline{e}h\right)^{\alpha} k_0^{1-\alpha} - \mu k_0 \tag{3.12b}$$

Proposition 4. *If* $\beta A k_1^{1-\alpha} \left(h^{\alpha} - (\underline{e}h)^{\alpha}\right) > \gamma W_0 + c > \beta A k_0^{1-\alpha} \left(h^{\alpha} - (\underline{e}h)^{\alpha}\right)$ *and* $(1-\beta) A h^{\alpha} \left(k_1^{1-\alpha} - k_0^{1-\alpha}\right) > \mu \left(k_1 - k_0\right) > (1-\beta) A \left(\underline{e}h\right)^{\alpha} \left(k_1^{1-\alpha} - k_0^{1-\alpha}\right)$, *then:*

1. *There exist two pure strategy Nash equilibria - one no-investment equilibrium and the other a full-investment one.*

2. *The full-investment equilibrium Pareto-dominates the no-investment one.*

Stated differently, Proposition 4 establishes the existence of two Pareto-ranked equilibria if two conditions hold simultaneously. First, there is a net benefit to education when the firm invests in skill-biased capital but a net loss to education when the firm retains the unskill-biased capital. Second, there is a net benefit to investing in skill-biased capital when the parent educates his child but a net loss to investing in skill-biased capital when the parent sends his child to work.

Proposition 4, like Propositions 2 and 3, captures complementarities between human and physical capital. The existence of a no-investment and full-investment equilibrium explains how some developing countries fall into an underdevelopment trap, which is difficult to escape. Inadequate initial conditions - low levels of investments in human and physical capital - can generate a vicious cycle of high levels of child labor and insufficient employment opportunities for educated labor. Propositions 2 and 3 show that improvements in the quality of education and easier access to education and skill-biased capital can act as forces that pull an economy out of an underdevelopment trap.

An interesting conclusion can be drawn from the existence of Pareto-ranked multiple equilibria. If an economy is at the no-investment equilibrium, then a ban on child labor or a compulsory schooling law that will move the economy away from the no-investment equilibrium and toward the full-investment one, is Pareto-improving. All agents - parents, children, and firms - are better off at the full-investment equilibrium than at the no-investment one. As mentioned in the introduction, this result is not obtained in the previous literature on child labor.[14]

3.5 Conclusion

The model presented here has shown that investments in human and physical capital are increasing in the average quality of education and decreasing in the average cost of education and average cost of firms' investing in skill-biased capital. While the majority of literature on child labor focuses on socio-economic household characteristics (poverty, asset ownership, parents education, etc.) as its major determinants, this paper shows that the institutional characteristics of an economy - education, investment, and trade structures and policies - can potentially have a large impact on child labor and child schooling in an economy.[15] Since institutional variables are more amenable to policy intervention than individuals' socio-economic background, the institutional determinants of child labor are worth examining.

Moreover, while the previous literature focuses on the enforcement of regulations, such as compulsory schooling laws and partial or full child labor bans, as ways to decrease or eradicate child labor, this paper explores policies that shift parents' in-

[14] The exception is Dessy & Pallage (2001).

[15] The cost of education and skill-biased capital depend, to a large extent, on access to schools and skill-biased capital, respectively. So policies that make schools and skill-biased capital more accessible to children and firms respectively will increase human and physical capital investments.

centives toward investing in their children's education. Improving the quality of education and access to schools, subsidizing skill-biased capital acquisition for firms, promoting the use of high-technology agricultural techniques that require more educated laborers, and improving access to skill-biased capital and machinery via openness of the economy, are policies that can significantly lower child labor levels and increase education in developing countries.

The model presented here differs from most theoretical studies on child labor (the exception is Dessy & Pallage (2001)) that find an ambiguous effect on workers' and firms' welfare as a result of a partial or full ban on child labor. In the continuous version of the model (Section 3.3), the welfare of all agents improves unambiguously in response to policies that improve the quality of education, lower the cost of education, or lower the cost of firms' investment in skill-biased capital. In the discrete model (Section 3.4), a ban on child labor or a compulsory schooling law that moves the economy away from the no-investment to the full-investment equilibrium is Pareto-improving.

Finally, with costly bilateral search and random matching in the labor market, such that workers and firms don't know with whom they will be paired, improving the quality of education and lowering the cost of education and firms' cost of investing in skill-biased capital for even a small proportion of agents, results in greater investments by, returns to, and welfare of all agents. This result suggests that a minimal cost policy to lower child labor and increase schooling potentially exists for developing countries.

3.6 Extensions

One interesting extension to the existing model is to allow the discount factor, δ, to be less than 1. Allowing $\delta < 1$ addresses a parent's incentive to educate his child. The lower the value of δ, the less weight a parent attaches to his child's future income, perhaps because it is less likely for the parent to claim his child's income. Also, allowing δ to vary across parents is one way of accounting for heterogeneity amongst households.

Chapter 4

Returns to Education, Child Labor, and Schooling in India

In this essay, we test the theoretical proposition established in the first essay that human capital investments respond to changes in the returns to education, by estimating the impact of the returns to education on participation in child labor and schooling in India. Section 4.1 gives a brief background on child labor and education in India. Section 4.2 describes the data while Section 4.3 outlines the empirical analysis. Section 4.4 presents the empirical results and Section 4.6 concludes.

4.1 Child Labor and Education in India

India serves as a good case study for our empirical analysis for several reasons. First, rather than attempt to control for differences in cultures, legal systems, and other institutions across countries, it is more effective to focus on a single country where these factors can be held constant (see Tables C.1 and C.2 in Appendix C for a comparison of India with other countries). Second, India is a large country, providing a large number of intra-national observations that are convenient for a statistical analysis. Third, not only does India have the largest number of child workers in the world, with credible estimates ranging from 60 to 115 million working children, there is also a considerable amount of regional variation in child labor and education across the country (see Table C.3 in Appendix C).

Child labor, as defined by the International Labor Organization (ILO) and by the Indian Census, is defined as children in the age group 5–14 years who are 'economically active'. A person is economically active if he/she does work on a regular basis for which he/she receives remuneration or if such labor results in output for the market. The education system in India consists of primary (grades 1 through 5), middle (grades 6 through 8), secondary (grades 9 through 10), and higher secondary (grades 11 through 12) education. Primary education is a shared responsibility of state and central governments, though state governments are the main actors responsible for the allocation of educational inputs at the local level. The majority of primary schools are public schools funded by state governments. Private schools are either aided or unaided. Aided private schools are privately managed but are financed, almost exclusively, by state governments.

Even though several laws prohibit the use of child labor in certain activities and compulsory education laws exist in several Indian states, legislation with respect to child labor and education is rarely enforced. Opposition from employers of child laborers and from parents of children who work creates political pressures that discourage enactment of these laws. The Child Labor Prohibition & Regulation Act (August, 1986) prohibits the employment of children below the age of 14 in certain occupations and processes, while regulating work conditions in other jobs. Children are prohibited from employment in bidi-making; carpet-weaving; cement manufacturing; cloth printing, dyeing, and weaving; match manufacturing; explosives and fireworks; mica cutting and splitting; shellac manufacturing; soap manufacturing; tanning; wool cleaning; and building and construction work. It also prohibits the employment of children on railway and port premises. The act provides for the protection of child laborers not employed in the above specified hazardous occupations and processes. It sets limits on the number of hours children can work continuously, limits the number of days of employment, and restricts the times of work. Central and state governments are permitted to set rules for cleanliness in the work place, the disposal of wastes and effluents, ventilation, temperature, dust, and fumes. Moreover, employers are required to maintain a register with the names and birth dates of all children they employ. This law only covers factories with over 10 workers. Since most children work in the informal sector and in unregistered factories with less than 10 workers, they are not protected by it. Children working in factories with over 10 workers are usually not recorded in the register. Moreover, employers who violate this law are required to pay a small fine, after which they continue to employ children. With respect to education, article 45 of the Indian Constitution declares that the state shall endeavor to provide free and compulsory education for all children below the age of 14 years.[1]

Lack of enforcement of child labor and education legislation is generally attributed to political pressures from employers of child laborers and parents who send their children to work. In many rural areas, employers and parents are unaware that child labor is an offense. Moreover, it is the norm or social custom amongst families (poor and relatively better-off ones) to stop educating their children after a few years of primary school and to send them to work.

There is a great deal of regional variation in child labor and schooling among the country's 31 states and union territories, with child labor as high as 55% in the western state of Gujarat and as low as 7% in Himachal Pradesh and schooling highest in Kerala at 94% and lowest in Bihar at 51% in 1999 (see Tables C.5, C.6, C.7, and C.8 in Appendix C).[2] Table C.9 in Appendix C reveals that child labor increased

[1] Table C.4 in Appendix C summarizes Indian legislation with respect to child labor and education.

[2] Child laborers consist of children who are engaged in full time or part time market work, house-

sharply from 1983 to 1988 and then declined from 1988 to 1999, while schooling has steadily increased from 1983 to 1999. From 1983 to 1988 children engaged in neither work nor school decreased dramatically. In our data, 28.52% of children are reported as too young to work or attend school in 1983 and are therefore included as children engaged in neither work nor school.

4.2 Data Source

The individual level data used in this study comes from the Employment and Unemployment Schedule of the National Sample Survey Organization (NSSO), administered nationally by the Government of India. The Employment and Unemployment Schedules are administered every five years in four sub-rounds, each with a duration of three months.[3] An equal number of households are allotted for survey during each of these four sub-rounds. We use the NSSO surveys for the years 1983, 1988, 1993, and 1999, which are the only years for which data is electronically available. The data set consists of a time-series of cross-sections since different households are surveyed every year. Households are selected via stratified random sampling.[4] The NSSO survey

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hold enterprise work, or domestic activities. Schooling consists of children who attend school full time or part time.

[3]The four sub-rounds are from July to September, October to December, January to March, and April to June.

[4]The survey covers the entire Indian Union except for certain inaccessible regions. Villages within a district are selected on the basis of their accessibility. For example, in the 1999 survey, the entire Ladakh and Kargil districts of Jammu and Kashmir, interior villages of Nagaland located beyond 5 kilometers of a bus route, and some inaccessible villages of Andaman and Nicobar Islands were excluded. The number of sample households surveyed within a village or town is chosen on the basis of its population. Households are first listed and then divided into two groups, affluent and non-affluent households, based on monthly expenditure levels (urban) and ownership of certain items

includes household and individual level data - household size and composition, social group, religion, income, assets, indebtedness, demographic variables (age, gender, marital status), education participation and attainment, and a detailed employment section on principle and subsidiary activities (industry, occupation, type and amount of income earned, and intensity of each activity).

4.3 Empirical Analysis

The empirical analysis examines the theoretical proposition that parents invest more in their children's education in response to higher returns to education. Specifically, higher returns to primary and middle school are expected to lower participation in child labor and increase participation in schooling.[5]

The returns to education can lower child labor and increase schooling through two mechanisms. First, parents' expectations of the future returns to investing in their children's education affect their present educational investment decisions for their children. This is the mechanism that our theoretical model captures. However, the returns to education can also affect participation in child labor and schooling via the income effect. In other words, in states with higher returns to education, educated parents are wealthier, making them less likely to send their children to work and more likely to educate their children. The results of the empirical analysis capture the impact of the returns to education on participation in child labor and schooling

(rural). A fixed number of households within each group are then randomly selected.

[5] Children aged 5 to 14 years are included in our analysis. Given that children in the age-group 5 to 14 years attend primary or middle school, only the returns to primary and middle school are included as explanatory variables. However, if parents are forward looking, the returns to high school and college could also affect parents' investment in their children's education. As a robustness check we include the returns to high school and college as explanatory variables (see Section 4.5.2).

via both these mechanisms. In our empirical analysis, though we cannot rule out the income effect, we expect the first mechanism to be the primary channel through which state-level returns to education affect participation in child labor and schooling for the following reason. The returns to education are estimated at the state level. If the income effect determines participation in child labor and schooling, it is more likely to work through household-level income rather than state-level returns to education. Household income and land ownership are included as controls in order to capture an income effect.

4.3.1 Estimating the Returns to Education

Earnings regressions are estimated, after correcting for selection bias using the method developed by Bourguignon et al. (2001), separately for males and females in each Indian state (25 states and 6 union territories) for four years (1983, 1988, 1993, and 1999). Using data for the adult population aged 15 years and above, earnings regressions are estimated after correcting for selection bias since non-zero wages are reported only for a sub-sample, i.e. those engaged in wage employment.[6] If the selection of this sub-sample of individuals is random, then the estimates of an ordinary least squares earnings regression will be consistent and unbiased. If, however, the selection of this sub-sample is systematic - i.e. the error terms in the selection regression and the earnings regression are correlated - then ignoring the non-random nature of the sample will introduce a selection bias.[7] Therefore the selection process is modeled as having four possible outcomes: (1) non-participation in the labor market, (2)

[6] Appendix B includes a detailed discussion of the correction for selection bias in estimating the returns to education.

[7] See Kingdon & Unni (1998) and Duraiswamy (2000) for similar studies on the Indian labor market.

unemployment, (3) self-employment, and (4) wage employment. A multinomial logit model is used to estimate the selection process. The selection bias correction term is calculated from the selection regression and included in the earnings regression to correct for the selection bias, using the method developed by Bourguignon et al. (2001).[8]

Consider the following equations for the earnings regression (Equation 4.1a) and the selection process into wage employment (Equation 4.1b):[9]

$$y_s = x_s \beta_s + \mu_s \tag{4.1a}$$

$$y_s^* = z_s \gamma_s + \eta_s \tag{4.1b}$$

where y_s is earnings (the outcome variable) and y_s^* is employment status (the selection variable) and s is a categorical variable representing an individual's choice between M alternatives, $s = 1, ..., M$. The variables x_s and z_s are exogenous, where x_s is a subset of z_s in order to identify the earnings equation.[10] The error term in the earnings regression, μ_s, has $E(\mu_s|x, z) = 0$ and $V(\mu_s|x, z) = \sigma^2$.

[8]See Chapter 5, Section 5.4 for a discussion of our results on selection bias in our earnings regressions.

[9]The i subscript for individuals is suppressed.

[10]The appropriate identifying variables as suggested by labor supply theory are an exogenous source of non-labor income to capture household need and variables such as parent's education to capture family background. In the absence of data on non-labor income and parent's education, alternate identifying variables have been used in this analysis. Household need is captured by the total area of land owned by the household, whether or not the individual is married, and the size of the household. These three variables are expected to affect participation in wage employment but not wages earned. Earnings regressions are estimated separately for males and females in each of 31 states and 4 years. This gives us a total of 248 earnings regressions (2 x 31 x 4). The variables included in x_s are four dummies to capture an individual's highest level of education (primary, middle, high school, or college, where the omitted category is no education), an individual's age and

To obtain consistent estimates of β_4, since the observed outcome belongs to category $s = 4$, Bourguignon et al. (2001) propose estimating the following model:

$$y_4 = x_4\beta_4 + \lambda + \nu_4 \tag{4.2}$$

where λ consists of the selection bias correction terms and its coefficients and is defined as:

$$\lambda = \sigma_4 \left[\tilde{\rho}_4 m\left(P_4\right) + \sum_{s<4} \tilde{\rho}_s \frac{P_s}{(P_s - 1)} m\left(P_s\right) \right] \tag{4.3}$$

and the error term ν_4 is orthogonal to all other terms on the RHS and has zero expectation.[11]

Earnings regressions are estimated using a standard semi-logarithmic specification following Mincer (1970):

$$\ln y_4 = x_4\beta_4 + \lambda + \nu_4 \tag{4.4}$$

The return to education level e for gender g in state j and year t is calculated as:

$$Return_{egjt} = \beta_{egjt} - \beta_{e-1,gjt} \tag{4.5}$$

where β_{egjt} is the coefficient for the dummy for education level e for gender g in state j and year t in the earnings regression. The subscript e represents primary, middle, high school, and college education ($e = \{p, m, h, c\}$)[12], gender g can be male or female,

age-square, dummies for an individual's caste (low-caste/high-caste), religion (Muslim/non-Muslim), and sector (urban/rural), three season dummies (the omitted season is from July to September) to capture when the individual was surveyed, and the local unemployment rate. The variables included in z_s consist of all those in x_s and the total area of land possessed, whether or not the individual is married, and the household size.

[11] Refer to Equation B.15 in Appendix B for details.

[12] High school consists of secondary school (grades 9 and 10) and higher secondary school (grades 11 and 12).

state j represents India's 31 states, and t represents four years (1983, 1988, 1993, and 1999). The rate of return to education level e captures the additional log of hourly wages earned by an individual with education level e compared to an individual with education level $(e-1)$, per year of education level e, and is calculated as:

$$Rate_{egjt} = \frac{Return_{egjt}}{Years_e} \tag{4.6}$$

where $Years_e$ represents the number of years required to complete education level e (five years for primary school, 3 years for middle school, four years for high school, and 3 years for college).

4.3.2 Returns to Education, Child Labor, and Schooling

Participation in child labor and schooling is estimated using the rates of return to primary and middle school as the key independent variables for boys and girls aged 5 to 14 years. The returns to education capture both inter-state and inter-temporal variation. Household- and individual-level controls are included as well as year and state dummies. Because aggregate variables (returns to education) are used to estimate individual outcomes (participation in child labor and schooling), the standard errors are corrected for clustering at the year-state level (Moulton (1990)).

Two points should be noted. First, we estimate the impact of *present* rather than *expected* rates of return to education on child labor and schooling. We do this not because we expect future returns to be identical to present returns to education, but because in the absence of a measure of expected returns, present returns to education represent some signal of returns to education in the future. Second, rates of return to education not only in a child's state of residence but also in other states could affect his participation in child labor and schooling. Even though inter-state migration is relatively low in India (due to language barriers), education provides individuals with greater mobility in labor markets. Yet, returns to education in one's own state may be the only signal individuals have of employment opportunities for educated workers. In any case, an extension to our analysis could be to include the rates of returns to education not only in one's own state but also in neighboring states as explanatory variables.

Because the dependent variables for participation in child labor and schooling are both binary, the binary probit model is used. The probit model assumes that there is a latent variable y^*_{ikjt} that can be expressed as a linear function of variables that affect the probability of participation in child labor (or schooling). This expression can be written as:

$$y^*_{ikjt} = \beta X_{ikjt} + \varepsilon_{ikjt} \tag{4.7}$$

where X_{ikjt} is a set of explanatory variables for child i in household k, state j, and year t, β is the vector of coefficients that are estimated, and ε_{ikjt} is an error term. The latent variable y^*_{ikjt} is unobservable and instead a dummy variable is defined as $y_{ikjt} = 1$ if a child participates in child labor (or schooling) and zero otherwise:

$$y_{ikjt} = \begin{cases} 1 & \text{if } y^*_{ikjt} > 0 \\ 0 & \text{otherwise} \end{cases} \tag{4.8}$$

The probit model assumes that the error term ε_{ikjt} is distributed according to the cumulative normal distribution function. Therefore, the probability of a child participating in child labor (or schooling) P_{ikjt} can be written as:

$$P_{ikjt} = \text{Prob}\left(y_{ikjt} = 1\right) = \frac{1}{\sqrt{2\Pi}} \int_{-\infty}^{\beta X_{ikjt}} e^{-0.5t^2} dt \tag{4.9}$$

where t is a standardized normal variable. Maximum likelihood estimation produces coefficient estimates.

4.3.3 Variables

Dependent Variables - Child Labor And Schooling

In estimating the impact of the returns to education on participation in child labor and schooling, the sample includes children aged 5 to 14 years to adhere to the ILO's definition of child labor. Children working in the market or household enterprise and those engaged in domestic duties are defined as child laborers for the purpose of this analysis.[13] Children who attend an educational institution are defined as attending school.

The dependent variable $ChildLabor-ftpt_{ikjt}$ reflects a child's employment status and equals 1 if he/she is reported as working full time or part time during the past 7 days and 0 otherwise.[14] The dependent variable $School-ftpt_{ikjt}$ reflects a child's school enrollment status and equals 1 if the child attended school full time or part time during the past 7 days and 0 otherwise. Table C.10 in Appendix C includes a description of the dependent and independent variables and the expected signs of their coefficients. Descriptive statistics for all variables are found in Table C.11 in Appendix C.

[13] Regression results don't vary significantly when children engaged in domestic work are excluded from the definition of child labor (see Section 4.5.2). Children engaged in domestic duties are considered child laborers because domestic duties constitute 'work' rather than 'leisure'. Domestic work includes mostly cooking, cleaning, and taking care of younger siblings.

[14] The index i represents the I children in the sample, k is an index for the K households, j is an index for the J states, and t is an index for the year.

Independent Variables

The key independent variables are the rates of return to primary and middle school. $Rate_{egjt}$ represents the rate of return to education level e ($e = \{primary, middle\}$) for gender g (male or female), state j, and year t. The rate of return to education level e captures the additional log of hourly wages earned by an individual with education level e compared to an individual with education level $(e-1)$, per year of education level e. The control variables in the empirical estimations can be divided into three categories - household demographic characteristics, household economic conditions, and individual child-specific controls. Year dummies and state dummies are included to capture time-variant and state-specific effects. Also, season dummies are included to capture when the individual was surveyed.[15]

Household demographic characteristics include the number of children in the household ($Children_{kjt}$), four dummies each to capture the father's education level ($F-Primary$, $F-Middle$, $F-High$, and $F-College$) and the mother's education level ($M-Primary$, $M-Middle$, $M-High$, and $M-College$), and dummy variables that capture whether the household is urban ($Urban_{kjt}$), low-caste ($Lowcaste_{kjt}$), and Muslim ($Muslim_{kjt}$).[16] The number of children in the household is included to capture the idea that families with more children have fewer resources to educate each

[15] The omitted year is 1983, the omitted state is Delhi, the nation's capital, and the omitted season is $Season_1$, from July to September. The other seasons are $Season_2$ from October to December, $Season_3$ from January to March, and $Season_4$ from April to June.

[16] Only households where a father and mother are both present are included. Therefore, the impact of both the father's and mother's education on child labor and child schooling can be examined. An alternative is to include all households and examine the impact of the education level and gender of the household head on child labor and child schooling. The omitted category for the parent's education dummies is less than primary or no formal education.

child, in other words the quantity-quality trade-off. The education levels of the father and mother are included because parents with higher education have greater value for education and are more likely to educate their children than uneducated parents. Work and school decisions for children might be considerably different for those in urban and rural regions. Agricultural activities in rural areas might make children more likely to work on the household farm. The Low-caste and Muslim dummies capture possible discrimination against these groups.

Since poverty and credit constraints have been shown to be the major causes of child labor, we control for household economic conditions and include the log of household monthly per capita consumption expenditure ($LogExpenditure_{kjt}$), adjusted to 1988 Rupees, a dummy variable to indicate whether or not the household owns land ($Asset_{kjt}$), and a dummy variable to indicate whether or not the child's mother works outside the household ($WorkingMother_{kjt}$).[17] Wealthier households are more likely to send their children to school rather than work. Ownership of assets indicates that a household is relatively wealthy and should decrease the likelihood of child labor and increase the likelihood of schooling. However, household ownership of land, especially in rural areas, could increase a child's likelihood of working because children are more likely to be engaged in agricultural activities (seasonal or full time) if their parents own and cultivate land. When the mother works outside the household, a child is

[17] We face several problems with the expenditure variable. First, household monthly per capita consumption expenditure ($LogExpenditure_{kjt}$) is endogenous since it includes wages earned by children in calculating household expenditure. Second, household expenditure is calculated using an abbreviated list of items in 1999 compared to the three previous years. Therefore household expenditure is lower in 1999 compared to 1983, 1988, and 1993. We exclude this variable as an explanatory one as a robustness check (see Section 4.5.2) and find that our main results remain robust.

more likely to be engaged in domestic chores like cooking and taking care of younger siblings, especially in the case of female children. On the other hand, if the mother works, the household could be less dependent on earnings from child labor, making child labor less likely and schooling more likely.

Individual child-specific controls include the child's age (Age_{ikjt}), the square of his/her age ($Agesq_{ikjt}$), and a gender dummy ($Male_{ikjt}$). In most empirical studies on child labor it has been found that older children are more likely to work than younger children and that this effect diminishes with a child's age. Older children are more likely to work because they tend to be more productive than younger children and therefore earn higher wages than younger children. Moreover, older children are sent to work to support younger siblings. In many developing countries, educating sons are given priority over educating daughters. In India, traditional gender roles still persist, even though these are becoming weaker. A boy's education improves his income-earning potential while a girl's education is often considered worthwhile only because it improves her marriage prospects.

Interactions of all the independent variables with the gender dummy are included to incorporate different effects of each independent variable on participation in child labor and schooling for boys and girls.

4.4 Results

4.4.1 Overall Significance

Before discussing results of individual variables, some indication of the overall predictive performance of the model is useful. Table 4.1 reports results of the likelihood

Table 4.1: Likelihood-Ratio Test

Dependent Variable	**LR Test Statistic**
Work - full time or part time	602.24***
School - full time or part time	353.44***

***Significant at 1%.

ratio test for the restricted and unrestricted regressions.[18] The likelihood ratio test results indicate that the rates of return to primary and middle school are significant determinants of participation in child labor and schooling for all groups of children.

Two measures of overall predictive performance are reported in Table 4.2. The pseudo R-square is defined as 1 − (Log Likelihood/Restricted Log Likelihood) and supports the results of the likelihood ratio test. The pseudo R-square increases slightly when the rates of return to education are added as explanatory variables.

The second measure is $\bar{I}_R$ from Betancourt & Clague (1981), which is a measure of information that scores each prediction by giving it points not only in accordance with whether the prediction is right or wrong but also in a way that reflects the degree

[18]The restricted regression includes all the independent variables discussed in Section 4.3.3 except the rates of return to primary and middle school while the unrestricted regression includes the rates of return to primary and middle school. The likelihood ratio (LR) test has the following null and alternate hypotheses:

$$H_O : \beta_e = 0, H_A : \beta_e \neq 0$$

for $e = \{p, m\}$. In other words, the null hypothesis is that the restricted regression is correct while the alternate hypothesis is that the unrestricted regression is correct. The LR test statistic is calculated as $2\left(LogLikelihood_{UR} - LogLikelihood_{RR}\right)$, which has a chi-square distribution. With 4 degrees of freedom (4 restrictions) the critical chi-square is 13.28 at the 1% level of significance. A *** indicates that the LR test statistic is greater than the critical chi-square value and therefore the null hypothesis is rejected at the 1% level of significance.

Table 4.2: Measures of Predictive Performance

Dependent Variable	Pseudo R-Square		$\bar{I}_R$	
	Restricted	Unrestricted	Restricted	Unrestricted
Work	0.1824	0.1836	0.1743	0.1753
School	0.2502	0.2508	0.2196	0.2201

of certainty of the prediction.[19] The measure also corrects for the degrees-of-freedom by penalizing specifications with more explanatory variables. This measure further strengthens the results of the likelihood ratio test. $\bar{I}_R$ increases slightly when the rates of return to education are added as explanatory variables.

4.4.2 Rates of Return to Education

Tables C.12 and C.13 in Appendix C reports marginal effects for the binary probit models for participation in child labor and schooling after correcting the standard errors for clustering at the year-state level. The impact of the rates of return to education on participation in child labor and schooling are summarized in Table 4.3. The coefficient for boys is calculated as the sum of the coefficient for all children and the interaction term with the male dummy. The significance level for boys is based on the Wald test with the null hypothesis that the sum of these coefficients is zero.

We find a positive and significant relationship between increases in the rates of return to primary and middle schooling and declines in child labor. The magnitude of this relationship is large. For girls, a 1% increase in the middle to primary school wage ratio per year of middle school is associated with a 10 percentage point decline in child labor. For boys, a 1% increase in the primary to no school wage ratio per year of primary school is associated with a 44 percentage point decline in child labor and

[19]For example, in the dichotomous case, more credit is given to a correct prediction that is close to 1 than to a correct prediction that is close to 0.5.

Table 4.3: Rates of Return to Education, Child Labor, and Schooling

	Work	School
Girls		
Primary	-0.0358	-0.1031
Middle	-0.1014*	0.0174
Boys		
Primary	-0.4400***	0.4662***
Middle	-0.0516	0.1342***

*Significant at 10%, **Significant at 5%, ***Significant at 1%. Robust standard errors are corrected for clustering at the year-state level.

a 1% increase in the middle to primary school wage ratio per year of middle school is associated with a 5 percentage point decline in child labor.[20]

We find a positive and significant relationship between increases in the rates of return to primary and middle schooling and increases in schooling for boys. A 1% increase in the primary to no school wage ratio per year of primary school is associated with an almost 47 percentage point increase in schooling while a 1% increase in the middle to primary school wage ratio per year of middle school is associated with a 13 percentage point increase in schooling amongst boys.

The gender differential observed in Table 4.3 can perhaps be attributed to the persistence of traditional gender roles in India. Though women's participation in the work force has been steadily increasing over time, conservative and orthodox beliefs persist in many regions in India. While education is expected to improve a

[20]The coefficient on the rate of return to education level e measures the change in probability that a child works (attends school) with a 1% increase in the wage ratio of education level e to education level $e-1$ per year of education level e:

$$Coefficient = \frac{\partial P}{\partial Rate_e} = \frac{\partial P}{\partial\left(\frac{\ln wage_e - \ln wage_{e-1}}{Years_e}\right)} = \frac{\partial P}{\frac{\partial \ln\left(\frac{wage_e}{wage_{e-1}}\right)}{Years_e}} \tag{4.10}$$

where P is the probability that a child works (attends school).

Table 4.4: Year Dummies, Child Labor, and Schooling

	Work	School
Girls		
Year88	0.2824***	0.0491***
Year93	0.2284***	0.1432***
Year99	0.2021***	0.1903***
1988-1999	-0.0803	0.1412
Boys		
Year88	0.2832***	0.0305***
Year93	0.2304***	0.1354***
Year99	0.2423***	0.1355***
1988-1999	-0.0410	0.1050

*Significant at 10%, **Significant at 5%, ***Significant at 1%. Robust standard errors are corrected for clustering at the year-state level.

boy's income-earning potential, for many girls education is expected to improve only her marriage prospects. Also, while sons are expected to provide for their parents, daughters are not. Therefore, boys' participation in both child labor and schooling respond strongly to higher benefits to their education in the labor market.

4.4.3 Year Dummies

Coefficients of the year dummies capture trends in participation in child labor and schooling for boys and girls. As Table 4.4 shows, child labor and schooling are both higher in 1988, 1993, and 1999, compared to the omitted year, 1983. From 1988 onwards, child labor has been decreasing and schooling increasing. The coefficient for boys is calculated as the sum of the coefficient for all children and the interaction term with the male dummy. The significance level for boys is based on the Wald test with the null hypothesis that the sum of these coefficients is zero.

The year dummies capture a decreasing trend in child labor and an increasing trend in schooling between 1988 and 1999. These trends are significantly different for boys and girls. Between 1988 and 1999, child labor has declined by 8 (4) percentage points and schooling has increased by 14 (10) percentage points amongst girls (boys). The year dummies could be capturing changes in education policies, for example free primary education and the provision of school meals. Perhaps education policies have a stronger effect on girls rather than boys because the base is lower for girls - i.e. child labor was higher and schooling was lower amongst girls to begin with. Therefore, there is more scope to lower child labor and increase schooling amongst girls than boys. Cultural changes could also be playing a role in increasing schooling, especially amongst girls.

The trends captured by the year dummies are reflected in actual changes in the proportion of children participating in child labor and schooling between 1988 and 1999. Table 4.5 reports these changes.[21]

4.4.4 Control Variables

The control variables have the expected signs (except for a child's age) and are mostly significant at the 1% level.

We find that a higher number of children in the household makes a child more likely to work. However, the number of children in a household is not a significant determinant of a child's participation in school. All children are less likely to work and more likely to attend school if their father and/or mother have completed primary, middle, high school or college. Two observations are interesting. First, the father's

[21]The figures reported are the total number of hours spent working (market work, household enterprise work, and domestic work) or attending school as a percentage of the total number of hours spent in all activities (including hours spent doing nothing - i.e. neither work nor school) in each group (boys or girls). The figures remain almost identical if we calculate the number of children engaged in work or school as a proportion of all children in each group (boys or girls).

Table 4.5: Observed Child Labor and Schooling (%), 1988-1999

	Work	School
Girls		
1988	44.42	55.23
1993	31.70	68.00
1999	29.14	70.63
1988-1999	-15.28	15.40
Boys		
1988	31.94	67.54
1993	21.66	78.02
1999	21.65	78.03
1988-1999	-10.29	10.49

The change in child labor and schooling is in percentage points.

education has a stronger impact on children's participation in work and school than the mother's education. Second, both parents' education has a stronger impact on participation in child labor and schooling for girls than for boys. Thus, our results indicate that parental education increases educational investments in girls more so than in boys.

Children residing in urban regions are less likely to work and more likely to attend school. This urban bias is stronger for girls than for boys. In other words, the difference in participation in child labor and schooling between urban and rural girls is much larger than the difference between urban and rural boys. Being lowcaste or Muslim increases the likelihood of child labor and decreases the likelihood of attending school for both boys and girls, reflecting the widespread discrimination against these groups.

All children are more likely to work and less likely to attend school if his or her mother works outside the home. This effect is particularly strong for girls and can be explained by the fact that working mothers often take their children, especially daughters, with them to work or make their daughters perform household chores while they work. A higher log of per capita monthly household expenditure makes a child less likely to work and more likely to attend school. Ownership of land has a negative impact on boys' participation in child labor and a positive impact on both boys' and girls' participation in schooling.

There is a U-shaped (inverted-U-shaped) relationship between age and child labor (schooling) - a child is less (more) likely to work (attend school) from the ages of 5 to 9 and then more (less) likely to work (attend school) from the ages of 9 to 14. In most of the empirical literature on child labor, older children are found to be more likely to work.

We find that boys are more likely to work than girls. Thus, after controlling for the indirect effect that being male has on participation in child labor and schooling, via household and individual characteristics, the direct effect of being male is the opposite of what we expected.

4.5 Robustness

Table 4.3 shows the empirical evidence we find to validate the main predictions of our theory for the case of India. In response to higher rates of return to education child labor falls and schooling increases. In this section we show that our results are robust to a variety of specifications and robustness checks.

4.5.1 Overcorrection of Standard Errors

The results reported in Tables 4.3 and 4.4 are obtained after correcting the standard errors for clustering at the year-state level. According to Moulton (1990), when estimating the impact of aggregate variables on individual outcomes, unobservable characteristics at the aggregate level can affect all observations within a cluster and inflate

Table 4.6: Rates of Return to Education, Child Labor, and Schooling: Without Correcting Standard Errors for Clustering

	Work	School
Girls		
Primary	-0.0358**	-0.1031***
Middle	-0.1014***	0.0174*
Boys		
Primary	-0.4400***	0.4662***
Middle	-0.0516***	0.1342***

*Significant at 10%, **Significant at 5%, ***Significant at 1%. Standard errors are not corrected for clustering at the year-state level.

the statistical significance of the aggregate variable. In our case, the rates of return to primary and middle school are calculated for each state in each year. Therefore, correlations within each year-state combination must be accounted for. Correcting the standard errors for clustering at the year-state level provide us with an estimator of the variance covariance matrix which is consistent in the presence of any correlation pattern within states over time. One drawback to this procedure, however, is that the standard errors are over-corrected. The over-correction occurs because all the intra-cluster correlations (i.e. the correlation within every year-state combination) are assumed to be significant. Without this correction, all the intra-cluster correlations are assumed to be insignificant. In reality, the intra-cluster correlations within some clusters are significant while others are not. Therefore, the true variance covariance matrix lies in between these two extreme cases.

Without correcting the standard errors for clustering at the year-state level, the rates of return to education are found to be far more significant determinants of participation in child labor and schooling. The results are reported in Tables C.14 and C.15 in Appendix C and summarized in Table 4.6 below.

When we don't correct the standard errors for clustering at the year-state level for both boys and girls, participation in full time or part time work and school respond strongly to changes in the rates of return to both primary and middle school. The results reported in Table 4.6 represent one extreme assumption (that the intra-cluster correlation within every cluster is insignificant) while those presented in Table 4.3 represent the other extreme (that the intra-cluster correlation within every cluster is significant). The true variance covariance matrix lies in between these two extreme cases.

4.5.2 Other Robustness Checks

Children Engaged in Domestic Chores

In this section, we exclude children engaged in domestic chores from our definition of child labor and include only those engaged in market or household enterprise work. We do this in order to keep to the ILO's definition of child labor. The results are reported in Table C.16 in Appendix C and summarized in Table 4.7. We find a significant decrease in child labor amongst girls brought about by higher rates of return to middle school and a significant decrease in child labor amongst boys in response to higher rates of return to primary school.

Full Time Work, Full Time School, and Part Time Work and School

To test the robustness of the empirical results, we use three different specifications of child labor and schooling. The dependent variable $ChildLabor-ft_{ikjt}$ equals 1 if a child is reported as working full time during the past 7 days and 0 otherwise. Similarly, $School-ft_{ikjt}$ equals 1 if a child attended school full time during the past 7 days and 0 otherwise. $ChildLabor-School-pt_{ikjt}$ equals 1 if a child was engaged in both work and school part time during the past 7 days and 0 otherwise. Tables C.17,

Table 4.7: Rates of Return to Education & Child Labor: Excluding Children Engaged in Household Chores from Child Labor

	Work
Girls	
Primary	-0.0687
Middle	-0.1108***
Boys	
Primary	-0.2885**
Middle	-0.0124

*Significant at 10%, **Significant at 5%, ***Significant at 1%. Standard errors are corrected for clustering at the year-state level.

Table 4.8: Rates of Return to Education, Full Time Work, Full Time School, & Part Time Work & School

	Full Time Work	Full Time School	Part Time Work & School
Girls			
Primary	0.0147	-0.0498	-0.0011
Middle	-0.0488	0.0710	-0.0011***
Boys			
Primary	-0.2710**	0.6581***	-0.0022*
Middle	-0.0681	0.1147	0.0002

*Significant at 10%, **Significant at 5%, ***Significant at 1%. Standard errors are not corrected for clustering at the year-state level.

C.18, and C.19 in Appendix C report marginal effects for the binary probit models for participation in child labor and schooling while the results are summarized in Table 4.8. We find a significant decrease in part-time work and school amongst girls as a result of higher rates of return to middle school. In response to higher rates of return to primary school, boys are less likely to engage in full time work, more likely to engage in full time school, and less likely to engage in part-time work and school.

Table 4.9: Rates of Return to Education, Child Labor, & Schooling: Excluding Household Expenditure

	Work	School
Girls		
Primary	-0.0402	-0.0937
Middle	-0.1021*	0.0195
Boys		
Primary	-0.4482***	0.4852***
Middle	-0.0473	0.1280

*Significant at 10%, **Significant at 5%, ***Significant at 1%. Standard errors are not corrected for clustering at the year-state level.

Endogeneity of Per Capita Household Expenditure

As an additional robustness check, we exclude the variable $LogExpenditure_{kjt}$ because per capita household expenditure could be endogenous. In other words, a child's participation in work could raise household income, household expenditure, and thereby per capita household expenditure. Omitting this variable from the right hand side does not significantly change the results. Tables C.20 and C.21 in Appendix C report the results, which are summarized in Table 4.9. Higher rates of return to middle school lower participation in child labor amongst girls while higher rates of return to primary school lower child labor and increase schooling amongst boys.

Including the Rates of Return to High School & College

One can argue that in deciding whether to send their children to primary or middle school or to work, parents respond to the returns to high school and college as well. This argument is based on the fact that a child's completion of primary and middle school is necessary before he or she attends high school or college. To check the validity of this argument we include the rates of return to high school and college as determinants of participation in child labor and schooling. The results are reported in

Table 4.10: Rates of Return to Education & Child Labor: Including Rates of Return to High School & College

	Work	School
Girls		
Primary	-0.0145	-0.0755
Middle	-0.0861	0.0300
High	0.0342	0.0307
College	0.0244	0.0184
Boys		
Primary	-0.5386***	0.4835***
Middle	-0.0386	0.1418
High	0.1557	-0.0285
College	0.1461	-0.0009

*Significant at 10%, **Significant at 5%, ***Significant at 1%. Standard errors are not corrected for clustering at the year-state level.

Tables C.22 and C.23 in Appendix C and summarized in Table 4.10. We find that the rates of return to high school and college are statistically insignificant in determining participation in child labor and schooling. Moreover, when the rates of return to high school and college are included as explanatory variables, we find a negative and significant association between the rates of return to primary school and child labor amongst boys and a positive and significant association between the rates of return to primary school and schooling amongst boys.

4.6 Conclusion

The empirical results presented here indicate that higher rates of return to education decrease child labor and increase education amongst boys and decrease child labor amongst girls. The rate of return to primary school has a strong impact on boys' participation in child labor and schooling while girls' participation in child labor responds to changes in the rate of return to middle school. In light of these results, policies that raise the returns to education can have a beneficial impact on human capital investments in India by providing parents with the correct incentives to educate their children. Such policies can be used to complement anti-child-labor and compulsory education laws.

One way of raising the returns to education is by increasing the demand for skilled labor via the creation of skilled-labor-intensive employment opportunities. Amongst the policies that can be used to expand employment opportunities for educated workers and raise the benefits to obtaining an education are the liberalization of trade and investment. Rather than lower the demand for skilled labor, as the Stolper-Samuelson theorem predicts, trade liberalization in developing countries can increase the demand for skilled labor via the transfer of skill-biased technology. A greater demand for skilled labor can raise the returns to education and foster greater investment in human capital. Without incentives for firms to invest in skill-biased capital, however, trade liberalization may be insufficient to generate skill-biased investment by firms.

4.7 Extension

In this essay we estimate and find a positive impact of the rates of return to education on human capital investments. One could argue that the reverse direction of causation holds, whereby higher human capital investments raise the rates of return to education by attracting skill-biased investment by firms. For the case of India, two states provide anecdotal evidence that this argument may not hold. Even though the states of Kerala and Himachal Pradesh have the highest levels of education, there is very little investment by firms. An interesting extension to this essay would be to estimate the impact of human capital investments on investments by firms, or more specifically on skill-biased investments by firms.

Chapter 5

Changes in Returns to Education and Relative Wages in India: Demand & Supply Factors

The determinants of the returns to education and relative wages can be broadly classified as demand-side factors, supply-side factors, and wage legislation. The objective of this essay is to measure changes in relative wages and the returns to education in India during the period 1983 to 1999 and to examine the extent to which demand and supply changes can explain changes in relative wages. We focus on whether or not India's liberalization of trade and investment during this period has contributed to changes in the relative wages of skilled and unskilled labor. One prediction of the Heckscher-Ohlin-Samuelson model is that trade liberalization should raise the demand for and returns to the abundant factor - i.e. unskilled labor in India (Stolper-Samuelson Theorem). However, India's trade and investment liberalization reforms, which began in the 1980s but were more thoroughly implemented since 1991, are expected to have resulted in the transfer of skill-biased capital and technology from developed or technologically more advanced countries, which works through capital- and technology-skill complementarities to raise the demand for and returns to skilled labor.

We first measure the overall change in relative wages and then determine to what extent these changes are explained by changes in wages by level of education, age, and gender. Next, we examine in more detail the relationship between education and wages by estimating the returns to education, using the selection bias correction method developed by Bourguignon et al. (2001). Finally, we conduct a simple demand and supply analysis using the non-parametric method proposed by Katz & Murphy (1992).

Section 5.1 describes India's 1991 economic reforms, which are expected to drive variation in the relative wages and returns to education in the country. Section 5.2 describes our data. Section 5.3 reports changes in relative wages in India between 1983 and 1999 and Section 5.4 analyses changes in the returns to education during this period. In Sections 5.5 and 5.6 we investigate the extent to which relative demand and supply changes have contributed to changes in relative wages in India. Section 5.7 explores the role of international trade in contributing towards relative demand changes during the 1980s and 1990s in India. Section 5.8 concludes.

5.1 Indian Economic Policies

India's economic reforms began partially in the 1980s and were implemented more thoroughly since 1991. These reforms included the liberalization of trade and investment as well as reforms in the public sector and industry. Two opposing predictions of the impact of trade liberalization on relative wages in developing countries are that unskilled wages should rise relative to skilled wages (according to the Stolper-Samuelson Theorem) and that skilled wages should rise relative to unskilled wages (as a result of skill-biased technology transfer). Either way, trade and investment liberalization is expected to change relative wages and the returns to education.

After gaining independence from Britain in 1947, India embarked on a socialist strategy of state-directed, heavy-industry based, and import substitution industrialization, which beginning in the early 1950s, was implemented through a series a five-year plans. High levels of protection were provided to import-competing industries, primarily machinery and equipment, which were complemented by a system of complex licensing and financial repression. Although some tentative steps were taken in 1985 to liberalize and unshackle the economy by de-licensing a few industries, these partial and rather ad hoc measures contributed to the creation of severe and unsustainable macroeconomic imbalances (Joshi & Little 1997). Severe restrictions on foreign direct investment (FDI) and portfolio investment before 1991 contributed further to India's economic stagnation.

Faced with a severe balance of payments crisis as foreign exchange reserves plummeted to US $1 billion in late June 1991, India entered into a structural adjustment program with the International Monetary Fund. Along with stabilization policies that combined fiscal tightening with exchange rate devaluation, the then finance minister, Manmohan Singh, implemented a range of far-reaching economic policy reforms in the industrial, external, investment, and public sectors.

The trade policy reforms aimed at liberalizing and promoting both exports and imports. Exports were liberalized via the abolition of export subsidies and controls. Imports were liberalized by a rapid reduction in tariff rates and the abolition of licensing and quantitative restrictions on most imports except consumer goods. The average ad valorem tariff rate fell from 125% in 1990 to 40% in 1999 (see Table C.24 in Appendix C).[1] Within the manufacturing sector, the ad valorem tariff rates for all goods declined during the 1990s, (see Table C.25 in Appendix C). The reforms

[1]The ad valorem tariff rate is reported as a percentage. If the ad valorem tariff rate is t and the foreign price is $p*$, then the domestic price, p, is $p = p*(1+t)$. So if $t = 12.5\%$ then $p = p*(1+1.25) = p*(2.25) = 2.25p*$.

reduced non-tariff barriers by eliminating quantitative restrictions - quotas and import licensing requirements - particularly on capital and intermediate goods. The import licensing regime was replaced by a negative list which listed all those goods that could not be imported. Items not included on the list could be imported without a license. In addition, technology imports were also liberalized in order to provide Indian industries access to modern and efficient techniques of production. Technology could be imported through the automatic route without any restrictions such as technology license requirements.

As a result of lower tariffs, elimination of quotas and import license requirements, and liberalization of technology imports, total exports and imports increased dramatically during the 1990s (see Table C.26 in Appendix C). Imports as a percentage of GDP doubled from 8% in 1985 to 16% in 2000 while exports as a percentage of GDP almost tripled from 5% in 1985 to 14% in 2000.

There was an increasing trend in the country's machinery imports from US$ 3.5 billion in 1988 to US$ 7.7 in 2000 (see Table C.27 in Appendix C). During this period, machinery imports from Japan, USA, and Germany constituted the majority of India's capital goods imports (see Table C.28 in Appendix C). Other countries from which India imported machinery consisted of the United Kingdom, France, Italy, Singapore, Malaysia, and the Republic of Korea.[2] Since these countries are developed or technologically more advanced compared to India, it is reasonable to assume that machinery imports from these countries embody skill-biased technology. There are several reasons why capital goods imports might increase in developing countries after trade liberalization. First and most importantly, a lower price of foreign machinery

[2]Table C.28 in Appendix C reveals a steady rise in India's capital goods imports from other countries - which include East and South-East Asian countries - perhaps because machinery from these countries are better suited to the labor-intensive production techniques in India.

and equipment, as a result of lower import tariffs, quotas, and licences, leads to increased imports of capital goods. Second, as a result of greater exports, foreign exchange constraints that may have existed under the old regime are relaxed, leading to increases in capital goods imports. Third, by fostering competition in international markets, trade liberalization might encourage domestic firms to modernize machinery and production.

During the 1990s, India's investment reforms liberalized FDI to a limited extent, resulting in an increase of FDI from $233 million to $3.3 billion during this period. Moreover, several Indian state governments implemented policies that attracted high levels of foreign and domestic investment during the 1990s. These policies included tax concessions, provision of land in industrial parks, and high quality infrastructure and power supply. States that pursued pro-investment policies during the 1990s include the southern states of Andhra Pradesh, Karnataka, and Tamil Nadu, and the western states of Gujarat and Maharashtra, which together attracted the bulk of FDI between 1991 and 2002.

5.2 Data Source

The individual level data used in this study comes from the Employment and Unemployment Schedule of the National Sample Survey Organization (NSSO), which is described in detail in Chapter 4 Section 4.2. The data covers four years - 1983, 1988, 1993, and 1999. We use data for individuals aged 15 years and above and create two samples. First, we create a wage sample that we use to measure hourly wages of workers by demographic group. Second, we create a count sample that we use to measure the amount of labor supplied by these demographic groups. We divide our data into 100 distinct labor groups, defined by 2 gender groups (male and female), 5 education groups (less than primary, primary, middle, high school, and college), and 10 age groups (15-20, 20-25, 25-30, 30-35, 35-40, 40-45, 45-50, 50-55, 55-60, and 60+ years).[3]

The wage measure we use throughout this essay is the average hourly wage of workers within a gender-education-age cell. An individual's average hourly wage is computed as total wages during the past week divided by total hours worked during that week. We then adjust individual wages to 1988 Rupees. Our wage sample includes regular wage and salary workers since wages are only reported for this group. Self-employed workers (both wage and non-wage earning) are excluded from our wage sample. The count sample includes all individuals who worked either as regular wage and salary workers or as self-employed workers (wage and non-wage earning). The amount of labor supplied by each demographic group is measured as the total hours worked by each group as a proportion of the total hours worked by all groups in that year. The total hours worked by each group is computed as the sum of hours worked during the past week for all individuals within each gender-education-age cell.

We calculate relative wages, a (100 X 4) matrix W_r, and relative supply, a (100 X 4) matrix X_r, from our wage and count samples. Our wage data consists of a (100 X 4) matrix W, which consists of the average hourly wage (adjusted to 1988 Rupees) from the wage sample for each of the 100 demographic groups in each of four years (1983, 1988, 1993, and 1999). Our labor supply data consists of a (100 X 4) matrix X, which consists of the proportion of hours worked from the count sample for each of the 100 demographic groups in each of four years (1983, 1988, 1993, and 1999). From X we construct a 100-element vector, N, of average employment shares of each group

[3]The total hours worked and average hourly wages of some groups are zero or missing as a result of too few observations in these groups. This does not pose a problem, however, because we aggregate relative wages, supply, and demand over broader groups.

over the four years. We use this vector of fixed weights to construct wage indices for each year as $N'W$, a (1 X 4) matrix. Deflating wages in each year (W) by the value of the wage index for that year ($N'W$) generates relative wages for each demographic group in each year, denoted by a (100 X 4) matrix W_r.[4]

From W_r we calculate a 100-element vector, Ω, of average relative wages of each group over the four years. The average of the relative wages of each demographic group over the four years provides a natural basis for aggregating quantities of labor supplied across groups in terms of efficiency units. We weight the employment share of each group (X) by the average relative wage of that group (Ω) and sum over all groups to construct a measure of the total labor supply in the economy in each year in efficiency units, $\Omega'X$, a (1 X 4) matrix. We then deflate actual labor supply (X) by the total labor supply in the economy measured in efficiency units ($\Omega'X$) for each demographic group in each year to get a (100 X 4) relative supply matrix X_r.[5]

5.3 Changes in Relative Wages in India

Table 5.1 reports average relative hourly wages for all workers, women, and men by education levels and age and changes in relative wages for 6 periods between 1983 and 1999 in India. The average hourly wages reported are relative wages - i.e. each group's wage relative to the wages for a fixed bundle of workers - described in Section 5.2 and calculated from the (100 X 4) matrix W_r.

For the period between 1983 and 1999, relative wages of all workers with less

[4]Each group's wage is indexed to the wages for a fixed bundle of workers (all workers who earned a regular wage or salary). Thus, the relative wage for each group is measured as each group's wage relative to the wages for a fixed bundle of workers.

[5]Each group's labor supply is measured relative to the total labor supply in the economy in efficiency units.

than primary, primary, and middle schooling decreased whereas those of high school and college educated workers increased substantially. For women, relative wages of workers with less than primary, primary, high school, and college education increased while those of workers with middle schooling decreased substantially. For men, relative wages of workers with less than primary and primary education decreased while those of middle, high school, and college educated workers increased.

For women, the rise in relative wages of both less and more educated workers suggests that both the Stolper-Samuelson and skill-biased technology transfer effects played a role. For men, on the other hand, the skill-biased technology transfer effect seems to have dominated the Stolper-Samuelson prediction. Can the increase in relative earnings of skilled workers be explained by firms' higher demand for skilled labor, as a result of the transfer of skill-biased technology after India's liberalization of trade and investment? We examine alternative explanations for changes in relative wages in Section 5.5 to answer this question. Before doing so we explore the education-wage relationship in more detail by estimating the returns to education for several groups of individuals, industries, and occupations in India.

5.4 Changes in Returns to Education in India

Earnings regressions are estimated, after correcting for selection bias using the method developed by Bourguignon et al. (2001), for several groups of individuals, industries, and occupations for four years - 1983, 1988, 1993, and 1999.[6]

[6] The empirical strategy in estimating the returns to education is identical to that described in Section 4.3.1 of Chapter 4. The difference here is that rather than estimate earnings regressions separately for each state, we estimate earnings regressions for all adults, men, and women, and for each industry or occupation. The right hand side variables are the same as in the second essay. However, state dummies are included here. Appendix B includes a detailed discussion of the

Table 5.1: Average Relative Wages & Changes in India: 1983-1999

Group	Year				% Change					
	1983	1988	1993	1999	83-88	83-93	83-99	88-93	88-99	93-99
All Adults										
< Primary School	0.54	0.67	0.55	0.53	24.67	2.46	-2.51	-17.82	-21.80	-4.85
Primary School	0.78	0.72	0.81	0.77	-7.30	3.20	-1.35	11.32	6.41	-4.41
Middle School	1.20	0.95	1.10	1.17	-20.63	-8.34	-2.05	15.48	23.41	6.87
High School	1.74	1.46	1.79	1.89	-16.25	3.09	8.63	23.08	29.70	5.38
College	2.53	2.80	2.74	2.88	10.64	8.17	13.91	-2.23	2.95	5.30
Age 15-40 years	1.12	1.01	1.06	1.06	-9.40	-4.73	-5.46	5.16	4.35	-0.77
Age 40 years & above	1.60	1.63	1.73	1.84	1.96	8.29	15.17	6.21	12.96	6.36
All Women										
< Primary School	0.38	0.52	0.41	0.39	38.25	8.28	3.89	-21.68	-24.86	-4.05
Primary School	0.54	0.49	0.61	0.58	-8.69	12.09	7.31	22.75	17.52	-4.26
Middle School	1.10	0.77	0.92	0.88	-30.13	-16.56	-20.47	19.43	13.82	-4.70
High School	1.67	1.35	1.73	1.96	-18.97	3.90	17.79	28.23	45.38	13.37
College	2.22	2.67	2.45	2.79	20.57	10.66	25.70	-8.22	4.25	13.59
Age 15-40 years	1.02	0.91	0.94	0.90	-11.17	-8.04	-11.66	3.52	-0.56	-3.94
Age 40 years & above	1.34	1.42	1.51	1.74	5.68	12.56	29.65	6.52	22.68	15.18
All Men										
< Primary School	0.70	0.82	0.70	0.66	17.36	-0.67	-5.95	-15.37	-19.86	-5.31
Primary School	1.02	0.95	1.00	0.96	-6.56	-1.51	-5.94	5.40	0.66	-4.50
Middle School	1.29	1.13	1.27	1.47	-12.50	-1.31	13.72	12.78	29.96	15.23
High School	1.82	1.57	1.86	1.82	-13.74	2.34	0.22	18.65	16.18	-2.08
College	2.84	2.92	3.02	2.97	2.89	6.23	4.70	3.25	1.76	-1.44
Age 15-40 years	1.21	1.12	1.19	1.21	-7.91	-1.93	-0.22	6.49	8.35	1.74
Age 40 years & above	1.85	1.84	1.95	1.94	-0.73	5.20	4.72	5.98	5.49	-0.46

The return to education level e in group r and year t captures the percentage increase in hourly wages earned by an individual with education level e compared to an individual with education level $(e-1)$, and is calculated as:

$$Return_{ert} = exp\left(\beta_{ert} - \beta_{e-1,rt}\right) - 1 = \frac{wage_{ert} - wage_{e-1,rt}}{wage_{e-1,rt}} \tag{5.1}$$

where β_{ert} is the coefficient for the dummy for education level e in group r and year t in the earnings regression. The subscript e represents primary, middle, high school, and college education ($e = \{p, m, h, c\}$)[7], group r represents the individual, industry, or occupation groups, and t represents four years (1983, 1988, 1993, and 1999).

5.4.1 Returns to Education for All Adults, Women, & Men

The returns to education for all adults, women, and men are reported in Table 5.2, which are calculated from regression estimates given in Tables C.30, C.31, and C.32 in Appendix C.[8] For the period between 1983 and 1999, returns to education for all workers with primary, middle, and high school fell while returns to college educated workers increased substantially. For women, returns to primary and college education increased while returns to middle and high school education decreased. The pattern for men follows that for all workers, with returns to primary, middle, and high school decreasing and returns to college education increasing.

correction for selection bias in estimating the returns to education.

[7]High school consists of secondary school (grades 9 and 10) and higher secondary school (grades 11 and 12).

[8]See Table C.29 in Appendix C for the total hours spent and the number of individuals in each category.

Table 5.2: Returns to Education in India: 1983-1999

Group	**Year**				**% Change**			
	1983	1988	1993	1999	1983-88	1988-93	1993-99	1983-99
All Adults								
Primary School	23.65	23.33	18.29	23.17	-1.37	-21.60	26.65	-2.06
Middle School	20.09	12.48	16.20	15.25	-37.87	29.77	-5.87	-24.11
High School	49.32	50.46	55.46	44.61	2.32	9.91	-19.58	-9.55
College	39.83	49.63	59.24	69.69	24.60	19.36	17.64	74.96
Women								
Primary School	10.10	10.57	9.36	11.54	4.63	-11.42	23.24	14.22
Middle School	35.65	25.38	14.58	5.02	-28.81	-42.55	-65.58	-85.92
High School	91.90	84.69	104.01	91.31	-7.86	22.82	-12.21	-0.65
College	27.50	58.97	39.32	59.98	114.44	-33.33	52.55	118.10
Men								
Primary School	34.66	34.33	19.60	20.92	-0.98	-42.91	6.74	-39.65
Middle School	31.12	27.44	16.64	22.48	-11.82	-39.36	35.09	-27.75
High School	49.29	44.77	45.86	44.33	-9.16	2.44	-3.34	-10.05
College	42.82	40.32	55.98	70.09	-5.82	38.84	25.19	63.69

5.4.2 Returns to Education by Industry

To explore our hypothesis - that the liberalization of trade and investment in India facilitated the transfer of skill-biased capital and technology, thereby raising the demand for and returns to skilled labor - we estimate the returns to education for 18 industry and 3 occupation groups. We use three occupation groups to differentiate between skilled (non-production or white-collar) and unskilled (production or blue-collar) labor, which though imperfect is consistent with the methodology used by Katz & Murphy (1992) and is the most common division between more and less skilled workers using survey data (Lawrence & Slaughter (1993)). Table 5.3 illustrates the classification of these groups.

Table 5.4 reports changes in returns to education by industry and occupation groups which are calculated from Tables C.33, C.34, C.35, and C.36 in Appendix C. Between 1983 and 1999 returns to primary school and college education increased for

Table 5.3: Industry & Occupation Groups

	Industry/Occupation	Skill Level
	Industry	
1	agriculture, hunting, forestry, and fishing	Low
2	mining and quarrying	Low
3	manufacture of food, beverage, and tobacco products	Low
4	manufacture of textiles, leather, fur, wearing apparel, and footwear	Low
5	manufacture of wood and wood products	Low
6	manufacture of paper, paper products, printing, and publishing	Medium
7	manufacture of chemicals, rubber, plastic, petroleum, and coal products	High
8	manufacture of non-metallic mineral products	Medium
9	manufacture of basic metals, metal products, and metal parts	Medium
10	manufacture of machinery and transport equipment and parts	High
11	other manufacturing industries	Medium
12	electricity, gas, steam, water works, and water supply	Medium
13	construction	Low
14	wholesale trade, retail trade, restaurants, and hotels	Medium
15	transport, communications	Medium
16	storage, warehousing, repair services	Medium
17	financing, insurance, real estate, business services	High
18	community, social, personal services, except repair services	Medium
	Occupation	
1	professional, technical, administrative, executive, & managerial workers	High
2	clerical & sales workers	Medium
3	production & service workers	Low

Industry 4 includes cotton, wool, silk, man made and synthetic fiber, and jute and other vegetable fiber textiles. Occupational category 3 - i.e. production & service workers - includes farmers, fishermen, hunters, loggers, and related workers.

the majority of industries while returns to middle and especially high school decreased for many industries. There was an increase in the returns to primary, middle, high school, and college education for both high- and low-skill occupations for the 1983-1999 period. For medium-skill occupations, however, returns to primary, middle, and high school decreased while returns to college increased.

5.5 Alternative Explanations for Relative Wage Changes

Sections 5.3 and 5.4 illustrate large changes in relative wages and returns to education amongst both women and men and amongst several industries during the 1980s and 1990s in India. While the liberalization of trade and investment in India could be responsible for these changes by altering the relative demand for workers with different levels of education, other factors could have brought about these changes as well. Possible explanations for relative wage changes include not only relative demand changes but also relative supply changes for workers with different levels of education and changes in wage legislation during this period. We investigate relative supply and demand changes as potential determinants of the variation in relative wages in India.[9]

5.5.1 Changes in Relative Labor Supply

The decline in relative wages of some groups over the 1983-1999 period could have resulted from a large increase in the supply of these workers. For the entire sample, Table 5.5 shows a trend towards rising education levels during this period. Increases

[9] A third set of explanations for relative wage changes are related to wage legislation. We do not explore wage legislation as a determinant of relative wage changes in this essay primarily because during the time period under consideration - 1980s and 1990s - there were minimal changes in wage legislation in India.

Table 5.4: Changes in Returns to Education by Industry & Occupation : 1983-1999

Industry/Occupation	**Changes in Returns to Education (in percentage points)**			
	Primary	Middle	High	College
Industry				
agriculture, hunting, forestry, and fishing	-2.63	4.45	-7.13	-14.55
mining and quarrying	7.89	-7.99	-8.85	-30.58
manufacture of food, beverage, and tobacco products	7.36	-2.47	-15.65	-
manufacture of textiles, leather, fur, wearing apparel, and footwear	0.43	-16.15	20.39	64.08
manufacture of wood and wood products	-7.36	-2.28	-10.64	-
manufacture of paper, paper products, printing, and publishing	-12.04	-2.21	-6.62	-
manufacture of chemicals, rubber, plastic, petroleum, and coal products	3.21	6.01	-9.22	53.14
manufacture of non-metallic mineral products	10.61	-4.71	-22.74	54.86
manufacture of basic metals, metal products, and metal parts	-17.48	-5.87	7.12	20.45
manufacture of machinery and transport equipment and parts	7.31	1.83	24.61	-6.07
other manufacturing industries	8.24	25.66	-9.20	-80.51
electricity, gas, steam, water works, and water supply	-15.94	58.66	-13.84	-
construction	0.10	-5.65	-1.20	44.53
wholesale trade, retail trade, restaurants, and hotels	3.28	-0.96	-5.46	33.77
transport, communications	-20.24	17.59	-1.58	35.54
storage, warehousing, repair services	-16.92	14.04	-17.99	37.26
financing, insurance, real estate, business services	1.30	12.50	31.61	10.50
community, social, personal services, except repair services	42.19	17.93	30.46	49.60
Occupation				
professional, technical, administrative, executive, & managerial workers	9.79	17.54	32.26	23.75
clerical & sales workers	-6.19	-9.11	-14.08	10.27
production & service workers	1.60	13.96	7.41	18.08

A – shows that we were unable to estimate the return to education for either 1983 or 1999 for the corresponding industry as a result of too few observations within the relevant industry-education groups.

in education levels can be explained by the long term trend of rising education brought about by greater economic development. Further, educational policies - such as higher public expenditure on education, more schools, better accessibility to schools, an improvement in the quality of education, and other incentives such as provision of meals in schools - could be responsible for the rising trend in education during the 1980s and 1990s in India.

Table 5.5 summarizes changes in relative labor supply over the 1983-1999 period. Each group's supply is measured in efficiency units (actual hours multiplied by the average relative wage of the group for the 1983-1999 period) and includes all workers in the count sample described in Section 5.2. Each group's supply is then measured relative to the total supply in efficiency units in a given year. The figures in Table 5.5 represent changes in the log relative supply, multiplied by 100, for each group over the relevant time period. We find a substantial increase in the relative supply of more educated women and men and a decrease in the relative supply of less educated women and men.

The relative supply of all workers with less than primary and primary schooling declined in every time period while the relative supply of all workers with middle, high school, and college education increased during the same time intervals. The relative supply of women with less than primary schooling declined in every time period while the relative supply of women with primary, middle, high school, and college education increased in every period (except for the relative supply of women with primary schooling, which decreased between 1993 and 1999). The relative supply of men with less than primary, primary, and middle schooling decreased in all time periods (except for the relative supply of men with middle schooling which increased between 1993 and 1999) and the relative supply of men with high school and college education increased in all time periods.

5.5.2 Changes in Relative Labor Demand

Changes in relative wages throughout India can also be attributed to relative demand changes during the 1983-1999 period. Changes in the demand for labor with different education levels can be the result of changes in the sectoral composition of output, which can be attributed primarily to changes in product demand. As described in Section 5.1, during the 1980s and 1990s India's economy experienced a massive transformation whereby trade and investment were liberalized. India's liberalization of trade and investment is expected to have altered labor demand via two channels.

First, in the 2X2 Heckscher-Ohlin-Samuelson model, as protective import tariffs, quotas, and licences are removed, the price of formerly protected goods will fall. By the Stolper-Samuelson Theorem, a decrease in the relative price of a good will decrease the relative price of the factor used intensively in the production of that good and increase the relative price of the other factor. Since India is abundant in unskilled labor and scarce in human and physical capital, trade liberalization is expected to have lowered the price of human- and physical-capital-intensive goods, thereby decreasing the relative price of human and physical capital and increasing the relative price of unskilled labor. The argument is driven by the idea that once protective barriers are removed, resources shift from the production of goods in which the country has an artificial comparative advantage - i.e. human- and physical-capital-intensive goods - towards the production and export of goods in which the country has a natural comparative advantage - i.e. unskilled-labor-intensive goods in India.

Second, as a result of skill-biased technology transfer via trade and investment, India's liberalization is expected to have caused both between- and within-sector

Table 5.5: Relative Supply Changes: 1983-1999

Group	**Change in Log Relative Supply**					
	1983-1988	1983-1993	1983-1999	1988-1993	1988-1999	1993-1999
All Adults						
< Primary School	-9.52	-17.10	-23.98	-7.59	-14.46	-6.87
Primary School	-1.68	-9.67	-15.59	-8.00	-13.91	-5.91
Middle School	0.81	2.54	3.37	1.73	2.56	0.83
High School	8.21	15.87	21.08	7.66	12.87	5.21
College	14.85	20.69	24.58	5.84	9.72	3.89
Women						
< Primary School	-4.57	-12.50	-19.08	-7.93	-14.52	-6.59
Primary School	1.97	11.35	7.77	9.38	5.81	-3.58
Middle School	12.36	33.27	38.47	20.90	26.11	5.20
High School	11.93	34.07	40.20	22.14	28.27	6.14
College	22.81	35.37	41.59	12.57	18.78	6.22
Men						
< Primary School	-12.18	-19.57	-26.61	-7.39	-14.43	-7.04
Primary School	-2.20	-13.52	-20.02	-11.32	-17.82	-6.50
Middle School	-0.16	-0.82	-0.73	-0.66	-0.57	0.09
High School	7.85	13.73	18.80	5.88	10.95	5.07
College	13.66	18.27	21.68	4.61	8.02	3.41

The reported numbers are of the form $\Delta(log X_r) * 100$, where X_r represents relative supply.

changes in output away from unskilled-labor-biased to skilled-labor-biased production technology. The use of more skill-biased machinery and technology via capital goods and technology imports and foreign direct investment from more developed or technologically advanced countries is expected to result in the transfer of skill-biased technology. India's leading import partners and foreign direct investment sources include developed or technologically advanced countries which are abundant in skilled labor and tend to develop and utilize capital and technology that is biased towards the use of skilled labor. Skill-biased technology transfer is expected to raise the demand for and returns to skilled labor and lower the demand for and returns to unskilled labor.

Tables 5.6 and 5.7 report average industry and occupation distributions for five education groups each for men and women. The figures for each gender-education group represent the share of employment (measured in hours worked during the preceding week) of that group in the corresponding industry or occupation averaged over the four survey years. Large differences in employment shares by gender-education groups suggest that shifts in labor demand across industries and occupations could have a significant effect on the relative wages of these groups.

Table 5.8 reports employment distributions by industry and occupation (measured in hours worked during the preceding week) for all gender-education groups together and Table 5.9 shows changes in these distributions over the 1983-1999 period. Over the entire period there was a large decrease in employment in agriculture, hunting, forestry, and fishing. Smaller shifts in employment out of relatively low-skill industries - i.e. mining and quarrying; manufacture of food products, beverages, and tobacco; manufacture of textiles and textile products; manufacture of wood and wood products - also occurred during this period. Given the concentration of less educated work-

Table 5.6: Average Industry & Occupation Distributions for Men: 1983-1999

Industry/Occupation	**Education Level**				
	< Primary	Primary	Middle	High	College
Industry					
agriculture, hunting, forestry, and fishing	66.09	0.71	6.20	3.14	0.60
mining and quarrying	0.25	48.86	0.60	6.49	1.83
manufacture of food, beverage, and tobacco products	1.58	0.56	41.27	0.49	4.31
manufacture of textiles, leather, fur, wearing apparel, and footwear	1.38	1.85	0.82	25.42	0.48
manufacture of wood and wood products	0.80	2.85	1.55	1.32	10.56
manufacture of paper, paper products, printing, and publishing	0.87	1.31	4.01	0.82	1.37
manufacture of chemicals, rubber, plastic, petroleum, and coal products	4.54	0.53	1.51	5.51	0.30
manufacture of non-metallic mineral products	0.15	4.77	0.61	1.89	13.39
manufacture of basic metals, metal products, and metal parts	5.25	0.43	4.05	0.65	2.08
manufacture of machinery and transport equipment and parts	0.41	7.96	0.63	2.90	0.67
other manufacturing industries	1.85	0.87	11.39	0.94	2.43
electricity, gas, steam, water works, and water supply	8.23	2.26	1.17	23.44	0.92
construction	0.27	15.21	2.10	2.59	39.90
wholesale trade, retail trade, restaurants, and hotels	0.07	0.62	17.90	2.00	2.70
transport, communications	0.50	0.09	0.82	19.89	1.45
storage, warehousing, repair services	3.07	1.16	0.12	1.40	14.32
financing, insurance, real estate, business services	3.74	5.01	1.11	0.15	2.48
community, social, personal services, except repair services	0.98	4.95	4.14	0.96	0.21
Occupation					
professional, technical, administrative, executive, & managerial workers	38.85	17.44	40.13	11.26	55.43
clerical & sales workers	25.37	12.25	34.87	62.93	39.14
production & service workers	35.79	70.31	24.99	25.81	5.43

Table 5.7: Average Industry & Occupation Distributions for Women: 1983-1999

Industry/Occupation	**Education Level**				
	< Primary	Primary	Middle	High	College
Industry					
agriculture, hunting, forestry, and fishing	77.05	11.55	4.97	0.09	0.22
mining and quarrying	7.05	2.38	2.15	0.34	0.91
manufacture of food, beverage, and tobacco products	3.82	26.72	1.34	0.07	0.87
manufacture of textiles, leather, fur, wearing apparel, and footwear	1.43	2.72	1.13	0.15	0.82
manufacture of wood and wood products	0.12	1.41	11.39	0.58	0.18
manufacture of paper, paper products, printing, and publishing	0.49	0.48	1.96	0.39	0.29
manufacture of chemicals, rubber, plastic, petroleum, and coal products	0.03	0.24	1.77	21.17	1.00
manufacture of non-metallic mineral products	0.02	2.70	2.36	1.27	2.80
manufacture of basic metals, metal products, and metal parts	0.02	1.10	2.65	0.64	35.32
manufacture of machinery and transport equipment and parts	0.01	1.27	6.82	0.61	5.36
other manufacturing industries	3.73	1.59	2.46	0.26	6.35
electricity, gas, steam, water works, and water supply	0.77	0.68	2.96	47.13	24.40
construction	0.43	11.73	9.52	9.56	21.34
wholesale trade, retail trade, restaurants, and hotels	0.17	4.07	5.45	8.12	0.05
transport, communications	0.02	3.42	29.05	5.68	0.01
storage, warehousing, repair services	3.20	2.45	5.96	1.90	0.00
financing, insurance, real estate, business services	0.91	1.30	5.06	1.69	0.05
community, social, personal services, except repair services	0.73	24.20	3.01	0.35	0.04
Occupation					
professional, technical, administrative, executive, & managerial workers	69.89	6.15	57.15	3.69	62.74
clerical & sales workers	13.75	5.69	30.43	84.95	32.79
production & service workers	16.36	88.16	12.42	11.36	4.47

ers in these sectors, these shifts suggest that the demand for less-educated workers should have fallen during this period. A small decrease in the share of employment in the manufacture of non-metallic mineral products (a medium-skill sector) and in the manufacture of machinery and equipment, transport equipment, and parts (a high-skill sector) suggests that the demand for more-educated workers should have fallen as well between 1983 and 1999. Increases in employment shares occurred in all other sectors, the most significant being in construction; wholesale and retail trade, restaurants and hotels; storage, warehousing, and repair services; and financing, insurance, real estate, and business services. While some of these sectors are relatively low-skilled and others are high-skilled, these shifts suggest that the demand for both less- and more-educated workers should have increased during this period.

Over the entire period there was a large shift out of clerical and sales occupations (medium-skill) and a smaller shift out of production and service occupations (low-skill) and a large shift into professional, technical, administrative, executive, and managerial occupations (high-skill). These occupational changes suggest a fall in the demand for medium- and low-skill workers and a rise in the demand for high-skill workers.

5.6 Non-Parametric Method of Analysis

The non-parametric methodology proposed by Katz & Murphy (1992) provides a simple framework for decomposing the extent to which relative supply and demand changes contributed to relative wage changes in India. In Section 5.6.1 we test whether relative labor supply changes alone can explain changes in relative wages by education levels, or, instead, relative labor demand changes must have been non-neutral or factor-biased. In Section 5.6.2 we evaluate between- and within-sector changes in

Table 5.8: Industry & Occupation Distributions: 1983-1999

Industry/Occupation	**Employment Share**			
	1983	1988	1993	1999
Industry				
agriculture, hunting, forestry, and fishing	57.76	55.12	52.35	47.97
mining and quarrying	0.68	0.48	0.83	0.62
manufacture of food, beverage, and tobacco products	2.46	2.32	2.32	2.41
manufacture of textiles, leather, fur, wearing apparel, and footwear	4.32	4.59	2.71	2.80
manufacture of wood and wood products	1.34	1.40	1.23	1.14
manufacture of paper, paper products, printing, and publishing	0.36	0.41	0.36	0.43
manufacture of chemicals, rubber, plastic, petroleum, and coal products	0.56	0.66	0.76	0.90
manufacture of non-metallic mineral products	0.94	0.85	0.54	0.71
manufacture of basic metals, metal products, and metal parts	0.96	1.08	0.86	1.09
manufacture of machinery and transport equipment and parts	0.87	1.02	0.83	0.84
other manufacturing industries	0.56	0.66	0.62	0.87
electricity, gas, steam, water works, and water supply	0.46	0.45	0.61	0.53
construction	3.12	2.85	3.62	4.56
wholesale trade, retail trade, restaurants, and hotels	9.40	11.78	11.31	13.24
transport, communications	3.49	3.35	3.69	4.45
storage, warehousing, repair services	2.07	2.66	3.03	3.79
financing, insurance, real estate, business services	10.61	10.29	14.29	13.40
community, social, personal services, except repair services	0.03	0.03	0.04	0.25
Occupation				
professional, technical, administrative, executive, & managerial workers	15.30	25.43	23.00	29.88
clerical & sales workers	65.12	65.77	59.20	54.97
production & service workers	19.59	8.80	17.80	15.14

Table 5.9: Changes in Industry & Occupation Distributions: 1983-1999

Industry/Occupation	**Change in Employment Share (in percentage points)**			
	83-88	88-93	93-99	83-99
Industry				
agriculture, hunting, forestry, and fishing	-2.65	-2.77	-4.38	-9.80
mining and quarrying	-0.20	0.35	-0.22	-0.07
manufacture of food, beverage, and tobacco products	-0.14	0.01	0.09	-0.05
manufacture of textiles, leather, fur, wearing apparel, and footwear	0.27	-1.88	0.09	-1.53
manufacture of wood and wood products	0.06	-0.17	-0.08	-0.19
manufacture of paper, paper products, printing, and publishing	0.05	-0.05	0.07	0.07
manufacture of chemicals, rubber, plastic, petroleum, and coal products	0.09	0.11	0.14	0.34
manufacture of non-metallic mineral products	-0.09	-0.31	0.17	-0.23
manufacture of basic metals, metal products, and metal parts	0.12	-0.22	0.23	0.14
manufacture of machinery and transport equipment and parts	0.14	-0.18	0.01	-0.03
other manufacturing industries	0.10	-0.04	0.25	0.31
electricity, gas, steam, water works, and water supply	-0.01	0.16	-0.08	0.07
construction	-0.27	0.77	0.93	1.43
wholesale trade, retail trade, restaurants, and hotels	2.38	-0.47	1.93	3.84
transport, communications	-0.14	0.34	0.77	0.97
storage, warehousing, repair services	0.59	0.37	0.75	1.71
financing, insurance, real estate, business services	-0.31	3.99	-0.88	2.80
community, social, personal services, except repair services	0.01	0.00	0.21	0.22
Occupation				
professional, technical, administrative, executive, & managerial workers	10.14	-2.43	6.88	14.59
clerical & sales workers	0.65	-6.57	-4.23	-10.14
production & service workers	-10.78	9.00	-2.66	-4.44

relative labor demand.

5.6.1 Relative Supply Versus Relative Demand Changes

Using our measures for relative wages (W_r) and relative supply (X_r) described in Section 5.2, we first test whether relative labor supply changes alone can explain changes in relative wages by education levels, or, instead, relative labor demand changes must have been non-neutral or factor-biased.

In the Katz & Murphy (1992) framework, the aggregate production function consists of K types of labor inputs.[10] The vector of associated labor demands can be written as:

$$X_t = D\left(W_t, Z_t\right) \tag{5.2}$$

where X_t is a (K X 1) vector of labor inputs employed in the market in year t, W_t is a (K X 1) vector of market prices for these inputs in year t, and Z_t is a (K X 1) vector of demand shift variables in year t. The demand shift variables in Z_t embody the effects of technology, other non-labor inputs such as capital, and product demand on the demand for labor inputs.

Equation 5.2 can be written in terms of differentials as:

$$dX_t = D_w dW_t + D_z dZ_t \tag{5.3}$$

Under the assumption that the aggregate production function is concave, the (KxK) matrix of cross-price effects D_w is negative semidefinite which implies that

$$dW_t'\left(dX_t - D_z dZ_t\right) = dW_t' D_w dW_t \leq 0 \tag{5.4}$$

[10]In our analysis K represents 100 distinct labor groups, defined by 2 gender groups (male and female), 5 education groups (less than primary, primary, middle, high school, and college), and 10 age groups (15-20, 20-25, 25-30, 30-35, 35-40, 40-45, 45-50, 50-55, 55-60, and 60+ years).

which says that changes in factor supplies (dX_t) net of demand shifts ($D_z dZ_t$) and changes in wages (dW_t) must negatively covary. We can therefore test whether or not supply shifts alone can explain changes in relative wages. If factor demand is stable (i.e. Z_t is fixed or $dZ_t = 0$) then Equation 5.4 implies that $dW_t' dX_t \leq 0$. If we compare two years s and t, and find that

$$(W_t - W_s)' (X_t - X_s) \leq 0 \tag{5.5}$$

then the observed changes in relative wages can potentially be explained solely by supply shifts. In other words, if the inequality in Equation 5.5 holds then the period between years s and t could have experienced a fixed factor demand which would have had no impact on relative wages. If the inequality in Equation 5.5 does not hold, then supply shifts alone cannot explain relative wage changes. Instead, non-neutral or factor-biased demand shifts must also have played a role in explaining relative wage changes.

The inequality in Equation 5.5 being satisfied does not mean that relative demand changes did not occur. The inequality in Equation 5.5 is satisfied when $dW_t' (dX_t - D_z dZ_t) < 0$ which can occur if either $dW_t < 0$ and $(dX_t - D_z dZ_t) > 0$ or if $dW_t > 0$ and $(dX_t - D_z dZ_t) < 0$. In the first case, relative wages for a group fall ($dW_t < 0$) while the relative supply change net of the relative demand change is positive ($(dX_t - D_z dZ_t) > 0$). This can occur in two ways. First, relative supply increased while relative demand remained constant, increased but by less than the increase in relative supply, or decreased and reinforced the relative supply increase. Second, relative demand decreased while relative supply remained constant, decreased but by less than the decrease in relative demand, or increased and reinforced the relative demand decrease. In the second case, relative wages for a group rise ($dW_t > 0$) while the relative supply change net of the relative demand change is negative ($(dX_t - D_z dZ_t) < 0$). This can occur in two ways. First, relative supply decreased while relative demand remained constant, decreased but by less than the decrease in relative supply, or increased and reinforced the relative supply decrease. Second, relative demand increased while relative supply remained constant, increased but by less than the relative demand increase, or decreased and reinforced the relative demand increase.

If the inequality in Equation 5.5 does not hold, then relative demand changes must have occurred. When $dW_t' (dX_t - D_z dZ_t) > 0$, the inequality in Equation 5.5 is not satisfied. This can occur if either $dW_t < 0$ and $(dX_t - D_z dZ_t) < 0$ or if $dW_t > 0$ and $(dX_t - D_z dZ_t) > 0$. In the first case, relative wages for a group fall ($dW_t < 0$) and the relative supply change net of the relative demand change is negative ($(dX_t - D_z dZ_t) < 0$). The only way relative wages can fall with a constant relative demand is if relative supply increases, which would make the relative supply change net of the relative demand change positive. In the second case, relative wages for a group rise ($dW_t > 0$) while the relative supply change net of the relative demand change is positive ($(dX_t - D_z dZ_t) > 0$). The only way relative wages can rise with a constant relative demand is if relative supply decreases, which would make the relative supply change net of the relative demand change negative.

We test the stable relative demand hypothesis by computing the inner products of changes in relative wages and changes in relative supplies for the 100 gender-education-age groups $(W_t - W_s)' (X_t - X_s)$ for six time periods - 1983-1988, 1983-1993, 1983-1999, 1988-1993, 1988-1999, and 1993-1999. The results of our test are presented in Table 5.10. Five of the six comparisons are positive and therefore reject a stable relative demand hypothesis. These results indicate that between 1983 and 1988 there is a possibility that relative demand was stable and therefore did not affect

Table 5.10: Inner Products of Changes in Relative Wages with Changes in Relative Supplies: 1983-1999

1983-1988	**1983-1993**	**1983-1999**	**1988-1993**	**1988-1999**	**1993-1999**
-0.032555	0.005575	0.023470	0.020604	0.040608	0.000422

relative wages. For all other periods, shifts in relative demand played an important role in relative wage changes in India. Figure 5.1 illustrates these results by plotting changes in log relative wages against changes in log relative supplies for the 100 labor groups for each of the six periods. The lines drawn in the figures are predicted values from weighted least squares regressions of changes in log relative wages on changes in log relative supplies for each time period, using employment shares of each group in the initial period as weights. These six graphs reinforce our findings from the inner products - for five periods, the groups with the largest increases in relative labor supplies had the largest increases in relative wages. This relationship is strongest for the 1988-1999 period, followed closely by the 1983-1999 and 1988-1993 periods. These findings indicate that relative demand changes were a significant factor in bringing about relative wage changes during the 1980s and 1990s in India.

5.6.2 Between- & Within-Sector Demand Changes

To explore the role of relative demand changes in relative wage changes we focus on two types of demand changes - those that occur between industries (shifts that change the allocation of labor demand between industries at fixed relative wages) and those that occur within industries (shifts that change the allocation of labor demand within industries at fixed relative wages). Important sources of both between- and within-sector demand changes include skill-biased technology transfer, changes in prices of

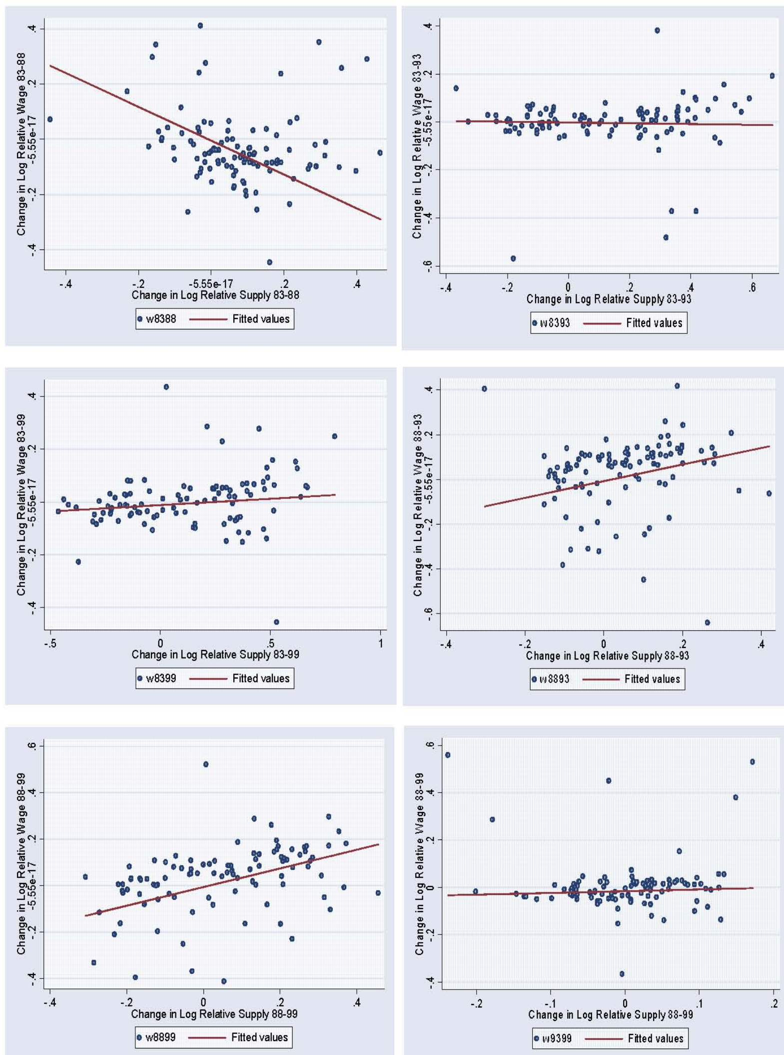

Figure 5.1: Wage & Supply Changes for 100 Groups: 1983-1999

non-labor inputs such as capital, changes in product demand, and changes in the composition of domestic output.

The between- and within-sector demand shift measures proposed by Katz & Murphy (1992) are based on the fixed coefficients manpower requirements index (Freeman (1980)). This index measures the percentage change in the demand for a demographic group as the weighted average of the percentage employment growth by industry, where the weights are the industrial employment distribution for the demographic group in a base period. The index can be written as:

$$\Delta X_k^d = \sum_j \left(\frac{E_{jk}}{E_k}\right)\left(\frac{\Delta E_j}{E_j}\right) = \frac{\sum\limits_j \alpha_{jk} \Delta E_j}{E_k} \tag{5.6}$$

where k indexes demographic groups and j indexes sectors. ΔX_k^d is the change in demand for group k, E_j is total labor input in sector j, ΔE_j is the change between years of total labor input in sector j, E_k is base year employment of group k, and $\alpha_{jk} = \frac{E_{jk}}{E_j}$ is group k's share of total employment in sector j in the base period. The employment measures E_k and E_j are in efficiency units.[11] We turn Equation 5.6 into an index of *relative* demand shifts by normalizing the employment measures E_k and E_j so that total employment in efficiency units in each year sums to one. We use the average of the four survey years to be our base period. Thus, we use the average share of total employment in sector j of group k over the 1983-1999 period as our measure of α_{jk} and the average share of group k in total employment over the 1983-1999 period as our measure of E_k.

We use Equation 5.6 to calculate overall, between, and within sector demand shifts based on employment in 18 industries and 3 occupations (defined in Table 5.3).

[11] For the employment measures E_k and E_j, we weight the total labor input (hours worked) of each group or sector by the average relative wage of that group or sector to construct measures of labor demand in efficiency units.

We define our overall (industry-occupation) demand shift index for group k, ΔX_k^d, as the index given in Equation 5.6 when j indexes our 48 industry-occupation cells. We also decompose this index into between- and within-industry components. The between-industry demand shift index for group k, ΔX_k^b, as the index given in Equation 5.6 when j indexes the 18 industries. The within-industry demand shift index for group k, ΔX_k^w, is calculated as the difference between the overall demand shift index and the between-industry demand shift index (i.e. $\Delta X_k^w = \Delta X_k^d - \Delta X_k^b$). The within-industry demand shifts reflect shifts in employment among occupations within industries. Table 5.11 reports relative demand shift estimates for 10 demographic groups and for 6 time periods. Between-sector demand shifted away from women with less than primary, primary, and middle schooling in favor of women with high school and college education in most time periods. In the periods 1983-1988 and 1983-1999 between-sector demand for women with high school and college education decreased. Between-sector demand for women with middle school education increased between 1983 and 1988. Between-sector demand for men with less than primary, primary, and middle schooling decreased in all time periods with one exception. Between 1983 and 1999, between-sector demand for men with primary schooling increased. For men with high school and college education, between-sector demand increased in every time period. The decline in between-sector relative demand for less educated men and women is consistent with the large shift out of agriculture, hunting, forestry, and fishing during the 1983-1999 period (see Table 5.9). Similarly, the growth in between-sector relative demand for more educated men and women is consistent with the shift into medium- (wholesale & retail trade, restaurants & hotels) and high-skill services (financing, insurance, real estate, & business services).

Within-sector demand also shifted away from women and men with less than primary, primary, and middle schooling in favor of women and men with high school and college education in most time periods. The exceptions are during 1983-1988 when within-sector demand for women with middle schooling increased and high school and college education decreased. Within-sector demand for men with high school education decreased during 1983-1993, 1983-1999, and 1993-1999. The decline in within-sector relative demand for less educated men and women is consistent with the substantial shift out of medium- (clerical and sales) and low-skill (production and service) occupations, while the growth in within-sector relative demand for more educated men and women is consistent with the growth in importance of high-skill occupations (professional, technical, administrative, executive, & managerial).

Overall demand shifted away from women and men with less than primary, primary, and middle schooling in favor of women and men with high school and college education in every time period.

In assessing these results, two factors must be taken into account. First, as noted in Katz & Murphy (1992), the between-sector demand shift index is a biased measure of between-industry demand shifts because it does not measure demand shifts only at fixed relative wages, but also includes demand shifts brought about by changing relative wages. Output shares of sectors that intensively employ labor groups with relative wage increases (decreases) are likely to fall (rise). Therefore, the bias term for relative wage increases (decreases) is negative (positive). The measured demand shift equals the true demand shift plus the bias term, where the true demand shift only measures shifts in demand at fixed relative wages. For example, between 1983 and 1988 relative wages for women with less than primary schooling increased (see table 5.1), which would tend to reduce output and labor demand in sectors that employ these women intensively, making the bias term negative. Table 5.11 indicates that

Table 5.11: Sector & Occupation Based Relative Demand Shifts: 1983-1999

Group	**83-88**	**83-93**	**83-99**	**88-93**	**88-99**	**93-99**
			Between Sector Shift			
Women						
< Primary School	-2.25	-3.30	-2.90	-5.74	-9.06	-6.44
Primary School	-1.04	-3.49	-1.79	-4.62	-6.62	-5.44
Middle School	0.11	-1.33	-0.73	-1.21	-1.97	-2.08
High School	-0.68	5.89	-2.03	5.30	3.50	4.12
College	-0.08	8.25	-1.46	8.18	6.97	7.04
Men						
< Primary School	-1.55	-3.34	-1.23	-5.01	-6.40	-4.67
Primary School	-0.06	-2.33	0.50	-2.40	-1.87	-1.80
Middle School	-0.31	-1.74	-0.18	-2.06	-2.25	-1.93
High School	0.78	1.53	0.80	2.28	3.04	2.30
College	1.53	3.92	1.28	5.32	6.45	5.09
			Within Sector Shift			
Women						
< Primary School	-1.72	-0.10	-1.91	-1.83	-3.82	-2.02
Primary School	-1.83	-0.11	-2.03	-1.94	-4.06	-2.14
Middle School	-1.07	0.55	-1.19	-0.51	-1.72	-0.62
High School	0.80	-0.25	0.74	0.56	1.29	0.50
College	1.86	-0.30	2.26	1.58	3.76	1.98
Men						
< Primary School	-2.06	-0.02	-1.75	-2.07	-3.91	-1.77
Primary School	-1.77	-0.07	-1.52	-1.84	-3.43	-1.59
Middle School	-1.43	-0.08	-1.81	-1.51	-3.39	-1.89
High School	0.53	-0.01	-0.01	0.52	0.51	-0.02
College	2.97	0.77	2.78	3.69	6.25	3.50
			Overall Shift (industry & occupation)			
Women						
< Primary School	-3.68	-3.36	-3.03	-7.35	-10.96	-6.64
Primary School	-1.83	-2.41	-1.00	-4.35	-5.45	-3.46
Middle School	-1.75	-1.82	-2.00	-3.65	-5.83	-3.91
High School	1.30	1.52	0.79	2.78	3.51	2.28
College	4.40	4.63	3.98	8.60	11.89	8.22
Men						
< Primary School	-4.07	-3.41	-4.95	-7.83	-13.82	-8.79
Primary School	-2.91	-3.61	-3.91	-6.78	-11.38	-7.87
Middle School	-0.96	-0.76	-1.94	-1.74	-3.76	-2.74
High School	0.13	5.68	-1.26	5.79	4.70	4.58
College	1.78	8.01	0.88	9.49	10.20	8.73

The reported numbers are of the form $log(1 + \Delta X_k^s) * 100$, where s represents between-sector (b), within-sector (w), and overall (d) demand.

between-sector demand for women with less than primary schooling fell between 1983 and 1988. Because the measured demand decline includes the negative bias term, it overstates the true demand decline (i.e. the negative bias term strengthens the true demand decline). On the other hand, between 1993 and 1999 relative wages for women with less than primary schooling decreased (see Table 5.1), which we expect to have increased output and labor demand in sectors that employ these women intensively, making the bias term positive. Table 5.11 shows that between-sector demand for this group decreased during 1993-1999. The measured demand decline in this case understates the true demand decline (i.e. the positive bias term counteracts the true demand decline).

Second, because the within-sector demand shifts proposed by Katz & Murphy (1992) measure shifts in employment between only 3 occupation groups, they might not capture the full effect of within-sector changes in relative demand. We would require more detailed information in the skill content of occupations within industries to obtain more precise within-sector demand shift estimates.

5.7 Demand Shifts Arising From International Trade

In this section we examine the extent to which international trade in manufactured goods was a source of relative demand shifts during the 1980s and 1990s in India. The Heckscher-Ohlin-Samuelson Theorem predicts a rise in the relative demand for less-skilled workers and a fall in the relative demand for more-skilled workers. On the other hand, as a result of the transfer of skill-biased technology via capital goods imports and investment, we expect a rise in the relative demand for more skilled workers and a fall in the relative demand for less-skilled workers.

Following Katz & Murphy (1992) we estimate the labor supply equivalents of trade (i.e. the implicit labor supply embodied in trade) by transforming trade flows into labor supply equivalents on the basis of the utilization of labor inputs in the domestic manufacturing industries. We measure only the direct labor supply embodied in trade and ignore the input-output effects. Therefore, the implicit labor supply in trade is the labor input required to produce traded output domestically.

We measure L_t^k, the implicit labor supply of demographic group k embodied in trade in year t as:

$$L_t^k = \sum_i \left[e_i^k E_{it} \left(\frac{I_{it}}{Y_{it}} \right) \right] \tag{5.7}$$

where i indexes 16 manufacturing industries, k indexes 10 demographic groups (2 gender and 5 education groups), and t indexes 4 years. e_i^k is the average proportion of employment in industry i amongst workers in group k over the 1983-1999 period, E_{it} is the share of employment in industry i in year t ($\sum\limits_i E_{it} = 1$), I_{it} is net imports in industry i in year t ($Imports_{it} - Exports_{it}$), and Y_{it} is output in industry i in year t. Positive net imports imply that the country is importing more foreign labor than it is exporting domestic labor, which will result in a fall in domestic labor demand.[12]

We measure T_t^k, the effect of trade on relative demand for group k in year t as:

$$T_t^k = -\left(\frac{1}{E^k} \right) \sum_i \left[e_i^k E_{it} \left(\frac{I_{it}}{Y_{it}} \right) \right] + \sum_i E_{it} \left(\frac{I_{it}}{Y_{it}} \right) \tag{5.8}$$

where E^k is the average share of total employment of group k over the 1983-1999 period.[13] The first term in Equation 5.8 is the implicit labor supply of group k embodied in trade, normalized by base year employment of group k (E^k) with the sign reversed to convert the supply shift measure into a demand shift measure. The

[12] e_i^k and E_{it} are measured in efficiency units by weighting the total labor input (hours worked) of each group or sector by the average relative wage of that group or sector.

[13] E^k is measured in efficiency units by weighting the total labor input (hours worked) of each group by the average relative wage of that group.

Table 5.12: Relative Demand Shifts Predicted by Changes in International Trade in Manufactures: 1983-1999

Group	83-88	83-93	83-99	88-93	88-99	93-99
Women						
< Primary School	-0.006	0.022	0.011	0.027	0.017	-0.011
Primary School	-0.048	-0.237	-0.285	-0.189	-0.237	-0.048
Middle School	-0.063	-0.355	-0.392	-0.292	-0.329	-0.037
High School	-0.022	-0.133	-0.124	-0.112	-0.103	0.009
College	0.010	0.046	0.080	0.035	0.070	0.035
Men						
< Primary School	-0.022	-0.038	-0.085	-0.016	-0.064	-0.048
Primary School	-0.048	-0.184	-0.263	-0.136	-0.216	-0.080
Middle School	-0.023	-0.069	-0.114	-0.047	-0.092	-0.045
High School	0.004	0.014	0.007	0.010	0.004	-0.007
College	0.016	0.046	0.064	0.029	0.047	0.018

The reported numbers are of the form $\Delta T^k_{tt'} = T^k_{t'} - T^k_t$, where t and t' represent different years and $t' > t$.

second term adjusts the demand shift measure so that trade affects only relative demands for labor.[14] We use data on imports, exports, and output by industry for the years 1983, 1988, 1993, and 1999 from the Trade & Production Database, provided by the World Bank. These data cover 3-digit ISIC manufacturing industries, which we aggregate into 16 industry groups (see Table C.37 in Appendix C).

Table 5.12 presents our estimated changes in relative demand predicted by changes in international trade in manufactures for 10 demographic groups over 6 time periods. For the period between 1983 and 1999, Table 5.12 shows that international trade in manufactures predicts large decreases in relative demand for women. For women with less than primary schooling, international trade in manufactures predicts a rise in relative demand. International trade in manufactures has decreased relative demand for men with less than primary, primary, and middle school education and increased relative demand for those with high school and college education.

[14] Refer to Murphy & Welch (1991) for details of this demand shift index.

Table 5.13: Changes in Relative Wages, Supply, & Demand, and Relative Demand Shifts Predicted by Changes in International Trade in Manufactures: 1983-1999

Group	**Relative Wages**	**Relative Supply**	**Relative Demand**	**Demand Shifts Predicted by Trade**
Women				
< Primary School	3.89	-19.38	-3.03	0.011
Primary School	7.31	10.84	-1.00	-0.285
Middle School	-20.47	42.27	-2.00	-0.392
High School	17.79	41.58	0.79	-0.124
College	25.70	44.85	3.98	0.080
Men				
< Primary School	-5.95	-25.86	-4.95	-0.085
Primary School	-5.94	-18.87	-3.91	-0.263
Middle School	13.72	0.84	-1.94	-0.114
High School	0.22	20.17	-1.26	0.007
College	4.70	25.61	0.88	0.064

Relative wage changes are the percentage change in relative wages between 1983 and 1999. The reported numbers for relative supply changes are of the form $\Delta(logX_r) * 100$, where X_r represents relative supply. The reported numbers for relative demand changes are of the form $log(1 + \Delta X_k^d) * 100$, where X_k^d represents overall demand. For relative demand shifts predicted by changes in international trade, the reported numbers are of the form $\Delta T_{tt'}^k = T_{t'}^k - T_t^k$, where t and t' represent different years and $t' > t$.

5.8 Conclusion

Our analysis in this chapter documents several interesting changes in relative wages and how relative supply and demand contributed to these changes in India. We summarize our results in Table 5.13 for the period 1983-1999.

For the period 1983-1999, we find that relative wages of women rose between 1983 and 1999 except for women with middle schooling and relative wages of less educated men fell while those of more educated men rose. We cannot reject the stable demand hypothesis for the period 1983-1988 but find that relative demand changes played a significant role in changing relative wages in all other periods, including the entire period from 1983 to 1999.

The relative supply of uneducated women declined while relative supplies of women with primary, middle, high school, and college education increased during this period. For men, relative supplies of men with less than primary and primary schooling declined while relative supplies of men with middle, high school, and college education increased. Overall demand shifted away from women with less than primary, primary, and middle schooling and towards women with high school and college education. Overall demand shifted away from men with no or any schooling but in favor of men with college education.

We find that international trade in manufactures raised firms' relative demand for women with college education and men with high school and college education. However, trade in manufactures also raised firms' relative demand for uneducated women and lowered it for women with primary, middle, and high school education. This suggests that even though the transfer of skill-biased technology via trade and investment has contributed to firms' relative demand for more educated men and women, the Stolper-Samuelson effect has also played a role by raising firms' relative demand for uneducated women.

For both women and men, relative wages of skilled workers (workers with high school and college education) rose during the 1980s and 1990s in India. The rise in relative wages was far greater for women than for men. This finding suggests that skill-biased technology transfer did indeed play a role after India's liberalization of trade and investment and that skilled women benefited more than skilled men. While relative wages of men with middle schooling increased, relative wages of women with middle schooling decreased substantially. Perhaps the decrease in relative wages of women with middle schooling was the result of a large increase in the supply of this group combined with a substantial fall in the demand for this group. We find that international trade changes brought about the largest decline in the demand for women with middle schooling.

The rise in relative wages of women with no or primary education could be the result of a relatively low supply of these groups in relation to their demand. On the other hand, the fall in relative wages of men with no or primary schooling suggests a relatively high supply of these groups in relation to demand for their demand. The creation and expansion of export-processing zones that engage in low-skill production techniques and employ mostly women coincides with India's liberalization of trade and investment during the 1983-1999 period and provides one explanation for this gender differential. These findings indicate that the Stolper-Samuelson effect played a role for women but not for men during this time period in India.

Two factors that we expect to have raised demand for and relative wages of more educated women and men is foreign direct investment and service sector employment brought about by developed countries outsourcing medium- and high-skill activities to India. For future research, an analysis of relative demand shifts predicted by changes in foreign direct investment and outsourcing might shed some light on these critical determinants of firms' relative demand for skilled labor.

Appendix A

Proofs

A.1 Proof of Proposition 1

The first best investment levels for worker p and firm f are:

$$e^{FB} = \left(\frac{\alpha(1-\alpha)^{(1-\alpha)/\alpha} A^{1/\alpha} h \mu^{(\alpha-1)/\alpha}}{c} \right)^{1/\Gamma} \tag{A.1a}$$

$$k^{FB} = \left(\frac{\alpha(1-\alpha)^{1/\theta} A^{(\Gamma+1)/\alpha} h^{\Gamma+1} \mu^{-1/\theta}}{c} \right)^{1/\Gamma} \tag{A.1b}$$

Where $\theta = \frac{\alpha}{\Gamma+1-\alpha}$.

(i) The optimal investment levels in the first best case, e_p^{FB} and k_f^{FB}, have unique solutions. Therefore, there is a unique equilibrium in the first best case.

(ii) The optimal investments of worker p and firm f are increasing in worker p's quality of education and decreasing in worker p's cost of education and in firm f's cost of capital.[1]

$$\frac{de_p}{dh_p}|_{dX=0} > 0 \qquad \frac{de_p}{dc_p}|_{dX=0} < 0 \qquad \frac{de_p}{d\mu_f}|_{dX=0} < 0$$
$$\frac{dk_f}{dh_p}|_{dX=0} > 0 \qquad \frac{dk_f}{dc_p}|_{dX=0} < 0 \qquad \frac{dk_f}{d\mu_f}|_{dX=0} < 0$$

The returns to all agents are:

$$W_p = \alpha A e_p^{\alpha} h_p^{1+\alpha} k_f^{1-\alpha} \tag{A.2a}$$

$$R_f = (1-\alpha) A \left(e_p h_p\right)^{\alpha} k_f^{1-\alpha} \tag{A.2b}$$

The returns to worker p and firm f are increasing in worker p's quality of education and decreasing in worker p's cost of education and in firm f's cost of capital for each worker p-firm f pair.

$$\frac{dW_p}{dh_p}|_{dX=0} = \frac{\partial W_p}{\partial h_p} + \frac{\partial W_p}{\partial e_p}\frac{de_p}{dh_p}|_{dX=0} + \frac{\partial W_p}{\partial k_f}\frac{dk_f}{dh_p}|_{dX=0} > 0$$
$$\frac{dW_p}{dc_p}|_{dX=0} = \frac{\partial W_p}{\partial e_p}\frac{de_p}{dc_p}|_{dX=0} + \frac{\partial W_p}{\partial k_f}\frac{dk_f}{dc_p}|_{dX=0} < 0$$
$$\frac{dW_p}{d\mu_f}|_{dX=0} = \frac{\partial W_p}{\partial e_p}\frac{de_p}{d\mu_f}|_{dX=0} + \frac{\partial W_p}{\partial k_f}\frac{dk_f}{d\mu_f}|_{dX=0} < 0$$
$$\frac{dR_f}{dh_p}|_{dX=0} = \frac{\partial R_f}{\partial h_p} + \frac{\partial R_f}{\partial e_p}\frac{de_p}{dh_p}|_{dX=0} + \frac{\partial R_f}{\partial k_f}\frac{dk_f}{dh_p}|_{dX=0} > 0$$
$$\frac{dR_f}{dc_p}|_{dX=0} = \frac{\partial R_f}{\partial e_p}\frac{de_p}{dc_p}|_{dX=0} + \frac{\partial R_f}{\partial k_f}\frac{dk_f}{dc_p}|_{dX=0} < 0$$
$$\frac{dR_f}{d\mu_f}|_{dX=0} = \frac{\partial R_f}{\partial e_p}\frac{de_p}{d\mu_f}|_{dX=0} + \frac{\partial R_f}{\partial k_f}\frac{dk_f}{d\mu_f}|_{dX=0} < 0$$

[1] From here on $dX = 0$ means that all exogenous variables except the one under consideration are held constant.

The payoffs of all agents are:

$$U_p = \alpha A e_p^{\alpha} h_p^{1+\alpha} k_f^{1-\alpha} - c_p \frac{e_p^{1+\Gamma}}{1+\Gamma} \tag{A.3a}$$

$$V_f = (1-\alpha) A \left(e_p h_p\right)^{\alpha} k_f^{1-\alpha} - \mu_f k_f \tag{A.3b}$$

The welfare of worker p and firm f are increasing in worker p's quality of education and decreasing in worker p's cost of education and in firm f's cost of capital.

$$\begin{aligned}
\frac{dU_p}{dh_p}|_{dX=0} &= \frac{\partial U_p}{\partial h_p} + \frac{\partial U_p}{\partial k_f}\frac{dk_f}{dh_p}|_{dX=0} > 0 \\
\frac{dU_p}{dc_p}|_{dX=0} &= \frac{\partial U_p}{\partial c_p} + \frac{\partial U_p}{\partial k_f}\frac{dk_f}{dc_p}|_{dX=0} < 0 \\
\frac{dU_p}{d\mu_f}|_{dX=0} &= \frac{\partial U_p}{\partial k_f}\frac{dk_f}{d\mu_f}|_{dX=0} < 0 \\
\frac{dV_f}{dh_p}|_{dX=0} &= \frac{\partial V_f}{\partial h_p} + \frac{\partial V_f}{\partial e_p}\frac{de_p}{dh_p}|_{dX=0} > 0 \\
\frac{dV_f}{dc_p}|_{dX=0} &= \frac{\partial V_f}{\partial e_p}\frac{de_p}{dc_p}|_{dX=0} < 0 \\
\frac{dV_f}{d\mu_f}|_{dX=0} &= \frac{\partial V_f}{\partial \mu_f} + \frac{\partial V_f}{\partial e_p}\frac{de_p}{d\mu_f}|_{dX=0} < 0
\end{aligned}$$

(iii) The optimal investments, returns, and welfare of worker p and firm f are independent of the distribution of workers and firms. The proof follows directly from the fact that the optimal investment levels of worker p and firm f depend only on their own parameters and the parameters of the agent that each is paired with.

A.2 Proof of Proposition 2

In the decentralized case with search and random matching, the optimal investments for all workers and firms with homogeneous agents are:

$$e^{*} = \left(\frac{\alpha\beta\left((1-\alpha)(1-\beta)\right)^{(1-\alpha)/\alpha} A^{1/\alpha} h \mu^{(\alpha-1)/\alpha}}{c} \right)^{1/\Gamma} \tag{A.4a}$$

$$k^{*} = \left(\frac{\alpha\beta\left((1-\alpha)(1-\beta)\right)^{1/\theta} A^{(\Gamma+1)/\alpha} h^{\Gamma+1} \mu^{-1/\theta}}{c} \right)^{1/\Gamma} \tag{A.4b}$$

Where $\theta = \frac{\alpha}{\Gamma+1-\alpha}$.

(i) The optimal investment levels in the decentralized case with homogeneous agents, e^{*} and k^{*}, have unique solutions. Therefore, there is a unique equilibrium in the decentralized case with homogeneous agents.

(ii) The first best equilibrium investment levels are independent of β and $(1-\beta)$ while the decentralized equilibrium investment levels depend on these shares. Because $0 < \beta < 1$, it follows that $e* < e^{FB}$ and $k* < k^{FB}$. So the optimal investment levels are inefficient in the decentralized case with homogeneous agents.

(iii) The optimal investments of all workers and firms are increasing in the quality of education for all workers and decreasing in the cost of education for all workers and in the cost of skill-biased technology for all firms.

$$\frac{de}{dh}|_{dX=0} > 0 \qquad \frac{de}{dc}|_{dX=0} < 0 \qquad \frac{de}{d\mu}|_{dX=0} < 0$$
$$\frac{dk}{dh}|_{dX=0} > 0 \qquad \frac{dk}{dc}|_{dX=0} < 0 \qquad \frac{dk}{d\mu}|_{dX=0} < 0$$

The returns to all agents are:

$$W = \beta A \left(eh\right)^{\alpha} k^{1-\alpha} \tag{A.5a}$$

$$R = (1-\beta) A \left(eh\right)^{\alpha} k^{1-\alpha} \tag{A.5b}$$

The returns to all workers and firms are increasing in the quality of education for all workers and decreasing in the cost of education for all workers and in the cost of skill-biased technology for all firms.

$$
\begin{aligned}
&\frac{dW}{dh}|_{dX=0} = \frac{\partial W}{\partial h} + \frac{\partial W}{\partial e}\frac{de}{dh}|_{dX=0} + \frac{\partial W}{\partial k}\frac{dk}{dh}|_{dX=0} > 0 \\
&\frac{dW}{dc}|_{dX=0} = \frac{\partial W}{\partial e}\frac{de}{dc}|_{dX=0} + \frac{\partial W}{\partial k}\frac{dk}{dc}|_{dX=0} < 0 \\
&\frac{dW}{d\mu}|_{dX=0} = \frac{\partial W}{\partial e}\frac{de}{d\mu}|_{dX=0} + \frac{\partial W}{\partial k}\frac{dk}{d\mu}|_{dX=0} < 0 \\
&\frac{dR}{dh}|_{dX=0} = \frac{\partial R}{\partial h} + \frac{\partial R}{\partial e}\frac{de}{dh}|_{dX=0} + \frac{\partial R}{\partial k}\frac{dk}{dh}|_{dX=0} > 0 \\
&\frac{dR}{dc}|_{dX=0} = \frac{\partial R}{\partial e}\frac{de}{dc}|_{dX=0} + \frac{\partial R}{\partial k}\frac{dk}{dc}|_{dX=0} < 0 \\
&\frac{dR}{d\mu}|_{dX=0} = \frac{\partial R}{\partial e}\frac{de}{d\mu}|_{dX0} + \frac{\partial R}{\partial k}\frac{dk}{d\mu}|_{dX=0} < 0
\end{aligned}
$$

The payoffs of all agents are:

$$U = \beta A\,(eh)^{\alpha}\,k^{1-\alpha} - c_i\frac{e^{1+\Gamma}}{1+\Gamma} \tag{A.6a}$$

$$V = (1-\beta)A\,(eh)^{\alpha}\,k^{1-\alpha} - \mu k \tag{A.6b}$$

The welfare of all workers and firms are increasing in the quality of education for all workers and decreasing in the cost of education for all workers and in the cost of skill-biased technology for all firms.

$$\frac{dU}{dh}|_{dX=0} = \frac{\partial U}{\partial h} + \frac{\partial U}{\partial k}\frac{dk}{dh}|_{dX=0} > 0$$
$$\frac{dU}{dc}|_{dX=0} = \frac{\partial U}{\partial c} + \frac{\partial U}{\partial k}\frac{dk}{dc}|_{dX=0} < 0$$
$$\frac{dU}{d\mu}|_{dX=0} = \frac{\partial U}{\partial k}\frac{dk}{d\mu}|_{dX=0} < 0$$
$$\frac{dV}{dh}|_{dX=0} = \frac{\partial V}{\partial h} + \frac{\partial V}{\partial e}\frac{de}{dh}|_{dX=0} > 0$$
$$\frac{dV}{dc}|_{dX=0} = \frac{\partial V}{\partial e}\frac{de}{dc}|_{dX=0} < 0$$
$$\frac{dV}{d\mu}|_{dX=0} = \frac{\partial V}{\partial \mu} + \frac{\partial V}{\partial e}\frac{de}{d\mu}|_{dX=0} < 0$$

A.3 Proof of Proposition 3

In the decentralized case with search and random matching, the optimal investments for type i worker and type j firm are:

$$e_1^* = \left(\alpha\beta\left((1-\alpha)(1-\beta)\right)^{(1-\alpha)/\alpha} A^{1/\alpha}\right)^{1/\Gamma} \left(\rho\left(\mu_1\right)^{(\alpha-1)/\alpha} + (1-\rho)\left(\mu_2\right)^{(\alpha-1)/\alpha}\right)^{1/\Gamma}$$
$$\left(\lambda\left(h_1\right)^{\alpha/(1-\alpha)}\left(c_1\right)^{-\alpha/(1-\alpha)} + (1-\lambda)\left(h_2\right)^{\theta(\Gamma+1)}\left(c_2\right)^{-\theta}\left(h_1\right)^{\theta\Gamma\alpha/(1-\alpha)}\left(c_1\right)^{-\theta\Gamma/(1-\alpha)}\right)^{(1-\alpha)/\alpha\Gamma} \tag{A.7a}$$

$$e_2^* = \left(\alpha\beta\left((1-\alpha)(1-\beta)\right)^{(1-\alpha)/\alpha} A^{1/\alpha}\right)^{1/\Gamma} \left(\rho\left(\mu_1\right)^{(\alpha-1)/\alpha} + (1-\rho)\left(\mu_2\right)^{(\alpha-1)/\alpha}\right)^{1/\Gamma}$$
$$\left(\lambda\left(h_1\right)^{\theta(\Gamma+1)}\left(c_1\right)^{-\theta}\left(h_2\right)^{\theta\Gamma\alpha/(1-\alpha)}\left(c_2\right)^{-\theta\Gamma/(1-\alpha)} + (1-\lambda)\left(h_2\right)^{\alpha/(1-\alpha)}\left(c_2\right)^{-\alpha/(1-\alpha)}\right)^{(1-\alpha)/\alpha\Gamma} \tag{A.7b}$$

$$k_1^* = \left(\alpha\beta\left((1-\alpha)(1-\beta)\right)^{1/\theta} A^{(\Gamma+1)/\alpha}\right)^{1/\Gamma} \left(\rho\left(\mu_1\right)^{-1/\theta} + (1-\rho)\left(\mu_2\right)^{(\alpha-1)/\alpha}\left(\mu_1\right)^{-\Gamma/\alpha}\right)^{1/\Gamma}$$
$$\left(\lambda\left(h_1\right)^{\theta(\Gamma+1)}\left(c_1\right)^{-\theta} + (1-\lambda)\left(h_2\right)^{\theta(\Gamma+1)}\left(c_2\right)^{-\theta}\right)^{1/\theta\Gamma} \tag{A.7c}$$

$$k_2^* = \left(\alpha\beta\left((1-\alpha)(1-\beta)\right)^{1/\theta} A^{(\Gamma+1)/\alpha}\right)^{1/\Gamma} \left(\rho\left(\mu_1\right)^{(\alpha-1)/\alpha}\left(\mu_2\right)^{-\Gamma/\alpha} + (1-\rho)\left(\mu_2\right)^{-1/\theta}\right)^{1/\Gamma}$$
$$\left(\lambda\left(h_1\right)^{\theta(\Gamma+1)}\left(c_1\right)^{-\theta} + (1-\lambda)\left(h_2\right)^{\theta(\Gamma+1)}\left(c_2\right)^{-\theta}\right)^{1/\theta\Gamma} \tag{A.7d}$$

Where $\theta = \frac{\alpha}{\Gamma+1-\alpha}$.

(i) The optimal investment levels in the decentralized case with heterogeneous agents, e_i^* and k_j^*, for $i = 1,2$ and $j = 1,2$, have unique solutions. Therefore, there is a unique equilibrium in the decentralized case with uncertainty.

(ii) and (iii) The optimal investments of type i worker and type j firm, for $i = 1,2$ and $j = 1,2$, are increasing in the quality of education for all workers and decreasing in the cost of education for all workers and in the cost of skill-biased technology for all firms. The optimal investments of type i worker and type j firm are also increasing in the proportion of high-skilled workers and skill-biased firms. For $i = j$ and $i \neq j$:

$$\frac{de_i}{dh_j}|_{dX=0} > 0 \quad \frac{de_i}{dc_j}|_{dX=0} < 0 \quad \frac{de_i}{d\mu_j}|_{dX=0} < 0 \quad \frac{de_i}{d\lambda}|_{dX=0} < 0 \quad \frac{de_i}{d\rho}|_{dX=0} < 0$$
$$\frac{dk_j}{dh_i}|_{dX=0} > 0 \quad \frac{dk_j}{dc_i}|_{dX=0} < 0 \quad \frac{dk_j}{d\mu_i}|_{dX=0} < 0 \quad \frac{dk_j}{d\lambda}|_{dX=0} < 0 \quad \frac{dk_j}{d\rho}|_{dX=0} < 0$$

The returns to all agents are:

$$W_i = \beta A\left(e_i h_i\right)^{\alpha}\left(\rho k_1^{1-\alpha} + (1-\rho)k_2^{1-\alpha}\right) \tag{A.8a}$$

$$R_j = (1-\beta)A k_j^{1-\alpha}\left(\lambda\left(e_1 h_1\right)^{\alpha} + (1-\lambda)\left(e_2 h_2\right)^{\alpha}\right) \tag{A.8b}$$

The returns to type i worker and type j firm, for $i = 1,2$ and $j = 1,2$, are increasing in the quality of education for all workers and decreasing in the cost of education for all workers and the cost of skill-biased technology for all firms. The returns to type i worker and type j firm are also increasing in the proportion of high-skilled workers and skill-biased firms. For $i = j$ and $i \neq j$:

$$\begin{aligned}
\frac{dW_i}{dh_j}|_{dX=0} &= \frac{\partial W_i}{\partial h_j} + \frac{\partial W_i}{\partial e_i}\frac{de_i}{dh_j}|_{dX=0} + \frac{\partial W_i}{\partial k_1}\frac{dk_1}{dh_j}|_{dX=0} + \frac{\partial W_i}{\partial k_2}\frac{dk_2}{dh_j}|_{dX=0} > 0 \\
\frac{dW_i}{dc_j}|_{dX=0} &= \frac{\partial W_i}{\partial e_i}\frac{de_i}{dc_j}|_{dX=0} + \frac{\partial W_i}{\partial k_1}\frac{dk_1}{dc_j}|_{dX=0} + \frac{\partial W_i}{\partial k_2}\frac{dk_2}{dc_j}|_{dX=0} < 0 \\
\frac{dW_i}{d\mu_j}|_{dX=0} &= \frac{\partial W_i}{\partial e_i}\frac{de_i}{d\mu_j}|_{dX=0} + \frac{\partial W_i}{\partial k_1}\frac{dk_1}{d\mu_j}|_{dX=0} + \frac{\partial W_i}{\partial k_2}\frac{dk_2}{d\mu_j}|_{dX=0} < 0 \\
\frac{dW_i}{d\lambda}|_{dX=0} &= \frac{\partial W_i}{\partial e_i}\frac{de_i}{d\lambda}|_{dX=0} + \frac{\partial W_i}{\partial k_1}\frac{dk_1}{d\lambda}|_{dX=0} + \frac{\partial W_i}{\partial k_2}\frac{dk_2}{d\lambda}|_{dX=0} < 0 \\
\frac{dW_i}{d\rho}|_{dX=0} &= \frac{\partial W_i}{\partial \rho} + \frac{\partial W_i}{\partial e_i}\frac{de_i}{d\rho}|_{dX=0} + \frac{\partial W_i}{\partial k_1}\frac{dk_1}{d\rho}|_{dX=0} + \frac{\partial W_i}{\partial k_2}\frac{dk_2}{d\rho}|_{dX=0} < 0 \\
\frac{dR_j}{dh_i}|_{dX=0} &= \frac{\partial R_j}{\partial h_i} + \frac{\partial R_j}{\partial e_1}\frac{de_1}{dh_i}|_{dX=0} + \frac{\partial R_j}{\partial e_2}\frac{de_2}{dh_i}|_{dX=0} + \frac{\partial R_j}{\partial k_j}\frac{dk_j}{dh_i}|_{dX=0} > 0 \\
\frac{dR_j}{dc_i}|_{dX=0} &= \frac{\partial R_j}{\partial e_1}\frac{de_1}{dc_i}|_{dX=0} + \frac{\partial R_j}{\partial e_2}\frac{de_2}{dc_i}|_{dX=0} + \frac{\partial R_j}{\partial k_j}\frac{dk_j}{dc_i}|_{dX=0} < 0 \\
\frac{dR_j}{d\mu_i}|_{dX=0} &= \frac{\partial R_j}{\partial e_1}\frac{de_1}{d\mu_i}|_{dX0} + \frac{\partial R_j}{\partial e_2}\frac{de_2}{d\mu_i}|_{dX=0} + \frac{\partial R_j}{\partial k_j}\frac{dk_j}{d\mu_i}|_{dX=0} < 0 \\
\frac{dR_j}{d\lambda}|_{dX=0} &= \frac{\partial R_j}{\partial \lambda} + \frac{\partial R_j}{\partial e_1}\frac{de_1}{d\lambda}|_{dX=0} + \frac{\partial R_j}{\partial e_2}\frac{de_2}{d\lambda}|_{dX=0} + \frac{\partial R_j}{\partial k_j}\frac{dk_j}{d\lambda}|_{dX=0} < 0 \\
\frac{dR_j}{d\rho}|_{dX=0} &= \frac{\partial R_j}{\partial e_1}\frac{de_1}{d\rho}|_{dX=0} + \frac{\partial R_j}{\partial e_2}\frac{de_2}{d\rho}|_{dX=0} + \frac{\partial R_j}{\partial k_j}\frac{dk_j}{d\rho}|_{dX=0} < 0
\end{aligned}$$

The expected payoffs of all agents are:

$$E\left(U_i\right) = W_0 + \beta A \left(e_i h_i\right)^{\alpha} \left[\rho k_1^{1-\alpha} + (1-\rho) k_2^{1-\alpha}\right] - c_i \frac{e_i^{1+\Gamma}}{1+\Gamma} \tag{A.9a}$$

$$E\left(V_j\right) = R_0 + (1-\beta) A k_j^{1-\alpha} \left[\lambda \left(e_1 h_1\right)^{\alpha} + (1-\lambda)\left(e_2 h_2\right)^{\alpha}\right] - \mu_j k_j \tag{A.9b}$$

The welfare of type i worker and type j firm, for $i = 1, 2$ and $j = 1, 2$, are increasing in the quality of education for all workers and decreasing in the cost of education for all workers and the cost of skill-biased technology for all firms. The welfare of type i worker and type j firm are also increasing in the proportion of high-skilled workers and skill-biased firms. For $i = j$ and $i \neq j$:

$$\begin{aligned}
\frac{dU_i}{dh_j}|_{dX=0} &= \frac{\partial U_i}{\partial h_j} + \frac{\partial U_i}{\partial k_1}\frac{dk_1}{dh_j}|_{dX=0} + \frac{\partial U_i}{\partial k_2}\frac{dk_2}{dh_j}|_{dX=0} > 0 \\
\frac{dU_i}{dc_j}|_{dX=0} &= \frac{\partial U_i}{\partial c_j} + \frac{\partial U_i}{\partial k_1}\frac{dk_1}{dc_j}|_{dX=0} + \frac{\partial U_i}{\partial k_2}\frac{dk_2}{dc_j}|_{dX=0} < 0 \\
\frac{dU_i}{d\mu_j}|_{dX=0} &= \frac{\partial U_i}{\partial k_1}\frac{dk_1}{d\mu_j}|_{dX=0} + \frac{\partial U_i}{\partial k_2}\frac{dk_2}{d\mu_j}|_{dX=0} < 0 \\
\frac{dU_i}{d\lambda}|_{dX=0} &= \frac{\partial U_i}{\partial k_1}\frac{dk_1}{d\lambda}|_{dX=0} + \frac{\partial U_i}{\partial k_2}\frac{dk_2}{d\lambda}|_{dX=0} < 0 \\
\frac{dU_i}{d\rho}|_{dX=0} &= \frac{\partial U_i}{\partial \rho} + \frac{\partial U_i}{\partial k_1}\frac{dk_1}{d\rho}|_{dX=0} + \frac{\partial U_i}{\partial k_2}\frac{dk_2}{d\rho}|_{dX=0} < 0 \\
\frac{dV_j}{dh_i}|_{dX=0} &= \frac{\partial V_j}{\partial h_i} + \frac{\partial V_j}{\partial e_1}\frac{de_1}{dh_i}|_{dX=0} + \frac{\partial V_j}{\partial e_2}\frac{de_2}{dh_i}|_{dX=0} > 0 \\
\frac{dV_j}{dc_i}|_{dX=0} &= \frac{\partial V_j}{\partial e_1}\frac{de_1}{dc_i}|_{dX=0} + \frac{\partial V_j}{\partial e_2}\frac{de_2}{dc_i}|_{dX=0} < 0 \\
\frac{dV_j}{d\mu_i}|_{dX=0} &= \frac{\partial V_j}{\partial \mu_i} + \frac{\partial V_j}{\partial e_1}\frac{de_1}{d\mu_i}|_{dX=0} + \frac{\partial V_j}{\partial e_2}\frac{de_2}{d\mu_i}|_{dX=0} < 0 \\
\frac{dV_j}{d\lambda}|_{dX=0} &= \frac{\partial V_j}{\partial \lambda} + \frac{\partial V_j}{\partial e_1}\frac{de_1}{d\lambda}|_{dX=0} + \frac{\partial V_j}{\partial e_2}\frac{de_2}{d\lambda}|_{dX=0} < 0 \\
\frac{dV_j}{d\rho}|_{dX=0} &= \frac{\partial V_j}{\partial e_1}\frac{de_1}{d\rho}|_{dX=0} + \frac{\partial V_j}{\partial e_2}\frac{de_2}{d\rho}|_{dX=0} < 0
\end{aligned}$$

A.4 Proof of Proposition 4

(i) Given the four possible outcomes, if the firm chooses to invest, the parent will choose to invest if $\beta A k_1^{1-\alpha}\left(h^\alpha - (eh)^\alpha\right) > \gamma W_0 + c$. If the firm chooses not to invest, the parent will choose not to invest if $\beta A k_0^{1-\alpha}\left(h^\alpha - (eh)^\alpha\right) < \gamma W_0 + c$. Similarly, if the parent chooses to invest, the firm will choose to invest if $(1-\beta)Ah^\alpha\left(k_1^{1-\alpha} - k_0^{1-\alpha}\right) > \mu\left(k_1 - k_0\right)$. If the parent chooses not to invest, the firm will choose not to invest if $(1-\beta)A\left(\underline{e}h\right)^\alpha\left(k_1^{1-\alpha} - k_0^{1-\alpha}\right) < \mu\left(k_1 - k_0\right)$. The full-investment and no-investment equilibria exist if both the following conditions hold simultaneously.

$$\beta A k_1^{1-\alpha}\left(h^\alpha-(\underline{e}h)^\alpha\right)>\gamma W_0+c>\beta A k_0^{1-\alpha}\left(h^\alpha-(\underline{e}h)^\alpha\right) \tag{A.10a}$$

$$(1-\beta)Ah^\alpha\left(k_1^{1-\alpha}-k_0^{1-\alpha}\right)>\mu\left(k_1-k_0\right)>(1-\beta)A\left(\underline{e}h\right)^\alpha\left(k_1^{1-\alpha}-k_0^{1-\alpha}\right) \tag{A.10b}$$

(ii) The full-investment equilibrium Pareto dominates the no-investment one.

For the parent,

$$\beta Ah^\alpha k_1^{1-\alpha}-\beta A\left(\underline{e}h\right)^\alpha k_1^{1-\alpha}>\gamma W_0+c$$

$$\beta Ah^\alpha k_1^{1-\alpha}-\beta A\left(\underline{e}h\right)^\alpha k_0^{1-\alpha}>\gamma W_0+c$$

$$\beta Ah^\alpha k_1^{1-\alpha}-c>\gamma W_0+\beta A\left(\underline{e}h\right)^\alpha k_0^{1-\alpha}$$

$$U_{11}>U_{00}.$$

Similarly, for the firm,

$$(1-\beta)Ah^\alpha k_1^{1-\alpha}-(1-\beta)Ah^\alpha k_0^{1-\alpha}>\mu\left(k_1-k_0\right)$$

$$(1-\beta)Ah^\alpha k_1^{1-\alpha}-(1-\beta)A\left(\underline{e}h\right)^\alpha k_0^{1-\alpha}>\mu\left(k_1-k_0\right)$$

$$(1-\beta)Ah^\alpha k_1^{1-\alpha}-\mu k_1>(1-\beta)A\left(\underline{e}h\right)^\alpha k_0^{1-\alpha}\mu k_0$$

$$V_{11}>V_{00}.$$

Appendix B

Correction of Wage Equations for Sample Selection Bias

Consider the following equations for the earnings regression (Equation B.1a) and the selection process into wage employment (Equation B.1b):[1]

$$y_s = x_s\beta_s + \mu_s \tag{B.1a}$$

$$y_s^* = z_s\gamma_s + \eta_s \tag{B.1b}$$

where y_s is earnings (the outcome variable) and y_s^* is employment status (the selection variable) and s is a categorical variable representing an individual's choice between M alternatives, $s = 1, ..., M$. The variables x_s and z_s are exogenous, where x_s is a subset of z_s in order to identify the earnings equation. The error term in the earnings regression, μ_s, has $E(\mu_s|x, z) = 0$ and $V(\mu_s|x, z) = \sigma^2$.

The outcome variable, y_s, is observed if and only if the category s is chosen, which happens when

$$y_s^* > \max_{j \neq s}\left(y_j^*\right) \tag{B.2}$$

Equation B.2 is equivalent to:

$$z_s\gamma_s > \varepsilon_s \tag{B.3}$$

[1] The i subscript for individuals is suppressed.

where,

$$\varepsilon_s = \max_{j \neq s} \left(y_j^* - \eta_s \right) \tag{B.4}$$

Assume now that the η's are independent and identically Gumbel distributed. Thus, their cumulative and density functions are respectively $G(\eta) = \exp(-e^{-\eta})$ and $g(\eta) = \exp(-\eta - e^{-\eta})$. As shown by McFadden (1974), this specification leads to the multinomial logit model with:

$$P(y_s^*) = P(z_s \gamma_s > \varepsilon_s) = \frac{\exp z_s \gamma_s}{\sum\limits_j \exp z_j \gamma_j} \tag{B.5}$$

where $P(y_s^*)$ is the probability that category s was chosen. Based on this expression, maximum likelihood estimates of the γ_j's can be easily obtained.

Because the error terms μ_s and η_s's are correlated, ordinary least squares estimates of β_s are inconsistent. To obtain consistent estimates of β_4, since the observed outcome belongs to category $s = 4$, Bourguignon et al. (2001) propose estimating the following model. Define the following standard normal variables for $s = 1, ..., 4$:

$$\eta_s^* = J(\eta_s) = \Phi^{-1}(G(\eta_s)) \tag{B.6}$$

where Φ is the standard normal distribution function. For every s, assume that the expected values of μ_4 and η_s^* are linearly related. If $\tilde{\rho}_s$ is the correlation coefficient between μ_4 and η_s^*, i.e. $\tilde{\rho}_s = \frac{\sigma_{4\eta_s^*}}{\sigma_4 \sigma_{\eta_s^*}}$ (where $\sigma_{4\eta_s^*}$ is the correlation between μ_4 and η_s^*, σ_4 is the standard deviation of μ_4, and $\sigma_{\eta_s^*}$ is the standard deviation of η_s^*) then μ_4 can be expressed as the following linear combination of the η_s^*'s:

$$\mu_4 = \sigma_4 \sum_s \tilde{\rho}_s \eta_s^* + \omega_4 \tag{B.7}$$

where ω_4 is an error term which is orthogonal to all the η_s^*'s and $E(\omega_4) = 0$. This expression uses the fact that the η_s^*'s are independent from each other. In order to make the earnings regression, B.1a, estimable through ordinary least squares for

$s = 4$, it is necessary to know the expectation of μ_4 conditional on the fact that category $s = 4$ is observed. Using the preceding relationships and the independence of the error term ω_4 from the η_s^*'s gives:

$$E\left(\mu_4 | y_4^* > \max_{j \neq 4}\left(y_j^*\right)\right) = \sigma_4 \sum_s \tilde{\rho}_s E\left(\eta_s^* | y_4^* > \max_{j \neq 4}\left(y_j^*\right)\right) \tag{B.8}$$

with

$$E\left(\eta_s^* | y_4^* > \max_{j \neq 4}\left(y_j^*\right)\right) = \int J\left(\eta_s\right) f\left(\eta_s | y_4^* > \max_{j \neq 4}\left(y_j^*\right)\right) d\eta_s \tag{B.9}$$

Bourguignon et al. (2001) derive the conditional densities $f\left(\eta_s | y_4^* > \max_{j \neq 4}\left(y_j^*\right)\right)$. It follows from there that for η_4^*,

$$E\left(\eta_4^* | y_4^* > \max_{j \neq 4}\left(y_j^*\right)\right) = \int J\left(\eta_4\right) g\left(\eta_4 + \log P_4\right) d\eta_4 \tag{B.10}$$

where $P_s = P\left(y_s^*\right)$ is the probability that category s was chosen. Let $v = \eta_4 + \log P_4$. Then,

$$E\left(\eta_4^* | y_4^* > \max_{j \neq 4}\left(y_j^*\right)\right) = \int J\left(v - \log P_4\right) g\left(v\right) dv \tag{B.11}$$

For η_s^*, $s \neq 4$,

$$\begin{aligned} E\left(\eta_s^* | y_4^* > \max_{j \neq 4}\left(y_j^*\right)\right) &= \int J\left(\eta_s\right) \frac{1}{\left(1 - P_s\right)} \left[g\left(\eta_s\right) - e^{-\eta_s} \exp\left(\frac{-e^{-\eta_s}}{P_s}\right)\right] d\eta_s \\ &= \frac{1}{\left(1 - P_s\right)} \int J\left(\eta_s\right) g\left(\eta_s\right) d\eta_s - \frac{1}{\left(1 - P_s\right)} \int J\left(\eta_s\right) e^{-\eta_s} \exp\left(\frac{-e^{-\eta_s}}{P_s}\right) d\eta_s \end{aligned} \tag{B.12}$$

Let $v = \eta_s + \log P_s$ and notice that $\int J\left(\eta_s\right) g\left(\eta_s\right) d\eta_s = E\left(\eta_s^*\right) = 0$. Then,

$$E\left(\eta_s^* | y_4^* > \max_{j \neq 4}\left(y_j^*\right)\right) = \frac{P_s}{\left(P_s - 1\right)} \int J\left(v - \log P_s\right) g\left(v\right) dv \tag{B.13}$$

For convenience, let $m\left(P_s\right) = \int J\left(v - \log P_s\right) g\left(v\right) dv, \forall s$. Substituting equations B.11 and B.13 into equation B.8 gives:

$$E\left(\mu_4 | y_4^* > \max_{j \neq 4}\left(y_j^*\right)\right) = \sigma_4 \left[\tilde{\rho}_4 m\left(P_4\right) + \sum_{s<4} \tilde{\rho}_s \frac{P_s}{\left(P_s - 1\right)} m\left(P_s\right)\right] \tag{B.14}$$

Replacing the error term in the earnings regression (Equation B.1a) by its conditional expected value (Equation B.14) and a residual term (ν_4) gives:

$$y_4 = x_4\beta_4 + \sigma_4 \left[\tilde{\rho}_4 m\left(P_4\right) + \sum_{s<4} \tilde{\rho}_s \frac{P_s}{\left(P_s - 1\right)} m\left(P_s\right) \right] + \nu_4 \qquad \text{(B.15)}$$

where $\tilde{\rho}_s$ is the correlation coefficient between μ_4 and η_s^*, i.e. $\tilde{\rho}_s = \frac{\sigma_{4\eta_s^*}}{\sigma_4 \sigma_{\eta_s^*}}$, $P_s = P\left(y_s^*\right)$ is the probability that category s was chosen, $m\left(P_s\right) = \int J\left(v - \log P_s\right) g\left(v\right) dv$, $v = \eta_s + \log P_s$, and $J\left(\circ\right) = \Phi^{-1}\left(G\left(\circ\right)\right)$, for $s = 1, ..., 4$.

The error term ν_4 is now orthogonal to all other terms on the RHS and has zero expectation. Because of this property ordinary least squares may now be used to provide consistent estimates of the β_4's, $(\sigma_4\tilde{\rho}_1)$, $(\sigma_4\tilde{\rho}_2)$, $(\sigma_4\tilde{\rho}_3)$, and $(\sigma_4\tilde{\rho}_4)$.[2] The selectivity correction within the multinomial logit setup involves all correlation coefficients between the disturbance term of the earnings equation (μ_4) and the disturbance terms of all categorical latent expressions (η_s^* for $s = 1, ..., 4$).

In terms of practical implementation, the method consists of two steps. First, estimate the multinomial logit, and derive from it the predicted probabilities $\hat{P}_s$'s using the $\hat{\gamma}_s$'s. The integrals $m\left(P_s\right)$ have no analytical solution as functions of P_s, so they must be computed numerically. This is not a source of computational complexity, however, as it must be done only once for each observation. In the Stata ado program Bourguignon et al. (2001) compute these numerical integrals using the Gauss-Laguerre quadrature method. The abscissas and weight factors used in the program are from Davis & Polonsky (1964). Second, estimate Equation B.15 by ordinary least squares.

[2]Note that in the second stage, if one is interested in the values of $\tilde{\rho}_1$, $\tilde{\rho}_2$, $\tilde{\rho}_3$, and $\tilde{\rho}_4$, full identification is provided by estimating σ_4 from the residuals of the earnings equation (Equation B.1a) where σ_4 is the standard deviation of μ_4. More directly, non-linear least squares may also be used.

Appendix C

Map and Tables

C.1 Map of India

Figure C.1: Map of India

C.2 Tables

Table C.1: India in Comparative Perspective, 1999

Country	**Population**	**Per Capita Income**	**Illiteracy Rate**	
	(billion)	(U.S.$)	Male	Female
South Asia	1.4	450.00	33	56
Low Income Countries	2.5	430.00	28	46
India	1.0	460.00	31	54

Source: World Development Indicators, 1999.

Illiteracy Rate: Percentage of illiterates in the age group 15 years and above. South Asia includes Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka, as defined by the World Bank. Low-income countries are defined by the World Bank as those with a per capita income of US $745 or less.

Table C.2: Child Labor, Illiteracy Rate, and Gross Primary Enrollment Ratio, by Income Group and Region, 1999

Category	**Child Labor**	**Illiteracy Rate**	**Primary Enrollment**
Income Group			
Low Income	21	46	86
Lower Middle Income	8	16	115
Upper Middle Income	9	12	104
High Income	0	0	103
Region			
East Asia & Pacific	10	16	120
Europe & Central Asia	4	4	99
Latin America & Caribbean	9	13	105
Middle East & North Africa	5	38	98
South Asia	16	49	90
Sub-Saharan Africa	30	12	76
India	14	47	97
World	13	26	102

Source: World Development Indicators, 1999.

Child Labor: Proportion of children aged 10-14 that are employed. Primary Enrollment: Proportion of children enrolled in primary school. These figures are reported for 1990.

Table C.3: Regional and Social Disparities in Literacy Rates in India, 2001

Region/State/Caste	**Gender**		
	Male	Female	Total
Urban	86.42	72.99	80.06
Rural	71.18	46.58	59.21
Kerala	94.20	87.86	90.92
Bihar	60.32	33.57	47.53
Scheduled Castes	49.91	23.76	37.41
Scheduled Tribes	40.65	18.10	29.60
India	75.64	54.03	65.20

Source: Census of India, 2001.

Table C.4: Child Labor & Education in India - A Legislative Review

Year	Legislation	Summary
	Child Labor Legislation	
1881	Factories Act	Imposed minimum working age of 7 years.
1922	Factories Act	Raised minimum age for factory employment to 15 years.
1923	Mines Act	Raised minimum age for employment in mines to 13 years.
1938	Employment of Children Act	Prohibited child labor in hazardous occupations and processes.
1948	Factories Act	Lowered minimum age for factory employment to 14 years.
1951	Plantations Labor Act	Set minimum age for employment on plantations as 12 years.
1952	Mines Act	Raised minimum age for employment in mines to 15 years.
1954	Factories Act	Prohibited factory employment of adolescents under 17 years at night.
1966	Bidi & Cigar Workers Act	Set minimum age for employment in bidi or cigar factories as 14 years.
1986	Child Labor Prohibition & Regulation Act	Prohibited child labor in hazardous occupations and processes & Regulated work conditions in other jobs.
	Education Legislation	
1950	Article 45, Constitution	Provision of free & compulsory education for children below the age of 14.
1986	National Policy on Education	Creation of model district schools for high-achieving rural youth & Universalization of education via Operation Blackboard & Non-Formal Education.

Source: Murphy & Welch (1991).

Table C.5: Child Labor in India: Girls (1983-1999)

State/Union Territory	1983	1988	1993	1999	83-88	88-93	93-99
Andhra Pradesh	27.69	46.78	33.84	26.61	19.10	-12.94	-7.23
Arunachal Pradesh	0.00	49.59	39.24	43.79	49.59	-10.34	4.55
Assam	11.45	30.87	23.60	27.08	19.42	-7.27	3.48
Bihar	25.09	66.72	50.80	54.51	41.63	-15.92	3.72
Goa, Daman & Diu	12.95	12.80	11.46	16.37	-0.15	-1.34	4.91
Gujarat	21.09	38.43	31.18	30.03	17.34	-7.25	-1.15
Haryana	27.14	43.55	23.82	19.61	16.41	-19.73	-4.21
Himachal Pradesh	17.69	30.39	17.75	8.95	12.70	-12.63	-8.80
Jammu and Kashmir	19.10	51.36	27.43	21.62	32.26	-23.93	-5.81
Karnataka	26.68	41.36	25.37	24.73	14.69	-15.99	-0.64
Kerala	6.31	10.36	4.61	5.38	4.06	-5.75	0.76
Madhya Pradesh	24.29	58.41	41.92	38.31	34.12	-16.49	-3.61
Maharashtra	18.22	30.87	20.38	18.00	12.65	-10.48	-2.39
Manipur	5.24	20.53	11.59	13.96	15.29	-8.95	2.37
Meghalaya	10.90	46.22	20.35	18.52	35.32	-25.87	-1.83
Mizoram	1.92	25.29	10.38	22.30	23.37	-14.91	11.92
Nagaland	3.57	18.03	9.40	8.29	14.46	-8.63	-1.12
Orissa	27.29	47.26	38.07	33.17	19.98	-9.19	-4.90
Punjab	19.07	32.53	20.41	15.88	13.46	-12.12	-4.53
Rajasthan	38.83	67.49	53.12	39.26	28.66	-14.37	-13.86
Sikkim	14.60	27.18	9.25	13.72	12.58	-17.93	4.47
Tamil Nadu	21.40	26.79	17.19	12.66	5.39	-9.60	-4.53
Tripura	7.73	34.33	13.60	15.31	26.59	-20.73	1.71
Uttar Pradesh	24.04	61.32	46.59	36.98	37.29	-14.73	-9.61
West Bengal	22.83	43.32	31.56	26.85	20.50	-11.77	-4.70
Andaman & Nicobar Islands	5.24	14.81	13.89	24.25	9.57	-0.92	10.36
Chandigarh	12.31	10.74	9.68	9.74	-1.58	-1.06	0.06
Dadra & Nagar Haveli	29.97	65.76	56.59	31.01	35.79	-9.17	-25.58
Delhi	11.01	12.24	11.43	12.42	1.23	-0.81	0.99
Lakshadweep	0.00	25.64	1.82	3.33	25.64	-23.82	1.52
Pondicherry	16.56	19.59	3.36	6.79	3.04	-16.23	3.43
All India	21.82	44.42	31.70	29.14	22.60	-12.72	-2.56

Source: NSSO Data, 1983, 1988, 1993, and 1999. The figures reported are the total number of hours spent working (market work, household enterprise work, and domestic work) as a percentage of the total number of hours spent in all activities (which includes hours spent doing nothing - i.e. neither work nor school). The change in child labor is in percentage points.

Table C.6: Child Labor in India: Boys (1983-1999)

State/Union Territory	1983	1988	1993	1999	83-88	88-93	93-99
Andhra Pradesh	19.39	32.50	22.42	19.13	13.11	-10.08	-3.29
Arunachal Pradesh	0.00	50.55	34.84	45.59	50.55	-15.71	10.75
Assam	7.65	27.57	20.95	20.98	19.92	-6.62	0.03
Bihar	12.56	49.89	34.02	43.02	37.33	-15.87	9.00
Goa, Daman & Diu	6.90	7.52	7.40	13.94	0.62	-0.12	6.54
Gujarat	9.58	27.84	20.59	20.35	18.26	-7.25	-0.25
Haryana	10.39	25.35	14.83	14.74	14.96	-10.52	-0.09
Himachal Pradesh	6.39	14.59	8.80	5.67	8.20	-5.79	-3.13
Jammu and Kashmir	8.72	31.56	15.15	13.94	22.84	-16.40	-1.21
Karnataka	17.13	31.87	19.73	21.05	14.74	-12.14	1.31
Kerala	4.43	7.53	4.66	4.60	3.10	-2.87	-0.06
Madhya Pradesh	14.29	39.11	28.80	28.52	24.81	-10.31	-0.27
Maharashtra	10.82	21.51	13.98	14.23	10.68	-7.53	0.24
Manipur	2.58	17.88	11.51	11.28	15.30	-6.37	-0.23
Meghalaya	8.75	54.40	19.26	17.43	45.66	-35.15	-1.83
Mizoram	2.66	25.41	11.05	17.63	22.74	-14.35	6.58
Nagaland	1.37	24.21	10.43	8.78	22.84	-13.78	-1.64
Orissa	13.43	32.86	27.93	25.00	19.44	-4.94	-2.93
Punjab	13.60	25.76	13.48	13.02	12.16	-12.28	-0.46
Rajasthan	16.63	36.98	24.16	17.90	20.35	-12.82	-6.25
Sikkim	8.97	20.86	6.48	13.46	11.89	-14.38	6.98
Tamil Nadu	10.95	15.46	11.70	9.35	4.51	-3.76	-2.35
Tripura	6.13	31.64	13.11	11.29	25.51	-18.53	-1.81
Uttar Pradesh	12.70	41.46	27.42	24.75	28.77	-14.04	-2.67
West Bengal	15.82	36.49	24.16	22.07	20.66	-12.33	-2.09
Andaman & Nicobar Islands	3.91	11.08	15.96	21.23	7.17	4.87	5.27
Chandigarh	4.88	15.96	6.35	7.19	11.08	-9.61	0.84
Dadra & Nagar Haveli	21.96	51.61	42.36	39.70	29.66	-9.25	-2.66
Delhi	5.66	10.11	6.89	10.22	4.44	-3.22	3.33
Lakshadweep	0.00	7.56	2.04	6.35	7.56	-5.52	4.31
Pondicherry	4.62	11.02	5.71	4.77	6.39	-5.30	-0.94
All India	12.21	31.94	21.66	21.65	19.73	-10.28	-0.01

Source: NSSO Data, 1983, 1988, 1993, and 1999. The figures reported are the total number of hours spent working (market work, household enterprise work, and domestic work) as a percentage of the total number of hours spent in all activities (which includes hours spent doing nothing - i.e. neither work nor school). The change in child labor is in percentage points.

Table C.7: Schooling in India: Girls (1983-1999)

State/Union Territory	1983	1988	1993	1999	83-88	88-93	93-99
Andhra Pradesh	46.58	52.64	65.29	72.74	6.06	12.66	7.45
Arunachal Pradesh	47.83	48.06	60.58	56.21	0.24	12.52	-4.37
Assam	58.52	68.18	76.35	72.78	9.66	8.17	-3.57
Bihar	24.97	33.15	48.98	45.40	8.18	15.84	-3.58
Goa, Daman & Diu	69.06	87.20	88.54	83.20	18.14	1.34	-5.34
Gujarat	52.41	61.00	68.48	69.71	8.59	7.49	1.23
Haryana	40.43	56.33	75.79	80.15	15.90	19.46	4.36
Himachal Pradesh	59.55	69.11	82.25	90.91	9.56	13.14	8.66
Jammu and Kashmir	38.76	48.40	72.38	78.17	9.64	23.97	5.79
Karnataka	45.43	57.77	74.24	75.17	12.34	16.47	0.93
Kerala	87.44	89.32	95.21	94.53	1.88	5.89	-0.68
Madhya Pradesh	34.73	41.51	57.90	61.61	6.77	16.39	3.72
Maharashtra	59.31	68.96	79.37	81.49	9.65	10.41	2.12
Manipur	58.46	79.28	88.30	85.86	20.81	9.02	-2.43
Meghalaya	64.86	53.26	79.65	81.48	-11.60	26.39	1.83
Mizoram	74.55	74.42	89.62	77.34	-0.13	15.20	-12.28
Nagaland	91.07	81.97	90.60	91.71	-9.10	8.63	1.12
Orissa	38.21	52.35	61.82	66.52	14.14	9.47	4.70
Punjab	61.32	67.12	79.52	84.12	5.81	12.40	4.59
Rajasthan	24.67	32.24	45.87	60.66	7.57	13.63	14.79
Sikkim	74.97	72.49	90.75	86.28	-2.48	18.26	-4.47
Tamil Nadu	62.02	72.67	82.32	87.08	10.65	9.65	4.76
Tripura	39.96	65.15	86.40	84.53	25.19	21.25	-1.87
Uttar Pradesh	29.60	38.53	53.19	62.85	8.92	14.67	9.66
West Bengal	52.34	56.45	68.18	72.65	4.11	11.73	4.47
Andaman & Nicobar Islands	80.50	85.00	85.82	75.75	4.49	0.82	-10.07
Chandigarh	66.58	89.26	88.71	90.06	22.69	-0.55	1.35
Dadra & Nagar Haveli	32.65	34.24	43.41	68.22	1.59	9.17	24.81
Delhi	80.90	87.53	88.25	87.38	6.63	0.73	-0.87
Lakshadweep	100.00	74.36	98.18	96.67	-25.64	23.82	-1.52
Pondicherry	74.70	79.97	96.64	93.21	5.27	16.67	-3.43
All India	46.51	55.23	68.00	70.63	8.72	12.77	2.63

Source: NSSO Data, 1983, 1988, 1993, and 1999. The figures reported are the total number of hours spent attending school as a percentage of the total number of hours spent in all activities (which includes hours spent doing nothing - i.e. neither work nor school). The change in schooling is in percentage points.

Table C.8: Schooling in India: Boys (1983-1999)

State/Union Territory	1983	1988	1993	1999	83-88	88-93	93-99
Andhra Pradesh	62.69	67.09	77.32	80.36	4.39	10.23	3.04
Arunachal Pradesh	68.42	48.31	64.83	54.41	-20.11	16.52	-10.42
Assam	61.28	70.63	78.73	78.60	9.35	8.11	-0.14
Bihar	46.94	49.84	65.86	56.77	2.90	16.02	-9.08
Goa, Daman & Diu	78.62	91.35	92.60	85.35	12.72	1.26	-7.25
Gujarat	65.37	71.44	78.94	79.46	6.07	7.50	0.53
Haryana	69.35	73.78	85.06	85.05	4.43	11.29	-0.02
Himachal Pradesh	79.99	85.08	91.07	94.33	5.09	5.99	3.26
Jammu and Kashmir	58.30	67.87	84.69	85.60	9.57	16.82	0.92
Karnataka	59.07	67.59	80.08	78.56	8.52	12.49	-1.52
Kerala	89.28	91.77	95.10	95.03	2.50	3.32	-0.07
Madhya Pradesh	55.38	60.51	71.04	71.17	5.12	10.54	0.13
Maharashtra	71.85	78.15	85.55	85.40	6.30	7.41	-0.15
Manipur	56.46	81.77	88.49	88.72	25.31	6.72	0.23
Meghalaya	65.67	45.60	80.58	82.57	-20.08	34.99	1.99
Mizoram	71.68	74.59	88.85	82.37	2.91	14.26	-6.49
Nagaland	82.19	75.79	89.57	91.22	-6.40	13.78	1.64
Orissa	57.34	66.71	71.74	74.84	9.37	5.03	3.10
Punjab	70.33	73.60	86.12	86.50	3.27	12.52	0.38
Rajasthan	55.83	62.67	74.98	81.82	6.85	12.31	6.84
Sikkim	80.77	79.14	93.52	86.39	-1.63	14.38	-7.14
Tamil Nadu	76.72	83.51	87.54	89.97	6.79	4.03	2.43
Tripura	43.42	68.00	86.89	88.71	24.57	18.90	1.81
Uttar Pradesh	51.54	58.19	72.10	75.03	6.65	13.91	2.93
West Bengal	60.96	63.05	75.64	77.05	2.08	12.59	1.41
Andaman & Nicobar Islands	83.80	88.74	84.04	78.77	4.93	-4.69	-5.27
Chandigarh	85.37	84.04	93.65	92.81	-1.32	9.61	-0.84
Dadra & Nagar Haveli	50.37	48.39	56.94	60.30	-1.98	8.56	3.36
Delhi	88.16	89.47	92.84	89.78	1.31	3.36	-3.05
Lakshadweep	83.33	90.76	97.96	93.65	7.42	7.20	-4.31
Pondicherry	88.61	88.12	93.63	95.23	-0.49	5.51	1.60
All India	61.82	67.54	78.02	78.03	5.72	10.47	0.01

Source: NSSO Data, 1983, 1988, 1993, and 1999. The figures reported are the total number of hours spent attending school as a percentage of the total number of hours spent in all activities (which includes hours spent doing nothing - i.e. neither work nor school). The change in schooling is in percentage points.

Table C.9: Child Labor & Schooling in India (1983-1999)

State/Union Territory	1983	1988	1993	1999	83-88	88-93	93-99
All India							
School	54.58	61.74	73.35	74.53	7.17	11.61	1.18
Work	16.76	37.82	26.34	25.19	21.06	-11.48	-1.15
Neither	28.67	0.44	0.31	0.28	-28.23	-0.13	-0.03
Urban							
School	72.10	75.88	83.72	82.87	3.78	7.84	-0.85
Work	9.39	23.72	15.97	16.87	14.34	-7.76	0.90
Neither	18.51	0.40	0.32	0.26	-18.11	-0.08	-0.06
Rural							
School	46.00	54.95	67.33	69.83	8.95	12.37	2.51
Work	20.36	44.58	32.36	29.87	24.22	-12.22	-2.49
Neither	33.64	0.46	0.31	0.29	-33.18	-0.15	-0.02
Male							
School	61.82	67.54	78.02	78.03	5.72	10.47	0.01
Work	12.21	31.94	21.66	21.65	19.73	-10.28	-0.01
Neither	25.97	0.52	0.33	0.33	-25.45	-0.19	0.00
Female							
School	46.51	55.23	68.00	70.63	8.72	12.77	2.63
Work	21.82	44.42	31.70	29.14	22.60	-12.72	-2.56
Neither	31.67	0.35	0.30	0.23	-31.32	-0.05	-0.07

Source: NSSO Data, 1983, 1988, 1993, and 1999. The figures reported are the total number of hours spent working (market work, household enterprise work, and domestic work), attending school, or doing nothing (neither work nor school) as a percentage of the total number of hours spent in all activities. All changes are in percentage points.

Table C.10: Description of Dependent and Independent Variables

Variable	Description	Expected Sign CL	CS
Dependent Variables			
$ChildLabor-ftpt_{ikjt}$	1 if child worked full time or part time during past week, 0 otherwise		
$School-ftpt_{ikjt}$	1 if child attended school full time or part time during past week, 0 otherwise		
$ChildLabor-ft_{ikjt}$	1 if child worked full time during past week, 0 otherwise		
$School-ft_{ikjt}$	1 if child attended school full time during past week, 0 otherwise		
$ChildLabor\&Schooling-pt_{ikjt}$	1 if child worked and attended school part time during past week, 0 otherwise		
Independent Variables			
$Rate-Primary_{gjt}$	Rate of return to primary school	-	+
$Rate-Middle_{gjt}$	Rate of return to middle school	-	+
$Children_{kjt}$	Number of children	+	-
$F-Primary_{kjt}$	1 if father has primary education, 0 otherwise	-	+
$F-Middle_{kjt}$	1 if father has middle education, 0 otherwise	-	+
$F-High_{kjt}$	1 if father has high school education, 0 otherwise	-	+
$F-College_{kjt}$	1 if father has college education, 0 otherwise	-	+
$M-Primary_{kjt}$	1 if mother has primary education, 0 otherwise	-	+
$M-Middle_{kjt}$	1 if mother has middle education, 0 otherwise	-	+
$M-High_{kjt}$	1 if mother has high school education, 0 otherwise	-	+
$M-College_{kjt}$	1 if mother has college education, 0 otherwise	-	+
$Urban_{kjt}$	1 if household resides in urban region, 0 otherwise	+	-
$Lowcaste_{kjt}$	1 if household is lowcaste, 0 otherwise	+	-
$Muslim_{kjt}$	1 if household is Muslim, 0 otherwise	+	-
$WorkingMother_{kjt}$	1 if mother works outside the household, 0 otherwise	+	-
$LogExpenditure_{kjt}$	Household monthly per capita consumption expenditure	-	+
$Asset_{kjt}$	1 if household owns land, 0 otherwise	-	+
Age_{ikjt}	Child's age in years	+	-
$Agesq_{ikjt}$	Square of child's age in years		
$Male_{ikjt}$	1 if child is male, 0 otherwise	+	-
$Season_s$	1 if household surveyed during season s, 0 otherwise		
$Year_t$	1 if year t, 0 otherwise		
$State_j$	1 if state j, 0 otherwise		

The subscript i represents each child, k each household, j each state, t each year, g each gender, and s each season.

Table C.11: Summary Statistics of Dependent and Independent Variables

Variable	Mean	Standard Deviation
Dependent Variables		
$ChildLabor-ftpt$	0.2926	0.4550
$School-ftpt$	0.6522	0.4763
$ChildLabor-ft$	0.2643	0.4409
$School-ft$	0.6271	0.4836
$ChildLabor\&School-pt$	0.0251	0.1564
Independent Variables		
$Rate-Primary$	0.0384	0.0698
$Rate-Middle$	0.0587	0.1514
$Rate-High$	0.1288	0.1753
$Rate-College$	0.1175	0.1741
$Year-83$	0.2726	0.4453
$Year-88$	0.2714	0.4447
$Year-93$	0.2212	0.4151
$Year-99$	0.2348	0.4238
$Children$	4.0250	1.7634
$Father-None$	0.5321	0.4990
$Father-Primary$	0.1485	0.3556
$Father-Middle$	0.1289	0.3351
$Father-High$	0.1333	0.3399
$Father-College$	0.0572	0.2322
$Mother-None$	0.7409	0.4381
$Mother-Primary$	0.1052	0.3068
$Mother-Middle$	0.0755	0.2643
$Mother-High$	0.0587	0.2351
$Mother-College$	0.0196	0.1386
$WorkingMother$	0.3284	0.4696
$LogExpenditure$	5.0487	0.5982
$Asset$	0.6669	0.4713
Age	9.3615	2.8263
$Agesq$	95.6251	53.7571
$Urban$	0.3427	0.4746
$Lowcaste$	0.3529	0.4779
$Muslim$	0.1505	0.3576
$July-Sep$	0.2492	0.4325
$Oct-Dec$	0.2523	0.4343
$Jan-March$	0.2476	0.4316
$April-June$	0.2509	0.4335
$Male$	0.5287	0.4992

Source: NSSO Data, 1983, 1988, 1993, and 1999.

Per capita monthly household expenditure ($LogExpenditure$) is adjusted to 1988 Rupees.

Table C.12: Probit Estimates for Participation in Full Time or Part Time Child Labor (Correcting Standard Errors for Clustering)

Variable	All Children	Robust Standard Error	Interaction with Male Dummy	Robust Standard Error
$Rate - Primary$	-0.0358	0.1081	-0.4042	0.1723**
$Rate - Middle$	-0.1014	0.0527*	0.0498	0.0797
$Year - 88$	0.2824	0.0244***	0.0009	0.0158
$Year - 93$	0.2284	0.0248***	0.0020	0.0174
$Year - 99$	0.2021	0.0222***	0.0402	0.0166**
$Children$	0.0205	0.0037***	0.0036	0.0011***
$Father - Primary$	-0.1107	0.0058***	0.0074	0.0054
$Father - Middle$	-0.1420	0.0070***	0.0063	0.0062
$Father - High$	-0.1750	0.0085***	0.0252	0.0067***
$Father - College$	-0.1763	0.0097***	0.0067	0.0115
$Mother - Primary$	-0.0998	0.0061***	0.0703	0.0082***
$Mother - Middle$	-0.0908	0.0087***	0.0760	0.0099***
$Mother - High$	-0.0685	0.0150***	0.0866	0.0129***
$Mother - College$	-0.0476	0.0177**	0.0948	0.0187***
$WorkingMother$	0.0630	0.0070***	-0.0225	0.0062***
$LogExpenditure$	-0.0784	0.0075***	0.0046	0.0053
$Asset$	-0.0070	0.0075	-0.0155	0.0056***
Age	-0.1567	0.0151***	-0.0302	0.0046***
$Agesq$	0.0089	0.0005***	0.0006	0.0002***
$Urban$	-0.0797	0.0062***	0.0318	0.0062***
$Lowcaste$	0.0514	0.0058***	0.0020	0.0046
$Muslim$	0.0563	0.0108***	0.0034	0.0076
$Oct - Dec$	-0.0051	0.0059	-0.0031	0.0052
$Jan - March$	-0.0204	0.0062***	-0.0036	0.0051
$April - June$	0.0005	0.0085	0.0039	0.0059
$Male$	0.0800	0.0412*		
N	440039			
Predicted DV	0.2476			
Pseudo R-Square	0.1836			

Marginal effects of independent variables and interactions of all independent variables with the male dummy are reported. Robust standard errors, corrected for clustering at the year-state level: *Significant at 10%, **Significant at 5%, ***Significant at 1%.

Table C.13: Probit Estimates for Participation in Full Time or Part Time Schooling (Correcting Standard Errors for Clustering)

Variable	All Children	Robust Standard Error	Interaction with Male Dummy	Robust Standard Error
$Rate-Primary$	-0.1031	0.1119	0.5693	0.1540***
$Rate-Middle$	0.0174	0.0439	0.1168	0.0591**
$Year-88$	0.0491	0.0142***	-0.0185	0.0225
$Year-93$	0.1432	0.0135***	-0.0077	0.0221
$Year-99$	0.1903	0.0111***	-0.0547	0.0208***
$Children$	0.0010	0.0015	-0.0010	0.0012
$Father-Primary$	0.1480	0.0044***	-0.0201	0.0048***
$Father-Middle$	0.1856	0.0049***	-0.0151	0.0061**
$Father-High$	0.2207	0.0070***	-0.0221	0.0066***
$Father-College$	0.2274	0.0075***	-0.0168	0.0131
$Mother-Primary$	0.1308	0.0057***	-0.0737	0.0088
$Mother-Middle$	0.1377	0.0067***	-0.0894	0.0111
$Mother-High$	0.1250	0.0097***	-0.0812	0.0136
$Mother-College$	0.1226	0.0162***	-0.1180	0.0252
$WorkingMother$	-0.0788	0.0073***	0.0401	0.0076
$LogExpenditure$	0.1277	0.0059***	-0.0112	0.0062*
$Asset$	0.0113	0.007	0.0220	0.0057***
Age	0.2619	0.0092***	0.0335	0.0046***
$Agesq$	-0.0135	0.0003***	-0.0009	0.0002***
$Urban$	0.1104	0.0086***	-0.0517	0.0080***
$Lowcaste$	-0.0633	0.0062***	-0.0066	0.0058
$Muslim$	-0.1041	0.0117***	-0.0095	0.0092
$Oct-Dec$	-0.0100	0.0051*	-0.0041	0.0054
$Jan-March$	0.0086	0.0052	-0.0009	0.0048
$April-June$	-0.0395	0.0101***	-0.0118	0.0062*
$Male$	-0.0323	0.0432		
N	440039			
Predicted DV	0.7074			
Pseudo R-Square	0.2508			

Marginal effects of independent variables and interactions of all independent variables with the male dummy are reported. Robust standard errors, corrected for clustering at the year-state level: *Significant at 10%, **Significant at 5%, ***Significant at 1%.

Table C.14: Probit Estimates for Participation in Full Time or Part Time Child Labor (Without Correcting Standard Errors for Clustering)

Variable	All Children	Standard Error	Interaction with Male Dummy	Standard Error
$Rate-Primary$	-0.0358	0.0173**	-0.4042	0.0311***
$Rate-Middle$	-0.1014	0.0079***	0.0498	0.0131***
$Year-88$	0.2824	0.0032***	0.0009	0.0040
$Year-93$	0.2284	0.0036***	0.0020	0.0045
$Year-99$	0.2021	0.0037***	0.0402	0.0048***
$Children$	0.0205	0.0005***	0.0036	0.0007***
$Father-Primary$	-0.1107	0.0023***	0.0074	0.0042*
$Father-Middle$	-0.1420	0.0024***	0.0063	0.0049
$Father-High$	-0.1750	0.0025***	0.0252	0.0059***
$Father-College$	-0.1763	0.0035***	0.0067	0.0096
$Mother-Primary$	-0.0998	0.0030***	0.0703	0.0061***
$Mother-Middle$	-0.0908	0.0039***	0.0760	0.0078***
$Mother-High$	-0.0685	0.0053***	0.0866	0.0099***
$Mother-College$	-0.0476	0.0098***	0.0948	0.0178***
$WorkingMother$	0.0630	0.0023***	-0.0225	0.0029***
$LogExpenditure$	-0.0784	0.0021***	0.0046	0.0030
$Asset$	-0.0070	0.0025***	-0.0155	0.0034***
Age	-0.1567	0.0026***	-0.0302	0.0036***
$Agesq$	0.0089	0.0001***	0.0006	0.0001***
$Urban$	-0.0797	0.0025***	0.0318	0.0039***
$Lowcaste$	0.0514	0.0024***	0.0020	0.0032
$Muslim$	0.0563	0.0032***	0.0034	0.0041
$Oct-Dec$	-0.0051	0.0027*	-0.0031	0.0038
$Jan-March$	-0.0204	0.0027***	-0.0036	0.0039
$April-June$	0.0005	0.0027	0.0039	0.0039
$Male$	0.0800	0.0219***		
N	440039			
Predicted DV	0.2476			
Pseudo R-Square	0.1836			

Marginal effects of independent variables and interactions of all independent variables with the male dummy are reported. Standard errors, not corrected for clustering at the year-state level: *Significant at 10%, **Significant at 5%, ***Significant at 1%.

Table C.15: Probit Estimates for Participation in Full Time or Part Time Schooling (Without Correcting Standard Errors for Clustering)

Variable	All Children	Standard Error	Interaction with Male Dummy	Standard Error
$Rate - Primary$	-0.1031	0.0193***	0.5693	0.0343***
$Rate - Middle$	0.0174	0.0089*	0.1168	0.0143***
$Year - 88$	0.0491	0.0029***	-0.0185	0.0042***
$Year - 93$	0.1432	0.0028***	-0.0077	0.0047
$Year - 99$	0.1903	0.0027***	-0.0547	0.0051***
$Children$	0.0010	0.0006	-0.0010	0.0008
$Father - Primary$	0.1480	0.0025***	-0.0201	0.0046***
$Father - Middle$	0.1856	0.0025***	-0.0151	0.0054***
$Father - High$	0.2207	0.0027***	-0.0221	0.0064***
$Father - College$	0.2274	0.0037***	-0.0168	0.0114
$Mother - Primary$	0.1308	0.0033***	-0.0737	0.0065***
$Mother - Middle$	0.1377	0.0042***	-0.0894	0.0088***
$Mother - High$	0.1250	0.0057***	-0.0812	0.0116***
$Mother - College$	0.1226	0.0108***	-0.1180	0.0224***
$WorkingMother$	-0.0788	0.0025***	0.0401	0.0031***
$LogExpenditure$	0.1277	0.0024***	-0.0112	0.0033***
$Asset$	0.0113	0.0028***	0.0220	0.0037***
Age	0.2619	0.0029***	0.0335	0.0040***
$Agesq$	-0.0135	0.0001***	-0.0009	0.0002***
$Urban$	0.1104	0.0027***	-0.0517	0.0042***
$Lowcaste$	-0.0633	0.0027***	-0.0066	0.0036*
$Muslim$	-0.1041	0.0036***	-0.0095	0.0045**
$Oct - Dec$	-0.0100	0.0031***	-0.0041	0.0043
$Jan - March$	0.0086	0.0031***	-0.0009	0.0043
$April - June$	-0.0395	0.0031***	-0.0118	0.0043***
$Male$	-0.0323	0.0250		
N	440039			
Predicted DV	0.7074			
Pseudo R-Square	0.2508			

Marginal effects of independent variables and interactions of all independent variables with the male dummy are reported. Standard errors, not corrected for clustering at the year-state level: *Significant at 10%, **Significant at 5%, ***Significant at 1%.

Table C.16: Probit Estimates for Participation in Full Time or Part Time Child Labor (Excluding Domestic Chores from Child Labor)

Variable	All Children	Robust Standard Error	Interaction with Male Dummy	Robust Standard Error
$Rate-Primary$	-0.0687	0.0875	-0.2198	0.1528
$Rate-Middle$	-0.1108	0.0403***	0.0984	0.0652
$Year-88$	0.3781	0.0277***	-0.0733	0.0108***
$Year-93$	0.3415	0.0276***	-0.0740	0.0106***
$Year-99$	0.3426	0.0275***	-0.0644	0.0110***
$Children$	0.0217	0.0032***	-0.0002	0.0009
$Father-Primary$	-0.0834	0.0046***	-0.0079	0.0044*
$Father-Middle$	-0.1043	0.0057***	-0.0142	0.0050***
$Father-High$	-0.1238	0.0076***	-0.0115	0.0058*
$Father-College$	-0.1208	0.0090***	-0.0354	0.0088***
$Mother-Primary$	-0.0654	0.0055***	0.0291	0.0065***
$Mother-Middle$	-0.0542	0.0082***	0.0257	0.0074***
$Mother-High$	-0.0367	0.0132***	0.0387	0.0097***
$Mother-College$	-0.0257	0.0156	0.0514	0.0159***
$WorkingMother$	0.0646	0.0084***	-0.0289	0.0066***
$LogExpenditure$	-0.0603	0.0069***	-0.0029	0.0052
$Asset$	-0.0004	0.0066	-0.0217	0.0046***
Age	-0.1174	0.0090***	-0.0528	0.0068***
$Agesq$	0.0053	0.0003***	0.0034	0.0003***
$Urban$	-0.0537	0.0050***	0.0145	0.0048***
$Lowcaste$	0.0437	0.0052***	-0.0012	0.0041
$Muslim$	0.0334	0.0106***	0.0149	0.0072**
$Oct-Dec$	-0.0010	0.0062	-0.0046	0.0052
$Jan-March$	-0.0076	0.0068	-0.0101	0.0043**
$April-June$	0.0110	0.0075	-0.0040	0.0047
$Male$	0.2601	0.0387***		
N	440039			
Predicted DV	0.1965			
Pseudo R-Square	0.1796			

Marginal effects of independent variables and interactions of all independent variables with the male dummy are reported. Robust standard errors, corrected for clustering at the year-state level: *Significant at 10%, **Significant at 5%, ***Significant at 1%.

Table C.17: Probit Estimates for Participation in Full Time Child Labor

Variable	All Children	Robust Standard Error	Interaction with Male Dummy	Robust Standard Error
$Rate - Primary$	0.0147	0.0840	-0.2857	0.1419**
$Rate - Middle$	-0.0488	0.0405	-0.0193	0.0625
$Year - 88$	0.2857	0.0203***	-0.0013	0.0146
$Year - 93$	0.1839	0.0234***	-0.0040	0.0171
$Year - 99$	0.1331	0.0198***	0.0312	0.0148**
$Children$	-0.0006	0.0011	0.0009	0.0010
$Father - Primary$	-0.1003	0.0051***	0.0034	0.0047
$Father - Middle$	-0.1321	0.0060***	0.0024	0.0055
$Father - High$	-0.1606	0.0072***	0.0144	0.0060**
$Father - College$	-0.1631	0.0081***	0.0112	0.0123
$Mother - Primary$	-0.1032	0.0042***	0.0639	0.0080***
$Mother - Middle$	-0.1117	0.0058***	0.0778	0.0108***
$Mother - High$	-0.1083	0.0080***	0.0880	0.0134***
$Mother - College$	-0.1074	0.0113***	0.1137	0.0236***
$WorkingMother$	0.0564	0.0057***	-0.0210	0.0057***
$LogExpenditure$	-0.0852	0.0071***	-0.0018	0.0048
$Asset$	-0.0053	0.0064	-0.0146	0.0053***
Age	-0.1527	0.0150***	-0.0297	0.0042***
$Agesq$	0.0087	0.0005***	0.0006	0.0002***
$Urban$	-0.0744	0.0055***	0.0298	0.0061***
$Lowcaste$	0.0448	0.0057***	0.0044	0.0046
$Muslim$	0.0745	0.0090***	0.0077	0.0068
$Oct - Dec$	0.0129	0.0038***	0.0020	0.0049
$Jan - March$	0.0029	0.0039	0.0027	0.0046
$April - June$	0.0347	0.0083***	0.0122	0.0055**
$Male$	0.1157	0.0369***		
N	440039			
Predicted DV	0.2073			
Pseudo R-Square	0.2078			

Marginal effects of independent variables and interactions of all independent variables with the male dummy are reported. Robust standard errors, corrected for clustering at the year-state level: *Significant at 10%, **Significant at 5%, ***Significant at 1%.

Table C.18: Probit Estimates for Participation in Full Time Schooling

Variable	All Children	Robust Standard Error	Interaction with Male Dummy	Robust Standard Error
$Rate - Primary$	-0.0498	0.1408	0.7079	0.1893***
$Rate - Middle$	0.0710	0.0607	0.0437	0.0787
$Year - 88$	0.0624	0.0224***	-0.0246	0.0226
$Year - 93$	0.1123	0.0205***	-0.0178	0.0217
$Year - 99$	0.1385	0.0222***	-0.0666	0.0212***
$Children$	-0.0229	0.0044***	-0.0025	0.0012**
$Father - Primary$	0.1551	0.0056***	-0.0233	0.0051***
$Father - Middle$	0.1908	0.0071***	-0.0192	0.0065***
$Father - High$	0.2300	0.0095***	-0.0345	0.0069***
$Father - College$	0.2356	0.0107***	-0.0130	0.0121
$Mother - Primary$	0.1220	0.0076***	-0.0761	0.0089***
$Mother - Middle$	0.1056	0.0104***	-0.0814	0.0103***
$Mother - High$	0.0684	0.0175***	-0.0784	0.0130***
$Mother - College$	0.0362	0.0224	-0.0895	0.0198***
$WorkingMother$	-0.0791	0.0086***	0.0380	0.0079***
$LogExpenditure$	0.1120	0.0080***	-0.0148	0.0063**
$Asset$	0.0104	0.0084	0.0216	0.0061***
Age	0.2548	0.0096***	0.0329	0.0048***
$Agesq$	-0.0131	0.0004***	-0.0009	0.0002***
$Urban$	0.1104	0.0095***	-0.0494	0.0080***
$Lowcaste$	-0.0661	0.0069***	-0.0046	0.0058
$Muslim$	-0.0795	0.0143***	-0.0055	0.0097
$Oct - Dec$	0.0106	0.0073	0.0004	0.0059
$Jan - March$	0.0350	0.0072***	0.0041	0.0053
$April - June$	0.0012	0.0100	-0.0058	0.0064
$Male$	-0.0074	0.0431		
N	440039			
Predicted DV	0.6641			
Pseudo R-Square	0.2097			

Marginal effects of independent variables and interactions of all independent variables with the male dummy are reported. Robust standard errors, corrected for clustering at the year-state level: *Significant at 10%, **Significant at 5%, ***Significant at 1%.

Table C.19: Probit Estimates for Participation in Part Time Child Labor & Schooling

Variable	All Children	Robust Standard Error	Interaction with Male Dummy	Robust Standard Error
$Rate-Primary$	-0.0011	0.0008	-0.0011	0.0013
$Rate-Middle$	-0.0011	0.0004***	0.0013	0.0008*
$Year-88$	-0.0001	0.0003	-0.0002	0.0002
$Year-93$	0.0455	0.0145***	-0.0004	0.0001**
$Year-99$	0.0626	0.0163***	-0.0004	0.0001**
$Children$	0.0004	0.0001***	0.0000	0.0000
$Father-Primary$	0.0003	0.0001***	-0.0001	0.0000
$Father-Middle$	0.0004	0.0001***	-0.0001	0.0000***
$Father-High$	0.0002	0.0001***	0.0000	0.0000
$Father-College$	0.0002	0.0001***	-0.0002	0.0000**
$Mother-Primary$	0.0004	0.0001***	-0.0001	0.0000***
$Mother-Middle$	0.0005	0.0001***	-0.0001	0.0000**
$Mother-High$	0.0008	0.0002***	-0.0001	0.0000
$Mother-College$	0.0013	0.0004***	-0.0001	0.0000
$WorkingMother$	0.0000	0.0000	0.0001	0.0000
$LogExpenditure$	0.0004	0.0001***	0.0000	0.0000
$Asset$	-0.0001	0.0000*	0.0000	0.0000
Age	0.0002	0.0000***	-0.0001	0.0000**
$Agesq$	0.0000	0.0000***	0.0000	0.0000**
$Urban$	-0.0001	0.0000	0.0000	0.0000
$Lowcaste$	0.0001	0.0000	-0.0001	0.0000***
$Muslim$	-0.0004	0.0001***	0.0000	0.0000
$Oct-Dec$	-0.0004	0.0001***	0.0000	0.0000
$Jan-March$	-0.0005	0.0001***	0.0000	0.0000
$April-June$	-0.0007	0.0001***	0.0000	0.0000
$Male$	0.0017	0.0011**		
N	439706			
Predicted DV	0.0003			
Pseudo R-Square	0.4518			

Marginal effects of independent variables and interactions of all independent variables with the male dummy are reported. Robust standard errors, corrected for clustering at the year-state level: *Significant at 10%, **Significant at 5%, ***Significant at 1%.

Table C.20: Probit Estimates for Participation in Full Time or Part Time Child Labor - Excluding $LogExpenditure$

Variable	All Children	Robust Standard Error	Interaction with Male Dummy	Robust Standard Error
$Rate-Primary$	-0.0402	0.1078	-0.4080	0.1724**
$Rate-Middle$	-0.1021	0.0527*	0.0548	0.0794
$Year-88$	0.2592	0.0240***	0.0026	0.0158
$Year-93$	0.1987	0.0242***	0.0035	0.0171
$Year-99$	0.1572	0.0221***	0.0412	0.0166**
$Children$	0.0237	0.0037***	0.0035	0.0010***
$Father-Primary$	-0.1173	0.0059***	0.0078	0.0053
$Father-Middle$	-0.1510	0.0072***	0.0070	0.0062
$Father-High$	-0.1883	0.0086***	0.0262	0.0064***
$Father-College$	-0.1922	0.0093***	0.0080	0.0109
$Mother-Primary$	-0.1057	0.0062***	0.0709	0.0082***
$Mother-Middle$	-0.1001	0.0088***	0.0774	0.0098***
$Mother-High$	-0.0868	0.0144***	0.0884	0.0125***
$Mother-College$	-0.0840	0.0162***	0.0975	0.0179***
$WorkingMother$	0.0689	0.0070***	-0.0227	0.0061***
$Asset$	-0.0135	0.0074*	-0.0141	0.0057**
Age	-0.1566	0.0150***	-0.0304	0.0046***
$Agesq$	0.0089	0.0005***	0.0006	0.0002***
$Urban$	-0.0914	0.0060***	0.0327	0.0061***
$Lowcaste$	0.0614	0.0064***	0.0020	0.0047
$Muslim$	0.0587	0.0109***	0.0036	0.0076
$Oct-Dec$	-0.0055	0.0061	-0.0036	0.0052
$Jan-March$	-0.0212	0.0062***	-0.0038	0.0051
$April-June$	-0.0013	0.0084	0.0038	0.0058
$Male$	0.1005	0.0266***		
N	440039			
Predicted DV	0.2488			
Pseudo R-Square	0.1790			

Marginal effects of independent variables and interactions of all independent variables with the male dummy are reported. Robust standard errors, corrected for clustering at the year-state level: *Significant at 10%, **Significant at 5%, ***Significant at 1%.

Table C.21: Probit Estimates for Participation in Full Time or Part Time Schooling - Excluding $LogExpenditure$

Variable	All Children	Robust Standard Error	Interaction with Male Dummy	Robust Standard Error
$Rate-Primary$	-0.0937	0.1113	0.5789	0.1561***
$Rate-Middle$	0.0195	0.0439	0.1085	0.0596*
$Year-88$	0.0775	0.0138***	-0.0217	0.0225
$Year-93$	0.1742	0.0124***	-0.0105	0.0219
$Year-99$	0.2352	0.0101***	-0.0568	0.0212***
$Children$	-0.0043	0.0015***	-0.0008	0.0011
$Father-Primary$	0.1579	0.0044***	-0.0208	0.0046***
$Father-Middle$	0.1991	0.0049***	-0.0166	0.0058***
$Father-High$	0.2407	0.0067***	-0.0245	0.0063***
$Father-College$	0.2489	0.0065***	-0.0193	0.0122
$Mother-Primary$	0.1401	0.0057***	-0.0752	0.0088***
$Mother-Middle$	0.1513	0.0066***	-0.0912	0.0109***
$Mother-High$	0.1507	0.0089***	-0.0850	0.0133***
$Mother-College$	0.1694	0.0128***	-0.1219	0.0241***
$WorkingMother$	-0.0876	0.0073***	0.0403	0.0074***
$Asset$	0.0213	0.0071***	0.0197	0.0057***
Age	0.2601	0.0091***	0.0341	0.0045***
$Agesq$	-0.0133	0.0003***	-0.0009	0.0002***
$Urban$	0.1276	0.0081***	-0.0532	0.0081***
$Lowcaste$	-0.0789	0.0067***	-0.0070	0.0058
$Muslim$	-0.1067	0.0116***	-0.0100	0.0092
$Oct-Dec$	-0.0090	0.0052*	-0.0034	0.0054
$Jan-March$	0.0104	0.0053*	-0.0007	0.0048
$April-June$	-0.0354	0.0101***	-0.0119	0.0061
$Male$	-0.0847	0.0247***		
N	440039			
Predicted DV	0.7054			
Pseudo R-Square	0.2416			

Marginal effects of independent variables and interactions of all independent variables with the male dummy are reported. Robust standard errors, corrected for clustering at the year-state level: *Significant at 10%, **Significant at 5%, ***Significant at 1%.

Table C.22: Probit Estimates for Participation in Full Time or Part Time Child Labor - Including Rates of Return to High School & College

Variable	All Children	Robust Standard Error	Interaction with Male Dummy	Robust Standard Error
$Rate-Primary$	-0.0145	0.1071	-0.5241	0.2092**
$Rate-Middle$	-0.0861	0.0528	0.0475	0.0818
$Rate-High$	0.0342	0.0367	0.1215	0.1282
$Rate-College$	0.0244	0.0358	0.1217	0.0964
$Year-88$	0.2812	0.0242***	0.0054	0.0163
$Year-93$	0.2300	0.0245***	-0.0082	0.0185
$Year-99$	0.2000	0.0221***	0.0295	0.0189
$Children$	0.0203	0.0037***	0.0038	0.0011***
$Father-Primary$	-0.1110	0.0057***	0.0081	0.0054
$Father-Middle$	-0.1423	0.0069***	0.0070	0.0061
$Father-High$	-0.1751	0.0085***	0.0251	0.0065***
$Father-College$	-0.1763	0.0097***	0.0064	0.0112
$Mother-Primary$	-0.1002	0.0061***	0.0714	0.0083***
$Mother-Middle$	-0.0915	0.0086***	0.0771	0.0100***
$Mother-High$	-0.0691	0.0150***	0.0875	0.0128***
$Mother-College$	-0.0482	0.0176**	0.0957	0.0186***
$WorkingMother$	0.0636	0.0070***	-0.0240	0.0064***
$LogExpenditure$	-0.0783	0.0075***	0.0048	0.0053
$Asset$	-0.0079	0.0075	-0.0143	0.0056**
Age	-0.1566	0.0151***	-0.0302	0.0047***
$Agesq$	0.0089	0.0005***	0.0006	0.0002***
$Urban$	-0.0793	0.0062***	0.0308	0.0064***
$Lowcaste$	0.0505	0.0058***	0.0036	0.0048
$Muslim$	0.0560	0.0110***	0.0035	0.0079
$Oct-Dec$	-0.0051	0.0059	-0.0029	0.0051
$Jan-March$	-0.0204	0.0062***	-0.0034	0.0049
$April-June$	0.0004	0.0085	0.0044	0.0058
$Male$	0.0589	0.0439		
N	440039			
Predicted DV	0.2475			
Pseudo R-Square	0.1839			

Marginal effects of independent variables and interactions of all independent variables with the male dummy are reported. Robust standard errors, corrected for clustering at the year-state level: *Significant at 10%, **Significant at 5%, ***Significant at 1%.

Table C.23: Probit Estimates for Participation in Full Time or Part Time Schooling - Including Rates of Return to High School & College

Variable	All Children	Robust Standard Error	Interaction with Male Dummy	Robust Standard Error
$Rate - Primary$	-0.0755	0.1175	0.5590	0.1664***
$Rate - Middle$	0.0300	0.0450	0.1118	0.0651*
$Rate - High$	0.0307	0.0280	-0.0592	0.0773
$Rate - College$	0.0184	0.0288	-0.0193	0.0613
$Year - 88$	0.0479	0.0147***	-0.0177	0.0228
$Year - 93$	0.1442	0.0121***	-0.0072	0.0194
$Year - 99$	0.1884	0.0113***	-0.0508	0.0218**
$Children$	0.0009	0.0015	-0.0010	0.0012
$Father - Primary$	0.1477	0.0044***	-0.0196	0.0048***
$Father - Middle$	0.1854	0.0049***	-0.0147	0.0060**
$Father - High$	0.2206	0.0069***	-0.0217	0.0066***
$Father - College$	0.2273	0.0075***	-0.0163	0.0132
$Mother - Primary$	0.1306	0.0057***	-0.0733	0.0088***
$Mother - Middle$	0.1376	0.0068***	-0.0889	0.0110***
$Mother - High$	0.1247	0.0097***	-0.0806	0.0134***
$Mother - College$	0.1222	0.0162***	-0.1171	0.0252***
$WorkingMother$	-0.0786	0.0073***	0.0397	0.0076***
$LogExpenditure$	0.1285	0.0059***	-0.0127	0.0061**
$Asset$	0.0114	0.0069*	0.0218	0.0054***
Age	0.2619	0.0092***	0.0334	0.0046***
$Agesq$	-0.0135	0.0003***	-0.0009	0.0002***
$Urban$	0.1105	0.0086***	-0.0521	0.0081***
$Lowcaste$	-0.0630	0.0063***	-0.0073	0.0059
$Muslim$	-0.1048	0.0118***	-0.0084	0.0092
$Oct - Dec$	-0.0101	0.0052*	-0.0039	0.0054
$Jan - March$	0.0086	0.0052	-0.0008	0.0047
$April - June$	-0.0397	0.0101***	-0.0116	0.0061*
$Male$	-0.0159	0.0451		
N	440039			
Predicted DV	0.7075			
Pseudo R-Square	0.2509			

Marginal effects of independent variables and interactions of all independent variables with the male dummy are reported. Robust standard errors, corrected for clustering at the year-state level: *Significant at 10%, **Significant at 5%, ***Significant at 1%.

Table C.24: Tariff Structure of the Indian Economy, 1990-2000

	1990/91	1993/94	1995/96	1996/97	1997/98	1998/99	1999/2000
Average Unweighted (%)							
Agriculture	113	43	27	26	26	30	29
Mining	100	70	30	26	25	29	27
Manufacturing	126	73	42	40	36	41	40
Whole Economy	125	71	41	39	35	40	40
Standard Deviation	41	30	19	19	15	15	14
Maximum	355	85	50	52	45	40	38
Import Weighted (%)	87	47	25	22	20	30	30

Source: Rajan & Sen (2000).

Import Weighted Tariff: Weighted by 1992/93 import values.

Table C.25: Tariff Rates in Manufacturing, 1990-1999

Industry	1990	1992	1997	1999	Decrease
Food Products	85.15	47.47	28.32	31.47	63.04
Beverages	190.71	181.9	124.76	116.67	38.82
Tobacco	100.00	65.00	40.00	40.00	60.00
Textiles	93.88	62.08	38.05	38.36	59.14
Wearing Apparel (Except Footwear)	99.84	64.98	39.88	39.92	60.02
Leather Products	82.13	55.32	19.36	29.79	63.73
Footwear (Except Rubber or Plastic)	100.00	65.00	40.00	40.00	60.00
Wood Products (Except Furniture)	64.57	60.11	30.21	33.19	48.60
Furniture (Except Metal)	100.00	65.00	40.00	40.00	60.00
Paper and Paper Products	90.48	58.45	23.47	31.94	64.70
Printing and Publishing	59.26	24.07	20.74	22.96	61.26
Industrial Chemicals	77.09	63.43	29.07	33.99	55.91
Other Chemicals	82.75	58.90	31.60	35.30	57.34
Petroleum Refineries	49.78	48.70	30.00	33.26	33.19
Miscellaneous Petroleum and Coal Products	70.00	53.75	27.50	28.75	58.93
Rubber Products	95.00	63.37	39.26	40.00	57.89
Plastic Products	100.69	64.90	31.67	35.20	65.04
Pottery, Chine, Earthenware	85.71	65.00	37.14	37.86	55.83
Glass and Glass Products	93.03	64.10	39.34	39.26	57.80
Other Non-Metallic Mineral Products	84.75	62.85	38.42	38.04	55.12
Iron and Steel	84.55	64.77	28.55	33.97	59.82
Nonferrous Metals	73.93	58.28	26.25	30.82	58.31
Fabricated Metal Products	75.00	59.87	29.83	32.54	56.61
Machinery (Except Electrical)	78.06	48.70	22.95	26.89	65.55
Electrical Machinery	81.95	57.73	31.29	31.48	61.59
Transport Equipment	62.76	52.72	31.12	35.61	43.26
Professional and Scientific Equipment	73.63	57.99	28.47	30.61	58.43
Other Manufactured Products	102.51	57.99	34.56	35.03	65.83

Source: UNCTAD.

The decrease in tariff rates from 1990 to 1999 is in percentage points.

Table C.26: Selected Indicators of India's External Sector, 1980-2000

Indicator	1980	1985	1990	1995	2000
Imports of goods and services (% GDP)	9.32	8.38	9.76	14.07	16.56
Exports of goods and services (% GDP)	6.04	5.51	7.14	10.90	13.95
Trade of goods and services (% GDP)	15.36	13.89	16.90	24.97	30.51
Foreign Direct Investment (% GDP)	0.04	0.05	0.05	0.59	0.85

Source: World Development Indicators, various years.

Table C.27: Machinery Imports, 1988-2000

Year	**Machinery Imports in $US**	**Machinery Imports as a % of GDP**
1988	3,550,568,960	1.29
1989	4,183,231,744	1.40
1990	4,189,261,312	1.67
1991	2,635,705,856	1.08
1992	3,457,639,424	1.34
1993	4,336,023,040	1.41
1994	5,445,228,032	1.63
1995	7,375,379,968	2.05
1996	7,320,150,016	1.92
1997	7,440,306,176	1.82
1998	6,703,518,720	1.62
1999	7,152,011,264	1.61
2000	7,777,176,576	1.70

Source: COMTRADE

Table C.28: Machinery Imports from Trading Partners (%), 1988-2000

Year	**USA**	**Japan**	**Germany**	**Other Partners**
1988	16.4	23.1	15.0	45.5
1989	16.5	19.2	13.6	50.7
1990	16.0	20.1	15.7	48.2
1991	17.5	21.3	18.1	44.6
1992	16.9	21.1	18.2	43.8
1993	28.4	15.7	15.8	40.1
1994	22.0	15.9	16.1	46.0
1995	18.2	14.8	19.2	47.8
1996	19.6	14.5	16.8	49.1
1997	17.6	16.5	14.5	51.4
1998	16.2	14.6	12.7	56.5
1999	13.9	17.4	10.7	58.0
2000	16.1	11.5	10.6	61.8

Source: COMTRADE

Other Partners include the United Kingdom, France, Italy, Singapore, Malaysia, and the Republic of Korea.

Table C.29: Hours Spent & Number of Individuals by Employment Status: 1983-1999

Year	**Status**	**Women**		**Men**	
		Hours	Number	Hours	Number
1983	Non-Participants	6582972	144601	1886172	61252
	Unemployed	236416	7269	633248	20182
	Self-Employed	1322144	33311	4229896	106838
	Regular Wage/Salary	852372	21005	2798716	64876
1988	Non-Participants	7173416	156764	2172100	67765
	Unemployed	228372	6910	622664	18574
	Self-Employed	1472844	37372	4759364	122948
	Regular Wage/Salary	594744	14041	1553888	34553
1993	Non-Participants	6297852	142431	1862520	50528
	Unemployed	157788	4545	418296	12322
	Self-Employed	1431540	39141	4133384	103054
	Regular Wage/Salary	809340	19677	2750100	62572
1999	Non-Participants	6989320	158607	2234580	65340
	Unemployed	173232	5090	524000	15898
	Self-Employed	1418184	40018	4213236	107081
	Regular Wage/Salary	879244	21634	2999972	68956

The figures reported are the total hours spent and the total number of inidviduals in each category.

Table C.30: Earnings Regression Results for All Adults, 1983-1999

Variable	**1983**		**1988**		**1993**		**1999**	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
Primary	0.2123	0.0070***	0.2097	0.0138***	0.1680	0.0129***	0.2084	0.0087***
Middle	0.3954	0.0090***	0.3273	0.0166***	0.3181	0.0130***	0.3503	0.0096***
High	0.7963	0.0102***	0.7359	0.0178***	0.7594	0.0128***	0.7191	0.0102***
College	1.1316	0.0123***	1.1389	0.0202***	1.2246	0.0173***	1.2480	0.0099***
Male	0.4090	0.0187***	0.7343	0.0341***	0.4747	0.0228***	0.4264	0.0293***
$Low - Caste$	-0.0990	0.0071***	-0.0213	0.0113*	-0.0021	0.0117	-0.0708	0.0065***
Urban	0.3497	0.0079***	0.2068	0.0210***	0.2182	0.0121***	0.2338	0.0107***
Age	0.0430	0.0014***	0.0738	0.0032***	0.0566	0.0027***	0.0630	0.0031***
$Age - Square$	-0.0005	0.0000***	-0.0008	0.0000***	-0.0006	0.0000***	-0.0006	0.0000***
UnempRate	-0.0116	0.0014***	0.0109	0.0018***	0.0000	0.0033	-0.0016	0.002
$Oct - Dec$	0.0156	0.0053***	-0.0090	0.0099	0.0425	0.0099***	0.0459	0.0066***
$Jan - March$	0.0284	0.0054***	0.0469	0.0105***	0.0923	0.0099***	0.0209	0.0066***
$April - June$	0.0552	0.0054***	0.0769	0.0104***	0.1056	0.0100***	0.0658	0.0066***
N	89383		33798		49186		60755	
Adjusted R-Squared	0.5609		0.5493		0.4210		0.5916	

Standard errors are in parentheses: *Significant at 10%, **Significant at 5%, ***Significant at 1%. The omitted category for the education dummies is less than primary school and for the season dummies is July-September. All regressions include state dummies. The omitted category for the state dummies is New Delhi, the nation's capital. The state dummies are jointly significant.

Table C.31: Earnings Regression Results for Women, 1983-1999

Variable	**1983**		**1988**		**1993**		**1999**	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
$Primary$	0.2976	0.0079***	0.2951	0.0173***	0.1790	0.0141***	0.1899	0.0092***
$Middle$	0.5686	0.0114***	0.5376	0.0244***	0.3329	0.0145***	0.3927	0.0095***
$High$	0.9693	0.0138***	0.9076	0.0277***	0.7104	0.0128***	0.7597	0.0101***
$College$	1.3256	0.0166***	1.2464	0.0287***	1.1550	0.0157***	1.2908	0.0110***
$Low - Caste$	-0.1701	0.0096***	-0.1498	0.0145***	-0.0306	0.0124**	-0.0745	0.0070***
$Urban$	0.4229	0.0089***	0.0161	0.0411	0.2572	0.0113***	0.3433	0.0080***
Age	0.0241	0.0020***	0.0266	0.0062***	0.0552	0.0025***	0.0276	0.0030***
$Age - Square$	-0.0001	0.0000***	-0.0001	0.0000*	-0.0006	0.0000***	-0.0002	0.0000***
$UnempRate$	-0.0311	0.0019***	-0.0076	0.0029***	-0.0048	0.0041	-0.0101	0.0025***
$Oct - Dec$	0.0307	0.0060***	0.0169	0.0123	0.0470	0.0116***	0.0455	0.0075***
$Jan - March$	0.0526	0.0063***	0.0906	0.0132***	0.1035	0.0116***	0.0197	0.0075***
$April - June$	0.0685	0.0062***	0.1165	0.0129***	0.1138	0.0117***	0.0607	0.0075***
N	67111		22260		36912		45585	
Adjusted R-Squared	0.5152		0.4208		0.3738		0.5562	

Standard errors are in parentheses: *Significant at 10%, **Significant at 5%, ***Significant at 1%. The omitted category for the education dummies is less than primary school and for the season dummies is July-September. All regressions include state dummies. The omitted category for the state dummies is New Delhi, the nation's capital. The state dummies are jointly significant.

Table C.32: Earnings Regression Results for Men, 1983-1999

Variable	**1983**		**1988**		**1993**		**1999**	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
$Primary$	0.0962	0.0238***	0.1005	0.0355***	0.0895	0.0355**	0.1092	0.0246***
$Middle$	0.4011	0.0376***	0.3266	0.0486***	0.2256	0.0454***	0.1581	0.0299***
$High$	1.0530	0.0275***	0.9401	0.0390***	0.9386	0.0416***	0.8069	0.0286***
$College$	1.2959	0.0277***	1.4037	0.0332***	1.2702	0.0497***	1.2767	0.0296***
$Low-Caste$	-0.0442	0.0166***	0.0527	0.0202***	-0.0027	0.0232	0.0112	0.0168
$Urban$	0.1142	0.0279***	0.0801	0.0366**	0.0618	0.0383	-0.0038	0.0292
Age	0.0271	0.0033***	0.0466	0.0055***	0.0445	0.0063***	0.0664	0.0052***
$Age-Square$	-0.0003	0.0000***	-0.0006	0.0000***	-0.0005	0.0000***	-0.0007	0.0000***
$UnempRate$	-0.0351	0.0037***	-0.0026	0.0032	-0.0235	0.0059***	-0.0094	0.0041**
$Oct-Dec$	0.0072	0.0111	0.0034	0.0159	0.0560	0.0184***	0.0446	0.0133***
$Jan-March$	0.0404	0.0111***	0.0571	0.0168***	0.0808	0.0192***	0.0190	0.0134
$April-June$	0.1104	0.0109***	0.0516	0.0174***	0.1047	0.0193***	0.0744	0.0137***
N	22272		11533		12273		15162	
Adjusted R-Squared	0.4780		0.5156		0.4358		0.5931	

Standard errors are in parentheses: *Significant at 10%, **Significant at 5%, ***Significant at 1%. The omitted category for the education dummies is less than primary school and for the season dummies is July-September. All regressions include state dummies. The omitted category for the state dummies is New Delhi, the nation's capital. The state dummies are jointly significant.

Table C.33: Returns to Education by Industry & Occupation: 1983

Industry/Occupation	**Number**	**Returns to Education**			
		Primary	Middle	High	College
Industry					
agriculture, hunting, forestry, and fishing	164328	9.29	0.29	20.12	88.78
mining and quarrying	2256	18.26	9.00	19.39	37.56
manufacture of food, beverage, and tobacco products	7268	7.60	16.56	29.64	-
manufacture of textiles, leather, fur, wearing apparel, and footwear	13471	15.57	19.47	7.66	41.41
manufacture of wood and wood products	3885	12.11	3.21	20.01	-
manufacture of paper, paper products, printing, and publishing	1258	24.97	13.67	47.45	-
manufacture of chemicals, rubber, plastic, petroleum, and coal products	1975	10.23	10.38	42.29	30.24
manufacture of non-metallic mineral products	2732	12.10	-3.97	41.44	34.06
manufacture of basic metals, metal products, and metal parts	3231	15.28	21.21	35.49	61.50
manufacture of machinery and transport equipment and parts	3151	-1.66	10.31	21.04	67.68
other manufacturing industries	1718	-0.58	-19.52	28.99	169.16
electricity, gas, steam, water works, and water supply	1617	15.94	8.45	23.62	47.05
construction	10809	5.71	5.33	10.35	58.41
wholesale trade, retail trade, restaurants, and hotels	24983	16.49	14.44	31.25	35.42
transport, communications	10974	26.94	4.42	27.74	27.55
storage, warehousing, repair services	6510	29.91	1.68	42.07	54.88
financing, insurance, real estate, business services	34446	35.27	22.13	38.55	31.11
community, social, personal services, except repair services	103	-	-	-	-
Occupation					
professional, technical, administrative, executive, & managerial workers	15545	21.41	6.74	15.07	20.66
clerical & sales workers	48171	18.17	16.76	45.96	54.92
production & service workers	24686	12.57	4.07	12.70	47.32

A − shows that we were unable to estimate the return to education for the corresponding industry as a result of too few observations within the relevant industry-education groups.

Table C.34: Returns to Education by Industry & Occupation: 1988

Industry/Occupation	**Number**	**Returns to Education**			
		Primary	Middle	High	College
Industry					
agriculture, hunting, forestry, and fishing	140683	13.33	-3.06	29.99	98.49
mining and quarrying	1748	27.01	10.74	24.09	-
manufacture of food, beverage, and tobacco products	6315	23.37	5.09	71.88	50.78
manufacture of textiles, leather, fur, wearing apparel, and footwear	12748	16.13	-0.47	19.52	39.69
manufacture of wood and wood products	3648	25.55	42.57	-2.19	24.64
manufacture of paper, paper products, printing, and publishing	1294	5.05	7.19	15.66	70.20
manufacture of chemicals, rubber, plastic, petroleum, and coal products	2239	4.04	38.47	54.94	69.15
manufacture of non-metallic mineral products	2399	8.67	15.48	64.21	47.29
manufacture of basic metals, metal products, and metal parts	3307	10.22	9.18	19.96	37.38
manufacture of machinery and transport equipment and parts	3354	-53.87	-7.07	-7.52	45.38
other manufacturing industries	1846	22.35	-41.33	150.55	22.98
electricity, gas, steam, water works, and water supply	1586	12.16	-14.68	70.16	62.39
construction	10953	15.07	-3.25	53.82	131.17
wholesale trade, retail trade, restaurants, and hotels	28510	24.56	13.25	27.68	74.18
transport, communications	9902	20.00	12.68	14.48	29.88
storage, warehousing, repair services	7812	29.27	12.03	33.71	60.34
financing, insurance, real estate, business services	33909	48.36	23.28	57.31	39.13
community, social, personal services, except repair services	110	-	-	-	-
Occupation					
professional, technical, administrative, executive, & managerial workers	12655	14.09	5.70	15.03	20.74
clerical & sales workers	14720	27.41	18.78	42.14	35.32
production & service workers	5982	30.87	19.20	32.83	32.25

A − shows that we were unable to estimate the return to education for the corresponding industry as a result of too few observations within the relevant industry-education groups.

Table C.35: Returns to Education by Industry & Occupation: 1993

Industry/Occupation	**Number**	**Returns to Education**			
		Primary	Middle	High	College
Industry					
agriculture, hunting, forestry, and fishing	89395	4.08	-3.25	12.47	75.90
mining and quarrying	1327	-19.17	62.67	25.17	-
manufacture of food, beverage, and tobacco products	3665	2.16	14.61	23.95	-
manufacture of textiles, leather, fur, wearing apparel, and footwear	4306	0.62	19.96	17.42	-
manufacture of wood and wood products	1966	0.15	-7.64	-11.25	46.75
manufacture of paper, paper products, printing, and publishing	535	-30.35	72.92	49.31	38.86
manufacture of chemicals, rubber, plastic, petroleum, and coal products	1215	-15.48	40.11	62.07	10.98
manufacture of non-metallic mineral products	907	14.05	34.53	17.22	-
manufacture of basic metals, metal products, and metal parts	1238	11.51	-7.28	10.78	-
manufacture of machinery and transport equipment and parts	1227	54.27	10.49	29.43	43.52
other manufacturing industries	932	67.76	-38.63	38.13	-
electricity, gas, steam, water works, and water supply	859	5.65	10.67	22.82	30.80
construction	6457	10.41	6.36	36.94	59.09
wholesale trade, retail trade, restaurants, and hotels	16020	4.84	-3.96	22.71	25.62
transport, communications	5522	16.72	12.76	26.87	24.87
storage, warehousing, repair services	4356	7.45	36.07	22.64	84.24
financing, insurance, real estate, business services	20670	42.00	35.19	65.53	36.61
community, social, personal services, except repair services	54	-	-	-	-
Occupation					
professional, technical, administrative, executive, & managerial workers	11454	23.37	12.80	47.58	30.41
clerical & sales workers	25913	8.18	9.49	30.57	72.38
production & service workers	9395	15.09	12.14	20.06	45.49

A − shows that we were unable to estimate the return to education for the corresponding industry as a result of too few observations within the relevant industry-education groups.

Table C.36: Returns to Education by Industry & Occupation: 1999

Industry/Occupation	**Number**	**Returns to Education**			
		Primary	Middle	High	College
Industry					
agriculture, hunting, forestry, and fishing	90585	6.66	4.74	12.99	74.22
mining and quarrying	1054	26.14	1.01	10.55	6.98
manufacture of food, beverage, and tobacco products	4169	14.96	14.09	13.98	89.10
manufacture of textiles, leather, fur, wearing apparel, and footwear	5212	16.00	3.33	28.06	105.50
manufacture of wood and wood products	2025	4.75	0.93	9.37	40.36
manufacture of paper, paper products, printing, and publishing	810	12.93	11.47	40.83	-
manufacture of chemicals, rubber, plastic, petroleum, and coal products	1734	13.45	16.39	33.07	83.38
manufacture of non-metallic mineral products	1321	22.71	-8.68	18.70	88.92
manufacture of basic metals, metal products, and metal parts	2001	-2.20	15.34	42.61	81.95
manufacture of machinery and transport equipment and parts	1574	5.65	12.14	45.65	61.61
other manufacturing industries	1519	7.66	6.14	19.79	88.65
electricity, gas, steam, water works, and water supply	865	-	67.11	9.78	-
construction	9402	5.81	-0.31	9.15	102.94
wholesale trade, retail trade, restaurants, and hotels	21087	19.77	13.48	25.79	69.19
transport, communications	7478	6.70	22.01	26.16	63.09
storage, warehousing, repair services	6504	12.99	15.72	24.08	92.15
financing, insurance, real estate, business services	21978	36.57	34.63	70.17	41.61
community, social, personal services, except repair services	489	42.19	17.93	30.46	49.60
Occupation					
professional, technical, administrative, executive, & managerial workers	19123	31.20	24.27	47.33	44.41
clerical & sales workers	28617	11.98	7.65	31.88	65.19
production & service workers	10928	14.17	18.03	20.12	65.40

A – shows that we were unable to estimate the return to education for the corresponding industry as a result of too few observations within the relevant industry-education groups.

Table C.37: Classification of Manufacturing Industries

	ISIC Code	**Industry**
1	311	manufacture of all food products
2	313, 314	manufacture of beverages, tobacco and related products
3	321	manufacture of all textiles
4	322	manufacture of textile products, including wearing apparel
5	331, 332	manufacture of wood and wood products
6	341, 342	manufacture of paper, paper products, printing, and publishing
7	323, 324	manufacture of leather, leather products, fur, leather substitutes, including footwear
8	351, 352	manufacture of chemicals and chemical products
9	353, 354, 355, 356	manufacture of rubber, plastic, petroleum, and coal products
10	361, 362, 369	manufacture of non-metallic mineral products
11	371, 372	manufacture of basic metals
12	381	manufacture of metal products, metal parts, except machinery and equipment
13	382	manufacture of machinery and equipment, excluding transport
14	383	manufacture of electrical machinery
15	384	manufacture of transport equipment and transport parts
16	385, 390	other manufacturing industries

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