DISCUSSION PAPERS IN ECONOMICS

Working Paper No. 01-01

Child Labor and International Trade: A Computational Analysis for the Apparel Sector in Asia

Mahmood Hussain
Department of Economics, University of Colorado at Boulder
Boulder, Colorado

January 2001

Center for Economic Analysis
Department of Economics

University of Colorado at Boulder
Boulder, Colorado 80309

1. Background and Literature Review

This paper studies the economics of child labor standards in the apparel sector in Asian countries and their relationships with international trade. An important issue in assessing the impacts

arrangements on environment and labor standards becoming the critical components of the treaty (Anderson 1995). The issue of labor standards is widely debated in the high-wage countries, where growing wage inequality and high levels of structural unemployment are currently quite dominant in economic discourse (Maskus and Holman 1996). Although economists have long argued that varying standards across countries is a natural outcome of an efficient allocation of world's resources, the debate on labor standards pc 33in

By developing a static Heckscher-Ohlin model, they show that trade policies may actually hurt the children as well as raise their employment under different scenarios. Finally, although they do not present any empirical evidence on the effectiveness of an education subsidy, their theoretical findings underscore the usefulness of various forms of financial assistance to the developing countries. These transfers can be used to subsidize the education of poor youth and in particular to provide children and their families an incentive to remove them from arduous activities.

Maskus and Holman (1996) present another interesting static model of trade. In their model, child workers are employed in an informal sector of the economy. The informal sector produces an intermediate good that is used in the production of the exportable good. They introduce a market for a minimum-age standard and show that the externalities resulting from the presence of child labor generates a social demand for a minimum age that might be higher or lower than the age determined by the market. They consider several policies to eliminate the inefficiency associated with the externalities and show theoretically that restrictive trade is an inefficient means of accomplishing a social goal of reducing child labor or increasing minimum-age standard. Although they allude to the significance of child education, they do not formally model it.

In another theoretical paper, Brown (1999) analyzes the economic mechanics and consequences of product labeling. When product labeling is applied to child labor, he finds that even in the optimistic case in which consumers pay a labeling premium that exceeds the additional cost of adult-only technology, there is no net reduction in the labor force participation of children. Children are better off only when the fund (that is, a transfer from the North to the children in South) is used for their benefit.

Agarwal (1995) conducts a descriptive study on the linkages between labor standards and trade and finds no support for labor standards in developing countries unduly influencing trade flows. Rodrik (1995) studies econometrically the connection between labor standards and international trade and finds that the results are statistically insignificant enough and cannot be used to support the claim that low labor standards or the presence of child labor can create comparative advantage. Rodrik (1995) uses dummy variables to investigate the effects of child labor. His paper is a pioneering empirical work in the area of child labor and international trade. He, however, stops

short of examining quantitatively how a reduction in child labor may affect trade flows or how different trade or non-trade instruments can influence the incidence of child labor. Among other econometric papers, Grootaert (1998), Psacharopoulas (1997), and Ravallion and Wondon (1999) primarily focus on the linkage between child labor and schooling in a closed economy.

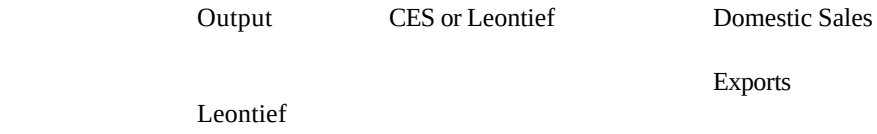
Hussain (1999) and Ranjan (1999) develop dynamic models of child labor and human

2.1 General Model Structure

There are three production sectors: wearing apparel, other goods, and composite investment sector.[2] In order to focus on the problem of child labor in Asia, in particular, the number of regions was limited to seven. They are the United States, OECD countries, India, Sri Lanka, Rest of South Asia (RAS), Rest of Asia (ASI), and Rest of the World (ROW). The three goods are produced by a total of six factors: land, natural resources, capital, skilled labor, unskilled labor, and child labor. Of these factors, child labor and unskilled labor constitute the total amount of unskilled labor in a region.

An Armington constant elasticity of substitution (CES) allows for substitution in goods produced for domestic and foreign markets. Here, the elasticity is assumed to be infinity. That is, produced goods can be transferred freely between domestic consumption and exports. Firms produce goods by combining value added and intermediate inputs. Intermediate inputs are aggregated by means of standard fixed coefficients from each economy's input-output structure. Each intermediate input is an aggregate of supply sources from the .1473 Tw (Armington constanti Uti UtArm.5
pring apparel, other goo2s input263d expory a total otors: land, natural resources,n sector, andpby a total o secal r

Figure 1. Technology and Preference Structure



indexes are measures of Hicksian equivalent variation for both agents.[3] The model equations are presented in Appendix A.

[3] Equivalent Variation=$\mu(p^o;p',m')-\mu(p^o;p^o,m^o)$. It uses the current prices as the base and measures how much additional money is needed at the benchmark prices to make the consumer as well off as he would be facing the current prices. (Varian 1992)

2.2 Empirical Implementation

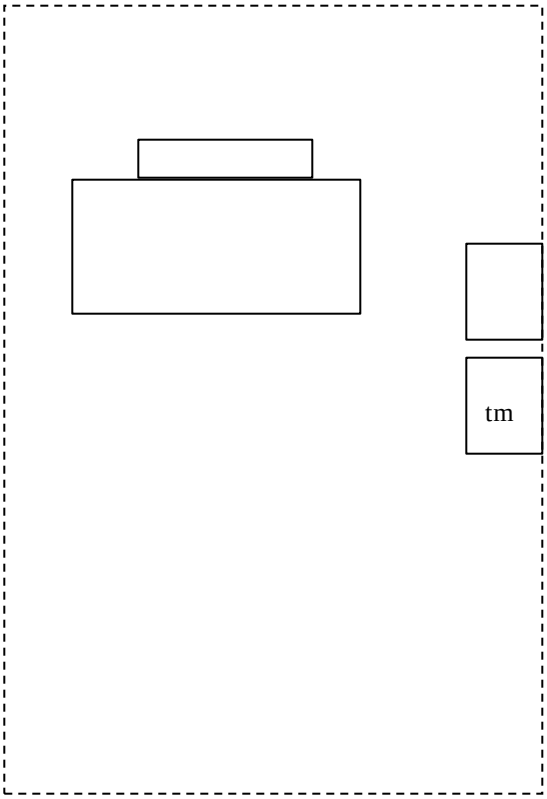
The CGE model described above is constructed for computational purposes with the Mathematical Programming System for General Equilibrium analysis (MPSGE, Rutherford 1999) in the Generalized Algebraic Modeling System (GAMS). GAMS is a computer language which was originally developed to assist economists at the World Bank in the quantitative analysis of economic policy questions.

The data on input-out structure and income flows of the world economy come from the Global Trade Analysis Project (GTAP) database (Rutherford, 1998). This dataset is based on a multi-regional, multi-sectoral general equilibrium model. All GTAP datasets are defined in terms of three primary sets: r – the set of countries and regions, i – the set of sectors and produced commodities, and f – the set of primary factors. It provides self-consistent production, consumption, and bilateral trade statistics for 45 regions and 50 goods. For the purpose of focusing exclusively on the apparel sector, 48 sectors were aggregated into one "others" sector. Also, the current analysis aggregates the 45 regions into 7 regions to focus on primary trade patterns.

Figure 2 presents the GTAP flows explicitly represented in the dataset. The parameters that begin with a "t" refer to taxes and other parameters in the figure refer to value of goods flow among sectors. A complete description of the parameters is given in Appendix B. Additionally, the GAMS representation of the GTAP dataset and the complete MPSGE formulation are presented in Appendix C.

The data that are used to proxy for children's participation in the labor market merit discussion at this point. In the CGE analysis, a factor's value share in production reflects its participation. The same convention is followed to capture children's participation in the apparel sector. Precise data on the monetary contribution of children to their household incomes do not exist. Therefore, different sources are used to extract the approximate value share of children from the share of unskilled labor in the apparel sector.

Figure 2. GTAP flows explicitly represented in the dataset.



Anker and Melkas (1996) indicate that each working child's contribution to household income ranges from 10 to 25 percent. Bailey-Wiebecke and Rahman (1996) state that child workers account for approximately 20% of the total labor force in the Bangladeshi apparel sector and their average monthly income is approximately 50% of that of an average adult worker. According to another study (Chaudhury and Majumder, 1991), 13% of the workers in the apparel sector were found to be child laborers. Based on these numbers and the fact that child labor is usually underreported, a conservative estimate of 10% of the unskilled laborers' income in the apparel sector is assigned to children's value share in the apparel sectors in India, Sri Lanka and rest of South Asia. For other Asian countries and the rest of the World child labor is assumed to be

Later, this assumption is relaxed and sensitivity analyses are conducted under the assumption that children can be employed in other sectors too.

We assume a high substitutability between child labor and adult unskilled labor. Specifically, we assume that the elasticity of substitution is 5 between child labor and unskilled adult labor. The support for a high elasticity is abundant in the literature. Among others, see Silvers (1996), Basu and Van (1998), and Rahman (1997). Silver (1996) argues that employers substitute unskilled workers with child labor in order to maintain a low cost of production. Basu and Van (1998) use this substitutability as the main basis of their model to generate multiple equilibria. While investigating the child labor situation in Bangladesh, Rahman (1997) identifies the substitutability between adult and child workers to be high. This substitutability works as a strong "pull" factor for the incidence of child labor.

Given the assumptions of the model, the first set of results is presented in a series of tables below. The detailed results of sensitivity analyses will be confined to the Appendix D. Table 1 shows the amount of child labor (value share of children in the apparel sector) in the apparel sector by regions in 5 different scenarios.

Table 1: Children's Value Share in Apparel Production by Scenario
(Millions of US dollars)

	Benchmark Equilibrium	Post-Tariff	Post-Tax (Revenue Transferred to children)	Post-Tax (Revenue Transferred to adults)	Post Subsidy
India	75	65	57	57	57

of 75% of benchmark child labor, the rates for the tariff, taxes, and subsidy were endogenously determined in the model. However, to achieve the target we allowed these instruments vary only between 0 and 2000%. That is, for example, if 2000% tariff or tax failed to reduce child labor by 25%, we didn't raise them any further because any further increase is unlikely in reality. Therefore, in the next four columns of Table 1 children's value shares are endogenously determined to reach the targeted level of 75% after the introduction of tariff, domestic taxes, and subsidy respectively.

Table 2 summarizes the magnitudes of these policy instruments. Interestingly, in spite of a 2000% tariff, children's value share does not fall by 25% (second column of Table 1) in India, the rest of Asia, or the rest of the world. For example, a 2000% tariff on apparel imports from India reduces child labor in that sector only by 14% (from US$75mill to US$65mill). While many experts and politicians advocate the use of tariff to curb child labor or seek to ban products made with child labor, the results show that even a prohibitively high tariff cannot achieve even a modest target in countries where the incidence of child labor is relatively high. On the other hand, domestic taxes and subsidies from the developed countries appear effective in achieving the target, at modest rates of 19-23%.

Table 2: Tariff, Tax, and Subsidy Rates by Scenarios and Subsidy Amounts

	Tariff	Tax (Revenue Transferred to children)	Tax (Revenue Transferred to adults)	Subsidy	Subsidy Amount (millions of US$)
India	2000	21	23	19	18
Sri Lanka	38	21	23	19	4
Rest of South Asia	54	21	23	19	10
Other Asian countries	2000	21	23	19	101
Rest of the world	2000	21	23	19	69

The last column of table 2 is of particular interest to policy makers in the US and the OECD. It translates the subsidy rates into absolute U.S. dollar amounts needed to induce children that are employed in the apparel sector to withdraw from work and participate in non-market

activity.[5] The number in the row for India is 18. It implies that the United States and OECD countries need to make a transfer payment of US$ 18 million, each paying 50% of this amount, to Indian children to encourage them to reduce their work effort by 25% and utilize the time saved in acquiring education. Only then will child labor fall to 75% of the benchmark level.

The United States and OECD countries, on a regular basis, transfer funds to different programs of the ILO for improving labor standards. If the US and the OECD countries desire to reduce the worldwide child labor in the apparel sector by 25%, they will need to earmark approximately US$202 million (table 2 column 5 total) for the countries where children work in the apparel sector.[6] Given the static nature of the analysis it should be noted that in a dynamic context this amount is expected to go higher. Therefore, this amount can be considered the estimated annual transfer amount that is required to go from the developed to the developing countries. In a related paper, Brown, Deardorff, and Stern (1999) conjectured that the amount of money needed to subsidize education of poor youth is minuscule compared to what the United States alone contributes to many domestic and even international initiatives. The figures presented here seem supportive to their conjecture.

The estimates of subsidies can further be compared with some figures derived from different ILO sources. A relevant question is whether the estimates of the subsidy amount, derived from the CGE analysis, make sense. To investigate this we need information on child labor in the apparel sector in a specific country or a region. Since figures on children employment in the apparel sector by country or region are not available, we will use estimates of child labor in the apparel sector of Bangladesh. The question we investigate is: how much should the subsidies be to reduce child labor in the apparel sector of Bangladesh by 25%?

Development Centre. They find that different NGOs were using a variety of income replacement or subsidy programs to attack the problem of child labor. 31 NGOs out of 34 reported that such programs were successful in reducing child labor. The payments in-kind were the most common form of benefit and their average cost per child per year was US$75. Rahman (1997) reports that approximately 200,000 children are employed in the apparel sector in Bangladesh. Based on the information provided by these two sources, the approximate subsidy required to reduce child labor by 25% from the Bangladeshi apparel sector is approximately US$4 million. According to the figures presented in Table 2, the United States and OECD need to pay US$10 million to reduce child labor by 25% in the apparel sector in the South Asia which is comprised of Bangladesh, Pakistan and Nepal in the disaggregated GTAP dataset. The estimates from the CGE model appear to be quite reasonable.

Table 3 summarizes the effects of the different instruments on apparel exports. The exporting countries are organized in rows and the importing countries in columns. The figures on the diagonal are total consumption of domestic apparel. As a result of 2000% tariff, apparel exports from Sri Lanka and the rest of South Asia to the US and the OECD countries fall by 64% and 84% respectively. A 2000% tariff by the United States and OECD reduces India's export volume of

Table 3: Apparel Trade Volumes under different scenarios (millions of US$)

	India	Sri Lanka	Rest of South Asia	Asia	USA	OECD	Rest of the World

These results refute the popular belief, advocated and made popular by Senator Tom

tariffs by the US and the OECD significantly alter the terms of trade and the volume of trade, domestic taxes or subsidies do not. The ineffectiveness of domestic taxes and subsidies to alter terms of trade and thus trade volumes in any significant way can be explained by the relatively small sizes of these exporting economies.

Before examining the welfare impacts of these instruments, we will briefly investigate the their impacts on adult labor in these countries. Table 4 summarizes the changes in value shares of skilled and unskilled adult workers in the production apparel and products. Not surprisingly, the effects of a tariff on the adults workers in developed are opposite compared with those on adult workers in the developing countries. On the one hand, the employment (represented by the value shares) of both types of workers in the US and the OECD apparel sectors rise. On the other hand, the employment of these two types of workers shrinks in the apparel sectors of India, Sri Lanka, the rest of South Asia, other Asian countries, and the rest of the world.

The employment effects of a tariff on the "other" sectors are exactly opposite. The employment of workers in the other sectors in the US and the OECD falls whereas the employment in the other sectors in all other countries rises. While Table 1 shows that a tariff needs to be prohibitively high to reduce child labor in some countries, table 4 shows that same tariff has the largest general equilibrium effects on the overall employments of adults in all countries. Since tariff affects unemployment via affecting demand for the apparel products, the employment of adults in both sectors and children in the apparel sector is affected significantly.

Table 4 also shows that domestic taxes and subsidies do not affect adult employment significantly. The reason is that child workers account for only between 2 and 10% of total employment in the countries that employ children. Therefore, a direct instrument that is capable of reducing child labor by 25% need not be strong enough to affect the employment of adults.

Table 4: Adults' Value Shares by Sectors under different scenarios (Millions of US$)

	Benchmark Equilibrium	Post Tariff	Post-Tax (Revenue Transferred to children)	Post-Tax (Revenue Transferred to adults)	Post Subsidy
4.1 Skilled Adults' Value Share in Apparel Production					
India	102	60	102	102	102
Sri Lanka	22	8	22	22	22
Rest of South Asia	56	22	56	56	56
Other Asian countries	1,660	768	1,660	1,660	1,660
OECD	10,738	13,511	10,740	10,740	10,740
US	6,099	7,054	6,100	6,100	6,100
Rest of the World	2,252	1,618	2,253	2,253	2,253
4.2 Unskilled Adults' Value Share in Apparel Production					
India	679	387	695	695	694
Sri Lanka	143	52	146	146	146
Rest of South Asia	379	139	387	387	387
Other Asian countries	8,261	3,729	8,349	8,349	8,349
US	22,417	25,904	22,421	22,421	22,421
OECD	50,991	64,061	51,004	51,004	51,004
Rest of the World	14,513	10,401	14,574	14,574	14,574
4.3 Skilled Adults' Value Share in the Production of Other Goods					
India	25,705	25,746	25,705	25,705	25,705
Sri Lanka	1,193	1,207	1,193	1,193	1,193
Rest of South Asia	6,405	6,439	6,405	6,405	6,405
Other Asian countries	169,978	170,870	169,978	169,978	169,978
US	1,693,422	1,692,467	1,693,422	1,693,422	1,693,422
OECD	3,328,921	3,326,148	3,328,921	3,328,921	3,328,921
Rest of the World	430,329	430,964	430,329	430,329	430,329
4.4 Unskilled Adults' Value Share in the Production of Other Goods					
India	111,995	112,288	111,980	111,980	111980
Sri Lanka	4,094	4,185	4,091	4,091	4,091
Rest of South Asia	26,970	27,209	26,961	26,961	26,961
Other Asian countries	462,296	466,828	462,208	462,208	462,208
US	2,486,905	2,483,418	2,486,901	2,486,901	2,486,901
OECD	5,502,399	5,489,330	5,502,387	5,502,387	5,502,387
Rest of the World	1,082,358	1,086,470	1,082,296	1,082,296	1,082,296

The welfare impacts of these instruments on children's welfare are summarized in Table 5. These impacts should be of interests to those who are concerned about the plight of children in poor countries. A prohibitive tariff or banning importation of apparel products from small regions, such as, the rest of South Asia unambiguously reduces the production of apparels and child labor in those

sectors. Such a drop in child labor is, however, accompanied by a worsening of children's welfare in those countries.

Table 5: Summary Report on Child Welfare
(% Changes in Hicksian Equivalent Variation)

	Post-Tariff	Post-Tax (Revenue Transferred to children)	Post-Tax (Revenue Transferred to adults)	Post Subsidy
India	-1	1	-2	4
Sri Lanka	-2	1	-2	4
Rest of South Asia	-2	1	-2	4
Other Asian countries	-1	1	-2	4
Rest of the World	-1	0	-2	4

The figures in the "Post-Tariff" column in table 5 confirm that tariffs imposed by developed countries are detrimental to children's welfare in developing countries. Whereas if the government in developing countries imposes proportional taxes on child labor with the concomitant

their [*developed countries*] humanitarian concern is the price that citizens are willing to pay for translating the concern into actual increase in welfare of workers in poor countries." According to table 5, children's welfare in these countries rises by 4% because such subsidies, by producing a wealth effect, is like to facilitate children's leisure and education. At this stage, it may not be unfair to conjecture that such large static gains have the potential to become even larger dynamic gains in the sense that these children will become adults with higher stock of human capital in the future. The static scope of this model does not allow for quantification of such gains.

Finally, Table 6 shows how these instruments affect the representative adults' welfare in both developing and developed countries. Under the tariff regime, the adults' welfare in India, Sri Lanka, the rest of South Asia, and other Asian countries falls significantly while the fall in welfare in the rest of the world, the US and the OECD is almost negiligible (not reported in the table). For the other instruments, the welfare effects in all the regions except Sri Lanka is negligible. To sum up the findings, a tariff appears to be the welfare worsening for all. The policy implications appear straightforward. Since developed countries can maintain almost the same level of welfare regardless of which instrument is used, it seems efficient to allow subsidization of children's non-market activities.

Table 6: Summary Report on Representative Agents' Welfare
(% Changes in Hicksian Equivalent Variation)

	Post-Tariff	Post-Tax (Revenue Transferred to children)	Post-Tax (Revenue Transferred to adults)	Post Subsidy
India	-1	0	0	0
Sri Lanka	-3	-1	-1	-1
Rest of South Asia	-3	0	0	0
Other Asian countries	-1	0	0	0
US	0	0	0	0
OECD	0	0	0	0
Rest of the World	0	0	0	0

3.2 Sensitivity Analysis

To better understand the influence of the parametric framework, brief discussions based the results from a number of sensitivity calculations are presented in this part. The tables pertaining to the discussion below are in Appendix D. It is found that the conclusions are robust with respect to changes in the underlying parameters and benchmark data. Only one individual change is considered at a time.

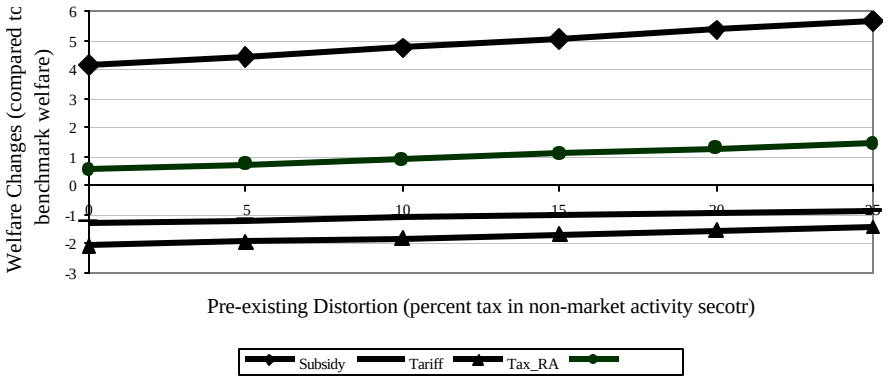
Case 1: Pre-existing Distortions

It is well documented in the literature that child labor exists primarily because a variety of market failures or distortions prevent children, or their parents, who make decisions on children's behalf, from allocating children's time efficiently between work and education or leisure. As a result, in the competitive equilibrium children's perticipation in the labor market is excessively high. In the static model of this study, we may introduce a pre-existing tax in the non-market activity of children to account for such an exogenous distortion. After introduction of this distortionary tax, although children are working 50% of the time, their labor supply is now inefficient unless the distortion is removed. That is, in the absence of the distortion, children would be enjoying more leisure or education and less work. Additionally, we know from the theory of the second best that introducing a second distortion (trade barriers or other forms of taxes or subsidies) in the presence of an existing distortion (taxes and subsidies) might make an agent better off (Markusen et al 1995).

We reinvestigate the effects of these instruments in the presence of the pre-exiting distortion in the non-market sector for the children. The above theory implies that introducing these instruments may actually improve children's welfare. The tables in Case 1 of Appendix D are produced under the assumption that a 25% pre-existing tax exists in the non-market sector of the children. A distortionary force causes excessive amount of child labor. Therefore, the tariff, taxes, and subsidy rates need to be higher, compared to those in the original case, to achieve the desired reduction in child labor. The trade, adult employment, and adult welfare do not change in any significant way. The relationships between different rates of distortionary tax and changes in welfare

resulting from the introduction of policy tools in all countries with child labor are similar. Therefore, figure 3 uses numbers from India and shows the relationships between the pre-existing distortionary tax and changes in welfare resulting from these four instruments.

Figure 3: Pre-existing Distortion in Children's Non-market Activity Sector and Welfare Effects of Different Instruments: India



(1999) find that an entrepreneur employs underage workers to retain adult workers, especially mothers. The children come with their mothers and sometimes with other family members since there are no day-care facilities available. Many garment workers are single mothers, usually because their husbands have deserted the family. Managers faced with pleas usually relent and allow the mothers to bring their children to the job to work with them. In this sense, we would expect to see very low substitutability between adult unskilled and child laborers in the apparel industry.

Under the new assumption on elasticity between unskilled adult labor and child labor, the employment scenario for all countries, and export or production performances of the apparel sector

for children. In the base case, welfare rises by a meager 1%, here children's welfare rises by 4%. The intuition is that although the children will have to pay a higher tax, they also receive higher transfers in return that can be utilized to receive a more education or more leisure.

The positive welfare effect of a subsidy is also much higher, as is expected from a higher subsidy rate and amount. The effects on trade are much less pronounced. One political economy implication of such low substitutability is that there is a need for a new system to empower the children. Thus, the children will benefit most when their labor is taxed with transfers coming back to them in a lumpsum fashion.

Case 3: Difference in children's value share.

In this exercise we examine how the children's value share and the effectiveness of each instrument are related. How do the results vary if children's value shares in these countries are actually twice as much as that assumed in section 3? Once again both the qualitative and quantitative results are identical except for children's value shares (which in the benchmark by assumption are not the same) and the subsidy amount. The reason for the required subsidy being twice as much is that the desired reduction in child labor is twice as much as before in absolute terms. Since including a set identical tables do not add any value to this discussion, only the table containing rates of tariff, taxes, and subsidies and the the subsidy amounts is in Appendix D.

Case 4: When children do not receive any transfer from the adults

a tariff to reduce substantially the employment in the informal sectors. Table 8 summarizes the effects of a tariff on the employment of children in two sectors.

Table 8: Change in Child Labor from a Tariff (as Percentage of Benchmark) by Sectors

	Apparel	Other	Overall
India	-41	-1.87	-2
Sri Lanka	-94	0.00	-7
Rest of South Asia	-74	-3.30	-5
Other Asian countries	-58	-7.78	-9
Rest of the world	30	-4.03	-5

Domestic taxes, and subsidies, assuming they are enforceable, are able to reduce child labor by 25% because they are attacking the child labor directly. In this case, however, subsidies required to induce children to withdraw from labor market are substantially higher. Essentially, the results in this section are only quantitatively different than those of the original model. For example, to reduce child labor in India by 25% the US and OECD need to share approximately US$1.4 billion of transfer fund to India (See Table D.5.2 in Appendix D). In the original case, in which child labor exists only in the apparel sector, a transfer of mere US$18 million can successfully achieve a 25% reduction in child labor. Thus, the results in section of sensitivity analysis deserve special attention from the policy makers because reducing child labor, let alone eliminating it, may be a very complex task.

Since a tariff directly reduces the demand for apparel products from developing countries, the employment of adults in the apparel sector cannot escape the impact of such a prohibitive tariff. Table 9 shows that a 2000% tariff reduces the adult employment in the apparel sectors of developing countries in the same way as it affect the child labor. As expected, the same tariff raises the employment of adult workers in the US and the OECD. These results are qualitatively similar to those derived from the original model. The zeros in Table 9, however, do not imply “no-change” in adult employment for the respective countries but that a the changes are insignificant. The employment of adults remains virtually unaffected after domestic taxes or subsidies (See table D.5.3 in Appendix D). Such reductions in employment in the apparel sector have implication for its production level. Tables presented in Appendix D show that the production of apparels and other

goods (the sum of row figures in tables D.5.4 and D.5.5) and their trade fall drastically after a 2000% tariff imposed by the US and the OECD.

Table 9: Change in Adult Labor from a Tariff (as Percentage of Benchmark) by Sectors

	Unskilled Labor		Skilled Labor	
	Apparel	Other	Apparel	Other
India	-40	0	-40	0

4. Summary

This paper uses a computational equilibrium model of international trade in apparel to investigate the consequences of policies intended to curb child labor in selected Asian countries. Tariffs applied to reduce child labor may be welfare worsening for working children. Domestic taxes on child labor, if accompanied by lump sum transfers to these children, increase their welfare. Instead, if the parents receive the lump sum transfers the children are worse off. This paper also shows that transfer payments from the developed countries in the form of subsidies to non-market activities of children in these countries may not only reduce child labor but also improve their welfare. Although stemming from a static model, which does not represent education decisions explicitly, the results bear important implications for policy makers in both developing and developed countries.

Further, some sensitivity analyses are carried out. The results from the sensitivity analyses can be summarized as follows. First, as the pre-existing distortions in children's non-market activity increases the trade or non-trade tools are required to be higher to achieve a 25% reduction in child labor in selected Asian countries. However, as is seen in the original case, only subsidies or domestic taxes with transfers can reduce child labor as well as improve the welfare of the children. Second, there is a positive relation between the elasticity of substitution between unskilled adult workers and child workers and the tariff. That is, when this elasticity is low, a modest tariff can reduce child labor by 25%. However, in this case, domestic instruments are not as effective. These instruments need to be more severe to achieve the target reduction in child labor.

Third, the larger the benchmark amount of child labor, the lower is effectiveness of all these instruments, especially tariff. Fourth, the poorer the children, the harder it is to remove them from work. For if children are too poor, even a 2000% tariff cannot reduce child labor by 25%. The taxes need to be higher too in this case. Subsidies, however, do not have to be raised in order to attract the working children to education or non-market activities. Finally, If children are employed in other sectors, which are not only significantly larger than the apparel sector but also beyond the direct influence of tariff it is impossible to reduce child labor with any trade restrictions. In this case,

domestic instruments can only achieve the desired reduction in child labor. However, subsidies, as seen in the original case, still remain the optimum choice to achieve the targeted reduction in child labor without worsening children's welfare.

These sensitivity analyses show that the qualitative conclusions of the original case are robust with respect to changes in the underlying parameters. It is worth reiterating that only a small portion of child laborers works in export industries. Thus the computed subsidy amounts from the original case should be viewed in combination with those calculated in case 5 and be considered as a partial guide to the solution of the child labor problem in poor countries. Any measure that exclusively targets export industries will have moderate effects on the total extent of child labor in developing countries (Melchoir, 1996).

Although stemming from a static model, which does not represent the education decision explicitly, the results bear important implications for policy makers in both developing and developed countries. A fruitful extension of this work would be the explicit inclusion of the education decision in this model to analyze the impact of these trade and non-trade instruments in a dynamic

Bibliography (Complete bibliography of my dissertation)

Abel, Andrew (1985), "Precautionary Saving and Accidental Bequests," *American Economic Review*, Vol. 75, No. 4.

Agarwal,

30728.

Barro, Robert and Jong-Wha Lee (1994), "Sources of Economic Growth," *Carnegie-Rochester Conference Series on Public Policy*, Vol. 40, June.

Barro, Robert and Jong-Wha Lee (1993), "International Comparisons of Educational Attainment," *Journal of Monetary Economics*, 32, pp. 363-394.

Barro, Robert (1991), "Economic Growth in a Cross Section of Countries," *The Quarterly Journal of Economics*, May.

Basu, Kaushik (2000), "The Intriguing Relation Between Adult Minimum Wage and Child Labour," *The Economic Journal*, Vol. 110, No. 462.

Basu, Kaushik (1999), "Child Labor: Causes, Consequence, and Cure, with Remarks on International Labor Standards," *Journal of Economic Literature*, vol. XXXVII, no. 3.

Basu, Kaushik, and Pham Hoang Van (1998), "The Economics of Child Labor," *American Economic Review*, vol. 88, no. 3.

Beauchemin, Kenneth (2000a), "Stagnation or Growth? The Role of Public Education," *Journal of Development Economics, forthcoming*.

Beauchemin, Kenneth (2000b), "W(h)ither Public Capital?" working paper in progress, State University of New York at Albany, Department of Economics.

Becker, Gary S., Kevin Murphy, and Robert Tamura (1990); "Human Capital, Fertility, and Economic Growth," *JPE*W (t t e y 1 e e p 6 5

Bonnet, M. (1993), "Child Labor in Africa," *International Labour Review*, 132 (3).

Bowcott, Owen (1997), "When Work is the Lesser of Two Evils," *Guardian Weekly*, October 26.

Brown, Drusilla (1999), "Can Consumer Product Labels Deter Foreign Child Labor Exploitation?" Tufts University, *Department of Economics Working Paper*, No. 99-19.

Brown, Drusilla, Alan Deardorff, and Robert Stern (1999), "U.S. Trade and Other Policy Options and Programs to Deter Foreign Exploitation of Child Labor," paper prepared for presentation at National Bureau of Economic Research Conference, New York.

Brown, Drusilla (1998), "A Transactions Cost Politics Analysis of International Child Labor Standards," Tufts University, *Department of Economics Working Paper*, No. 98-19.

Brown, Drusilla, Alan Deardorff, and Robert Stern (1996); " International Labor Standards and Trade : A Theoretical Analysis," in Jagdish Bhagwati and Robert Hudec Ed. *Fair Trade and Harmonization : Prerequisites for Free Trade? Volume 1*; MIT Press.

Chaudhury, S. and Pratima Paul Majumder (1991), "The Conditions of Garment Workers in Bangladesh – An Appraisal," Bangladesh Institute of Development Studies, Dhaka.

Fallon, Peter and Zafiris Tzannatos (1998), "Child Labor: Issues and Directions for the World Bank," The World Bank, Washington, DC.

Glomm, Gerhard and B. Ravikumar (1992), "Public versus Private Investment in Human Capital: Endogenous growth and Income Inequality," *Journal of Political Economy*, 100, 4, 818-834.

Goldin, Claudia (1979), "Household and Market Production of Families in a Late Nineteenth Century America City," *Explorations in Economic History*, 16, 111-131.

Griliches, Zvi (1997), "Education, Human Capital, and Growth: A Personal Perspective," *Journal of Labor Economics*, vol. 15, no. 1, pp. s330-s344.

Grootaert, Christiaan (1998), "*Child Labor in Côte d'Ivoire: Incidence and Determinants*," The World Bank.

Grootaert, Christiaan and Ravi Kanbur, (1995) "Child Labour: An Economic Perspective." *International Labour Review*, pp. 187-203.

Greene, William H. (1997), *Econometric Analysis*, 3rd edition, Prentice-Hall Inc.

Hall, Robert and Charles Jones (1999), "Why do Some Countries Produce So Much More Output per Worker than Others?" *The Quarterly Journal of Economics*, February.

Hertel, T. W. ed. (1997), *Global Trade Analysis: Modeling and Applications*, Cambridge University Press, Cambridge and New York.

Hoffman, L. W. (1988), "Cross-Cultural Differences in Child-Bearing Goals," in R. A. LeVine, P. M. Miller, and M. M. West (Eds.) *Parental Behavior in Diverse Societies: New Directions for Child Development*, San Francisco: Jossey-Bass.

Horrell, Sara and Jane Humphries (1995), "The Exploitation of Little Children: Child Labor and the Family Economy in the Industrial Revolution," *Explorations in Economic History*, 32, 485-516.

Hussain, Mahmood (1999), "Child Labor Standards and Economic Growth: An Econometric Analysis," *University of Colorado Department of Economics Working Paper*

Markusen, James R., James Melvin, William H. Kaempfer, and Keith E. Maskus (1995), *International Trade: Theory and Evidence*, International Edition, McGraw-Hill, Inc.

Maskus, Keith E. (1997), "Should Core Labor Standards Be Imposed Through International Trade Policy?," The World Bank Policy Research Working Paper 1817.

Maskus, Keith E. and Jill Holman (1996); "*The Economics of Child Labor Standards*," Working Paper # 96-10, Department of Economics, University of Colorado.

Maskus, Keith E., Thomas F. Rutherford, and Steven Selby (1995), "Implications of Chnages in Labor Srandards: A Computational Analysis for Mexico," *North American Journal of Economics and Finance*, 6(2): 171-188.

Melchoir, Arne (1996), "Child Labour and Trade Policy," in Bjorne Grimsrud and Arne Melchoir ed. *Child Labour and International Trade Policy*, Norwegian Institute of International Affairs and Institute for Applied Social Science, Oslo Norway.

Nerlove, Marc and Lakshmi Raut (1997), "Growth Models with Endogenous Population: A General Framework," *Handbook of Population and Family Economics*, Chapter 20, pp. 1117-1173.

Panagariya, Arvind (2000), "Trade-Labor Link: A Post-Seattle Analysis," Department of Economics, University of Maryland at College Park.

Paxson, Christina, and Nobert Schady (1999), "Do School Facilities Matter? The case of the Peruvian Social Fund (FONCODES)", *The World Bank Policy Research Working Paper*, No. 2229.

Psacharopoulos, G. (1994), "Returns to Investment in Education: A Global Update", *World Development*, 22 (9).

Psacharopoulas, George (1997), "Child Labor versus Educational Attainment: Some Evidence from Latin America," *Journal of Population Economics*, 10, pp. 377-386.

Quddus, Munir (1999), "Child Labor and Global Business: Lessons from the Apparel Industry in Bangladesh," University of Southern Indiana Department of Economics Working Paper.

Rahman, Wahidur (1997), *Child Labour Situation in Bangladesh: A Rapid Assessment*, ILO, Dhaka.

Ranjan, Priya (1999), "An Economic Analysis of Child Labor," *Economics Letters*, vol. 64, pp. 99-105.

Ranjan, Priya (1998), Credit Constraints and the Phenomenon of Child Labor, University of California, Irvine Economics Paper # 98-99-12.

Ravallion, Martin and Quentin Wondon (1999), "*Does Child Labor Displace Schooling? Evidence on Behavioral Responses to an Enrollment Subsidy*," Working Paper No. 2116, The World Bank.

Rodrik, Dani (1995), "Labor Standards and International Trade: Moving Beyond the Rhetoric," unpublished paper, prepared for the Overseas Development Council, Columbia University.

Rutherford, Thomas F. (1999), "Applied General Equilibrium Modeling with MPSGE as a GAMS Subsystem: An Overview of the Modeling Framework and Syntax," Computational Economics, Vol. 14, Nos. 1-2.

Rutherford, Thomas F. (1998), "GTAPin GAMS: The Dataset and Static Model," Working Paper, University of Colora5tTD /85 ltt CouColnomics,

Appendix A: Model Equations used in GAMS/MPSGE Codes in Chapter 4

This appendix draws heavily on Rutherford (1998). In addition, to the equation given in Rutherford (1998) some equations are added to describe the specific model used in the current analysis.

Production

In the GTAP model there are two types of produced commodities, goods produced for domestic markets and goods produced for export. Specifically, if D_{ir} is domestic output and X_{ir} is export, then

$$Y_{ir} = \left[\alpha_{ir}^{Y} D_{ir}^{1+1/\eta} + \beta_{ir}^{Y} X_{ir}^{1+1/\eta}\right]^{1/(1+1/\eta)}$$

where Y_{ir} is the activity level for good i in region r. w (in regio0s1ij 3 0he spec55 -33 TD /a5 -33 T21ne2 m6 -1

taking Y_{ir} as given. Linear homogeneity of the production function implies that factor demands may be expressed as the product of an activity and compensated demand function depending on factor prices and factor taxes:

$$FD_{ir} = Y_{ir} a_{ir}^{F}\left(p_{ir}^{F}, t_{ir}^{F}\right).$$

Among the five primary factors into production, unskilled labor is represented as a composite of unskilled adult and child labor. Thus, we have

$$UL_{ir} = \left[\alpha_{ir}^{UL} L_{ir}^{\gamma} + \beta_{ir}^{UL} CL_{ir}^{\gamma}\right]^{1/\gamma}.$$

As is the case for intermediate and public demand, an Armington aggregation of domestic and imported inputs defines each commodity:

$$CD_{ir}^{RA} = \left[\alpha_{ir}^{RA} DC_{ir}^{\rho} + \beta_{ir}^{RA} MC_{ir}^{\rho}\right]^{1/\rho}.$$

Aggregate final demand is then defined by regional expenditAgg1

$$\sum_{irs} T_{irs} = \varphi_T \prod_{i,r} TD_{ir}^{\theta_{ir}^T}$$

Bilateral trade flows are determined by cost-minimizing choice, given the fob export price from region r, p_{ir}^X, the export tax rate, t_{ir}^X, and the import tariff rate, t_{ir}^M. The model formulation assumes that the export tax applies on the *fob* price (net of transport margin), while the import tariff applies on the *cif* price, gross of export tax and transport margin. We may then write the demand for bilateral imports as:

$$M_{irs} = M_{is} a_{irs}^X \left(p_{ir'}^X, t_{ir's}^X, p^T, t_{ir's}^M \right)$$

Income and Expenditure

Consumer expenditures for a representative adult are the sum of factor earnings and tax revenue, net the cost of investment, public sector output and net capital outflows:

$$\begin{aligned}
M_r^{RA} = & \sum\nolimits_f p_{fr}^F F_{fr} && \text{Factor income} \\
& + \sum\nolimits_i t_{ir}^Y \left(p_{ir}^D D_{ir} + p_{ir}^X X_{ir} \right) && \text{Indirect taxes} \\
& + \sum\nolimits_{ij} t_{ifr}^{ID} p_{ir}^{ID} Y_{jr} a_{ijr} && \text{Taxes on intermediate goods} \\
& + \sum\nolimits_{fi} t_{fir}^F p_{fr}^F FD_{fir} && \text{Factor tax revenue} \\
& + \sum\nolimits_i t_{ir}^G p_{ir}^{GD} GD_{ir} && \text{Public tax revenue} \\
& + \sum\nolimits_i t_{ir}^C p_{ir}^{CD} CD_{ir} && \text{Consumption tax revenue} \\
& + \sum\nolimits_{is} t_{irs}^X p_{ir}^X M_{irs} && \text{Export tax revenue} \\
& + \sum\nolimits_{is} t_{irs}^M \left(p_{is}^X M_{isr} \left(1 + t_{irs}^X \right) + p^T T_{isr} \right) && \text{Tariff revenue} \\
& - \sum\nolimits_i p_{ir}^D I_{ir} && \text{Investment demand} \\
& - \sum\nolimits_i p_{ir}^G \left(1 + t_{ir}^G \right) GD_{ir}^G && \text{Public sector demand} \\
& - p_n^C B_r && \text{Current account balance}
\end{aligned}$$

Capital flows in the base year are represented by B_r in this expression, and in a counterfactual equilibrium these are held fixed and denominated in terms of the numeraire price index, the consumer price level in region *n* (USA).

Consumer expenditures for a representative child are the sum of labor earnings and endowment of consumption goods received from the representative adult.

$$M_r^{RC} = p_r^{CL} CL_r + E_c^{RC}$$

Market Clearance

$$D_{ir} = DI_{ir} + DG_{ir} + DC_{ir} + I_{ir} \qquad \text{Domestic Output}$$

$$M_{ir} = MI_{ir} + MG_{ir} + MC_{ir} \qquad \text{Imports}$$

$$X_{ir} = \sum_s M_{irs} + TD_{ir} \qquad \text{Exports}$$

$$F_{ir} = \sum_i Y_{ir} a^F_{fir} \qquad \text{Primary factors}$$

Zero profit

Production. Competitive producers operating constant-returns technology earn zero profit in equilibrium. For the GTAP producer, the value of output to the firm equals the value of sales in the domestic and export markets net of applicable taxes. Costs of production include factors inputs (taxed at rate t^F) and intermediate inputs (taxed at rate t^{ID}):

$$\left(p^D_{ir} a^D_{ir} + p^X_{ir} a^X_{ir}\right)\left(1 - t^Y_{ir}\right) = \sum_f a^F_{fir} p^F_{fr} \left(1 + t^F_{fir}\right) + \sum_f a^{ID}_{jir} p^{ID}_{jr} \left(1 + t^{ID}_{jir}\right)$$

Imports. Zero profit conditions apply to trade activities as well as production. In equilibrium, the value of imports at the domestic *cif* price therefore equals the *fob* price gross of export tax, the transportation margin and the applicable tariff.

$$p^M_{ir} = \sum_s a^M_{irs} \left[p^X_{is} \left(1 + t^X_{isr}\right) + \tau_{irs} p^T\right]\left(1 + t^M_{isr}\right)$$

Investment, public, and private demand. Armington aggregation functions transform domestic and imported goods into composite goods for investment demand, public sector demand, and private demand. Zero profit for these activities provide the following equilibrium identities:

$$p^I_{ir} = c\left(p^D_{ir}, p^M_{ir}, \alpha^I_{ir}, \beta^I_{ir}\right)$$
$$p^G_{ir} = c\left(p^D_{ir}, p^M_{ir}, \alpha^G_{ir}, \beta^G_{ir}\right)$$
$$p^C_{ir} = c\left(p^D_{ir}, p^M_{ir}, \alpha^C_{ir}, \beta^C_{ir}\right)$$

in which

)l1Gi r

Appendix B: GAMS Parameters Explicitly Represented

Symbols	Parameters	Description
Parameters in Figure 2:		
t_{ir}^{Y}	ty(i,r)	Output tax
t_{ir}^{ID}	ti(j,i,r)	Intermediate Input tax
t_{ir}^{F}	tf(f,I,r)	Factor tax
t_{isr}^{X}	tx(i,s,r)	Export tax
t_{isr}^{M}	tm(i,s,r)	Import tariff
t_{ir}^{G}	tg(i,r)	Tax rates on government demand
t_{ir}^{C}	tp(i,r)	Tax rates on private demand
$Y_{ir}a_{jir}$	vafm(j,i,r)	Aggregate intermediate inputs
FD_{fir}	vfm(f,i,r)	Value of factor inputs (net of tax)
M_{irs}	vxmd(i,r,s)	Value of commodity trade (fob – net of export tax)
T_{irs}	vtwr(i,r,s)	Transport services
TD_{ir}	vst(i,r)	Value of international transport sales
DG_{ir}	vdgm(i,r)	Government demand (domestic)
MG_{ir}	vigm(i,r)	Government demand (imported)
DC_{ir}	vdpm(i,r)	Aggregate private demand (domestic)
MC_{ir}	vipm(i,r)	Aggregate private demand (imported)
CL_{ir}	cvfm(i,r)	Children's value share in production
Other Parameters:		
M_{ir}	vim(i,r)	Total value of imports (gross tariff)
X_{ir}	vxm(i,r)	Value of exports (gross excise tax)
D_{ir}	vdm(i,r)	Value of domestic output (net excise tax)
DI_{ir}	vdfm(i,r)	Aggregate intermediate demand (domestic)
MI_{ir}	vifm(i,r)	Aggregate intermediate demand (imported)
CD_{ir}	vpm(i,r)	Private Expenditure
GD_{ir}	vgm(i,r)	Public Expenditure
MI_{dir}	vm(d,i,r)	Armington supply
DI_{dir}	vd(d,i,r)	Domestic supply
B_{r}	b(r)	Current account balance

Notes on subscripts:

i, j = Commodities (Apparel, other commodities, and investment composite goods)
r,s = Regions (USA, OECD, India, Sri Lanka, Rest of South Asia, Rest of Asia, and the Rest of the world)
f = Factors (Land, Capital, Natural Resources, Skilled, Unskilled, and Child)
d = Sectors (Private, Public, and Investment)

Appendix C: GAMS Representation of the GTAP dataset and MPSGE Formulation

```
$TITLE  GTAPinGAMS -- Static Multiregional Child Labor Model in MPSGE Syntax

*       Note:
*               This is the model implemented in MPSGE.
*               This implementation accomodates both constant-elasticity of
*               transformation between production for domestic and export
*               markets (eta < +INF), and perfect substitution between
*               those markets (eta=+INF).
*
```

```
SCALAR
        eta     Elasticity of transformation - domestic vs. exports     / +inf /,
        esubdm  Elasticity of substitution - domestic vs. imports    / 4 /,
        esubmm  Elasticity of substitution - imports                    / 8 /;

parameter elasdm Elasticity of substitution between imports;
elasdm(r,"Esubdm")=esubdm;

set     tmcl(i,s,r)     Identifies trade flows subject to tax,
        tlcl(s)         Identifies regions with tax on child labor
        scl(r)          Subsidy on child leisure;

scalar  cltax   Flag for tax paid to children /0/;

tmcl(i,s,r) = no;
tlcl(s) = no;
scl(r) = no;

PARAMETER   CLTARGET(R);  CLTARGET(R) = 1.1;

parameter waptrade Initial Apparel Trade;
waptrade(s,r) = vxmd("wap",s,r)*10000;
waptrade(s,s) = sum(d, vd(d,"wap",s))*10000;
waptrade(s,"tot_ex")=sum(r,vxmd("wap",s,r))*10000;
waptrade(s,"tot_prd")=(waptrade(s,"tot_ex")+waptrade(s,s));

parameter othtrade Initial Other Trade;
othtrade(s,r) = vxmd("oth",s,r)*10000;
othtrade(s,s) = sum(d, vd(d,"oth",s))*10000;
othtrade(s,"tot_ex")=sum(r,vxmd("oth",s,r))*10000;
othtrade(s,"tot_prd")=(othtrade(s,"tot_ex")+othtrade(s,s));

set     unsk(f) /lab/;

$ONTEXT

$MODEL:child

$SECTORS:
    C(r)                                ! Private consumption
    G(r)                                ! Public provision
    Y(i,r)$vom(i,r)                     ! Output
    M(i,r)$vim(i,r)                     ! Import aggregation
    A(d,i,r)$va(d,i,r)                  ! Armington aggregation of domestic and imports
   Cl(r)$cle(r)                         ! Child labor supply
   CLS(R)$cle(r)
   YT                                   ! Transport

$COMMODITIES:
   PC(r)                                ! Private demand
   PG(r)                                ! Public provision
   PY(i,r)$(vom(i,r) and (1/eta=0))  ! Output price
```

```
    PD(i,r)$(vdm(i,r) and 1/ETA)          ! Domestic price
    PX(i,r)$(vxm(i,r) and 1/ETA)          ! Export price
    PM(i,r)$vim(i,r)                      ! Import price
    PA(d,i,r)$va(d,i,r)                   ! Armington composite price
    PF(f,r)$evoa(f,r)                     ! Factor price
    PT                                    ! Transport services
    PCL(r)$cle(r)                 ! Child's Wage
    PCLS(r)$cle(r)                        ! Child's Wage
    PCLAB(r)$cle(r)                       ! Child's labor

$CONSUMERS:
    RA(r)                                 ! Representative agent
    RC(r)$cle(r)                          ! Representative Child

$AUXILIARY:
    TAU(s)$cle(s)                         ! Tariff/tax/ subsidy  rates

*    Production:
*        I have added the last line in this block
*        assumed CES in other inputs and child labor

$CONSTRAINT:TAU(r)$cle(r)
        CLTARGET(r) =E= CL(r);

$PROD:Y(i,r)$(vom(i,r)>0 and 1/eta>0)  S:0  T:eta  va:1 lab(va):5
    O:PD(i,r)      Q:vdm(i,r)    A:RA(r) T:ty(i,r)
    O:PX(i,r)      Q:vxm(i,r)    A:RA(r) T:ty(i,r)
    I:PA("i",j,r)  Q:vafm(J,i,r) A:RA(r) T:ti(j,i,r)
    I:PF(f,r)      Q:vfm(f,i,r)  P:pf0(f,i,r)
+                                    A:RA(r) T:tf(f,i,r) va:$(not unsk(f)) lab:$unsk(f)
    I:PCLAB(r)     Q:cvfm(i,r)   P:pcl0(i,r)
+                                    A:RC(r)$cltax A:RA(R)$(not cltax) T:tcl(i,r) N:TAU(r)$TLCL(r) lab:

*        I have added the last line in this block
*        assumed CES in other inputs and child labor

$PROD:Y(i,r)$(vom(i,r)>0 and 1/eta=0)  S:0  va:1   lab(va):5
    O:PY(i,r)      Q:vom(i,r)    A:RA(r) T:ty(i,r)
    I:PA("i",j,r)  Q:vafm(J,i,r) A:RA(r) T:ti(j,i,r)
    I:PF(f,r)      Q:vfm(f,i,r)  P:pf0(f,i,r)
+                                    A:RA(r)  T:tf(f,i,r) va:$(not unsk(f)) lab:$unsk(f)
    I:PCLAB(r)     Q:cvfm(i,r)   P:pcl0(i,r)
+                                    A:RC(r)$cltax A:RA(R)$(not cltax) T:tcl(i,r)  N:TAU(r)$TLCL(r) lab:

*    Armington aggregation over domestic versus imports:

$PROD:A(d,i,r)$va(d,i,r)  S:esubdm
    O:PA(d,i,r)            Q:va(d,i,r)
    I:PD(i,r)$(1/eta>0)    Q:vd(d,i,r)
    I:PY(i,r)$(1/eta=0)    Q:vd(d,i,r)
    I:PM(i,r)              Q:vm(d,i,r)

*    Armington aggregation across imports from different countries:
```

$PROD:M(i,r)$(vim(i,r)>0 and 1/eta>0)

```
$PROD:CLS(R)$CLE(R)
          O:PCLS(R)      Q:CLE(R)       A:RA("USA")     N:TAU(r)$SCL(r)  M:(-0.5)$scl(r)
+                        A:RA("OEC")     N:TAU(r)$SCL(r)  M:(-0.5)$scl(r)
          I:PCL(R)       Q:(CLE(R)/(1+TCLE0(R)))  P:(1+TCLE0(R))  A:RC(R)  T:TCLE0(R)


$DEMAND:RC(r)$cle(r)  s:2
          E:PCL(R)       Q:(clend(r)-(TCLE0(r))*(CLE(R)/(1+TCLE0(R))))
          E:PC(R)        Q:(endtfr*clend(r))
          D:PCLS(R)      Q:cle(r)
          D:PC(R)        Q:(sum(i,cvfm(i,r))+endtfr*clend(r))


$REPORT:
          V:CLEI(r)$cle(r)    O:PCLS(r)           PROD:CLS(r)
          V:WELFARE(r)$cle(r)        w:rc(r)
          V:WELRA(r)        w:ra(r)
     V:FDCL(i,r)$cle(r)    I:PCLAB(r)      PROD:Y(i,r)

     V:FDSKL(i,r)       I:PF("skl",r)    PROD:Y(i,r)
     V:FDLAB(i,r)       I:PF("lab",r)    PROD:Y(i,r)

     V:PRD(i,r)    O:PY(i,r)      PROD:Y(i,r)
     V:TOTCON(i,r)    O:PM(i,r)      PROD:M(i,r)
     V:GEXP(i,s,r)    I:PY(i,s)      PROD:M(i,r)
     V:YD(i,r)$(1/eta>0) O:PD(i,r)      PROD:Y(i,r)
     V:YX(i,r)$(1/eta>0) O:PX(i,r)      PROD:Y(i,r)
          V:DCNM(r)         I:PCLS(r)           PROD:CLS(r)



$OFFTEXT
$SYSINCLUDE mpsgeset child


*         Check the benchmark:

child.ITERLIM = 0;
$INCLUDE child.GEN
SOLVE child USING MCP;



*         Fix a numeraire to permit comparison with MCP:

RA.FX(num) = RA.L(num);

*         Do a cleanup calculation:

child.ITERLIM = 8000;
$INCLUDE child.GEN
```

```
SOLVE child USING MCP;

parameter          clrep      Child's Value Share in Apparel Production;
parameter          clrep2     Child's Value Share in Other Production;
parameter      skapp   Skilled Adult's Value Share in Apparel Production;
parameter      unskapp   Unskilled Adult's Value Share in Apparel Production;
parameter      skoth   Skilled Adult's Value Share in Other Sector;
parameter      unskoth   Unskilled Adult's Value Share in Other Sector;

clrep(r,"initial")$cle(r)=fdcl.l("wap",r)*10000;
clrep2(r,"initial")$cle(r)=fdcl.l("oth",r)*10000;
skapp(r,"initial")=fdskl.l("wap",r)*10000;
unskapp(r,"initial")=fdlab.l("wap",r)*10000;
skoth(r,"initial")=fdskl.l("oth",r)*10000;
unskoth(r,"initial")=fdlab.l("oth",r)*10000;

parameter clrep3 Child's Total Value Share;
clrep3(r,"initial")=clrep(r,"initial")+clrep2(r,"initial");

parameter chgcl Percent Change in Total Child Labor;
chgcl(r,"initial")$cle(r)=100*((clrep3(r,"initial")-clrep3(r,"initial"))/clrep3(r,"initial"));

parameter chgunsk Percent Change in Total Unskilled Labor In Apparel Sector;
parameter chgunsko  Percent Change in Total Unskilled Labor In Other Sector;
parameter chgska Percent Change in Total Skilled Labor In Apparel Sector;
parameter chgsko Percent Change in Total Skilled Labor In Other Sector;

chgunsk(r,"initial")=100*((unskapp(r,"initial")-unskapp(r,"initial"))/unskapp(r,"initial"));
chgunsko(r,"initial")=100*((unskoth(r,"initial")-unskoth(r,"initial"))/unskoth(r,"initial"));
chgska(r,"initial")=100*((skapp(r,"initial")-skapp(r,"initial"))/skapp(r,"initial"));
chgsko(r,"initial")=100*((skoth(r,"initial")-skoth(r,"initial"))/skoth(r,"initial"));

*          First consider the tariff instrument:

tmcl(i,s,"usa")$clshr(i,s) = yes;
tmcl(i,s,"oec")$clshr(i,s) = yes;

* Here we are setting target child labor

cltarget(r)$cle(r) = 0.75;
tau.lo(r)$cle(r) = 0;
* tau.up(r)$cle(r) = 5;
tau.fx(r)$cle(r) = 2;
* tau.fx("ind") =20;
* tau.fx("asi") =20;
* tau.fx("row") =20;

$INCLUDE child.GEN
SOLVE child USING MCP;

parameter          report     Summary Report on Child Welfare;
parameter          report2   Tariff Tax Subsidy Rates in Different Scenario;
parameter          report1   Summary Report on Representative Agents;
```

```
report2(r,"Tariff")$
```

```
skoth(r,"Tax_rc")=fdskl.l("oth",r)*10000;
unskoth(r,"Tax_rc")=fdlab.l("oth",r)*10000;
clrep3(r,"tax_rc")=clrep(r,"tax_rc")+clrep2(r,"tax_rc");
chgcl(r,"tax_rc")$
```

```
othtrd3(s,"tot_prd")=prd.l("oth",s)*10000;


tlcl(s)$cle(s) = no;
scl(s)$cle(s) = yes;
$INCLUDE child.GEN
SOLVE child USING MCP;

report2(r,"Subsidy")$cle(r) = 100 * tau.l(r);
report(r,"subsidy")$cle(r) = 100 * (welfare.l(r)-1);
report1(r,"subsidy") = 100 * (welra.l(r)-1);
clrep(r,"subsidy")$cle(r)=fdcl.l("wap",r)*10000;
clrep2(r,"subsidy")$cle(r)=fdcl.l("oth",r)*10000;
skapp(r,"subsidy")=fdskl.l("wap",r)*10000;
unskapp(r,"subsidy")=fdlab.l("wap",r)*10000;
skoth(r,"subsidy")=fdskl.l("oth",r)*10000;
unskoth(r,"subsidy")=fdlab.l("oth",r)*10000;
clrep3(r,"subsidy")=clrep(r,"subsidy")+clrep2(r,"subsidy");
```

```
$libinclude gams2tbl clrep3
$libinclude gams2tbl chgunsk

$libinclude gams2tbl chgunsko
$libinclude gams2tbl chgska
$libinclude gams2tbl chgsko
$libinclude gams2tbl skapp
$libinclude gams2tbl unskapp

$libinclude gams2tbl skoth
$libinclude gams2tbl unskoth
$libinclude gams2tbl report
$libinclude gams2tbl report1
$libinclude gams2tbl waptrade

$libinclude gams2tbl waptrd1
$libinclude gams2tbl waptrd2
$libinclude gams2tbl waptrd3
$libinclude gams2tbl waptrd4
$libinclude gams2tbl othtrade

$libinclude gams2tbl othtrd1
$libinclude gams2tbl othtrd2
$libinclude gams2tbl othtrd3
$libinclude gams2tbl othtrd4
```

Appendix D: Results of Sensitivity Analysis

Case 1: results produced under the assumption that the pre-exiting distortionary tax in children's non-market sector is 25%

Table D.1.1: Children's Value Share in Apparel Production

rtionar.098 Tw (Table D.1.1: Children's Value Share in Apparel lTw Tc US dollo

T a b

Table D.1.3 (Continued): Apparel Trade Volumes by Scenarios (millions of US$)

	India	Sri Lanka	Rest of South Asia	Asia	USA	OECD	Rest of the World

D.1.3.3 Post Input Tax (Tax Revenue Transferred to the Representative Adult):

Table D.1.4 (Continued) : Adults' Value Shares by Sectors by Scenarios (millions of US$)

Case 2: Results under the alternative assumption of low substitutability between unskilled adult and child labor (the elasticity of substitution =1)

Table D.2.1: Children's Value Share in Apparel Production

	Benchmark Equilibrium	Post-Tariff	Post-Tax (Revenue Transferred to children)	Post-Tax (Revenue Transferred to adults)	Post Subsidy
India	75	57	57	57	57
Sri Lanka	16	12	12	12	12
Rest of South Asia	42	32	32	32	32
Other Asian countries	435	326	326	326	326
Rest of the World	296	239	222	222	222

Table D.2.2: Tariff, Tax, Subsidy Rates and Subsidy Amounts by Scenarios

	Tariff	Tax (Revenue Transferred to children)	Tax (Revenue Transferred to adults)	Subsidy	Subsidy Amount (millions of US$)
India	55	49	55	42	40
Sri Lanka	20	48	54	41	8
Rest of South Asia	24	49	55	42	22
Other Asian countries	29	49	55	42	230
Rest of the World	2000	49	55	42	156

Table D.2.3: Apparel Trade Volumes by Scenarios (millions of US$)

	India	Sri Lanka	Rest of South Asia	Asia	USA	OECD	Rest of the World
D.2.3.1 Post Tariff:							
India	4,676	0	3	95	211	252	384
Sri Lanka	0	90	0	4	645	325	8
Rest of South Asia	0	4	1,483	15	1,096	923	119
Other Asian countries	5	10	49	27,897	6,443	8,524	5,403
US	2	1	0	123	108,788	5,676	2,580
OECD	5	6	12	1,587	14,778	222,958	4,558
Rest of the World	0	3	0	112	0	0	77,095
D.2.3.2 Post Input Tax (Tax Revenue Transferred to the Representative Child):							
India	4,747	0	3	91	967	2,379	365
Sri Lanka	0	93	0	3	894	609	8
Rest of South Asia	0	4	1,528	14	1,773	2,075	110
Other Asian countries	5	14	52	28,765	13,561	29,207	5,416
US	2	2	0	140	98,844	3,656	2,890
OECD	5	8	13	1,726	7,150	205,898	4,558
Rest of the World	0	5	0	115	9,749	20,346	77,595

Table D.2.3 (Continued): Apparel Trade Volumes by Scenarios (millions of US$)

	India	Sri Lanka	Rest of South Asia	Asia	USA	OECD	Rest of the World
D.2.3.3 Post Input Tax (Tax Revenue Transferred to the Representative Adult):							
India	4,747	0	3	91	967	2,379	365
Sri Lanka	0	93	0	3	894	609	8
Rest of South Asia	0	4	1,528	14	1,773	2,075	110
Other Asian countries	5	14	52	28,765	13,561	29,207	5,416
US	2	2	0	140	98,844	3,656	2,890
OECD	5	8	13	1,726	7,150	205,898	4,911
Rest of the World	0	5	0	115	9,749	20,346	77,595
D.2.3.4 Post- Subsidy:							
India	4,748	0	3	91	967	2,378	365
Sri Lanka	0	93	0	3	893	608	8
Rest of South Asia	0	4	1,529	14	1,772	2,073	110
Other Asian countries	5	14	52	28,770	13,558	29,203	5,416
US	2	2	0	140	98,843	3,656	2,891
OECD	5	8	13	1,727	7,150	205,897	4,911
Rest of the World	0	5	0	115	9,748	20,344	77,599

Table D.2.4: Summary Report on Welfare (% Changes in Hicksian Equivalent Variation)

	Post-Tariff	Post-Tax (Revenue Transferred to children)	Post-Tax (Revenue Transferred to adults)	Post Subsidy
D.2.4.1: Children's Welfare				
India	-2	4	-2	12
Sri Lanka	-2	4	-2	12
Rest of South Asia	-2	4	-2	12
Other Asian countries	-2	4	-2	12
Rest of the World	-2	4	-2	12
D.2.4.2: Representative Agents' Welfare				
India	-1	0	0	0
Sri Lanka	-2	-1	-1	-1
Rest of South Asia	-2	0	0	0
Other Asian countries	-1	0	0	0
USA	0	0	0	0
OECD	0	0	0	0
Rest of the World	0	0	0	0

Case 3: Children's value share is twice as much as that assumed in the original case

Table D.3.1: Tariff, Tax, Subsidy Rates and Subsidy Amounts by Scenarios

	Tariff	Tax (Revenue Transferred to children)	Tax (Revenue Transferred to adults)	Subsidy	Subsidy Amount (millions of US$)
India	2000	22	24	19	37
Sri Lanka	36	22	24	19	8
Rest of South Asia	49	22	24	19	20
Other Asian countries	2000	21	24	19	205

Case 4: When children do not receive any transfer from the adults

Table D.4.1: Children's Value Share in Apparel Production

	Benchmark Equilibrium	Post-Tariff	Post-Tax (Revenue Transferred to children)	Post-Tax (Revenue Transferred to adults)	Post Subsidy	Rest of South anka
India	75	72	57	57	57	
Sri Lanka	16	11	12	12	12	
Rest of South Asia	42	36	32	32	32	
Other Asian countries	435	296	326	326	326	
Rest of the World	296	287	222	222	222	

Table D.4.2: Tariff, Tax, Subsidy Rates and Subsidy Amounts by Scenarios

	Tariff	Tax (Revenue Transferred to children)	Tax (Revenue Transferred to adults)	Subsidy	Subsidy Amount (millions of US$)
India	2000	33	77	19	18
Sri Lanka	2000	33	77	19	4

Table D.4.3: Summary Report on Welfare (% Changes in Hicksian Equivalent Variation)

	Post-Tariff	Post-Tax (Revenue Transferred to children)	Post-Tax (Revenue Transferred to adults)	Post Subsidy
D.4.3.1: Children's Welfare				
India	-5	1	-20	12
Sri Lanka	-24	1	-20	12
Rest of South Asia	-12	1	-20	12
Other Asian countries	-7	1	-20	12
Rest of the World	-3	1	-20	12
D.4.3.2: Representative Agents' Welfare				
India	-1	0	0	0
Sri Lanka	-4	0	0	0
Rest of South Asia	-2	0	0	0
Other Asian countries	-1	0	0	0
USA	0	0	0	0
OECD	0	0	0	0
Rest of the World	0	0	0	0

Case 5: When children are employed in other sectors as well

Table D.5.1: Children's Value Share (Millions of US dollars)

	Benchmark Equilibrium	Post-Tariff	Post-Tax (Revenue Transferred to children)	Post-Tax (Revenue Transferred to adults)	Post Subsidy
D.5.1.1: Apparel Production					
India	75	44	57	57	57
Sri Lanka	16	1	12	12	12
Rest of South Asia	42	11	32	32	32
Other Asian countries	435	183	327	327	327
Rest of the World	296	206	223	223	223
D.5.1.2: Other Sectors					
India	5,600	5,495	4,199	4,199	4,200
Sri Lanka	205	205	153	153	153
Rest of South Asia	1,348	1,304	1,011	1,011	1,011
Other Asian countries	13,869	12,790	10,400	10,400	10,400
Rest of the World	10,824	10,388	8,117	8,117	8,117

Table D.5.2: Tariff, Tax, Subsidy Rates and Subsidy Amounts by Scenarios

	Tariff	Tax (Revenue Transferred to children)	Tax (Revenue Transferred to adults)	Subsidy	Subsidy Amount (millions of US$)
India	2000	22	23	19	1,346
Sri Lanka	2000	22	24	19	52
Rest of South Asia	2000	22	24	19	335

Table D.5.4: Apparel Trade Volumes by Scenario (millions of US$)

	India	Sri Lanka	Rest of South Asia	Asia	USA	OECD	Rest of the World
D.5.4.1 Post Tariff:							
India	4,497	0	3	90	0	0	564
Sri Lanka	0	79	0	4	0	0	15
Rest of South Asia	0	2	1,366	14	0	0	167
Other Asian countries	7	5	47	25,191	0	0	7,616
US	0	0	2	111,044	6,900	49	
OECD	0	0	0	19	21,227	225,507	81
Rest of the World	0	2	0	99	0	0	76,900
D.5.4.2 Post Input Tax (Tax Revenue Transferred to the Representative Child):							
India	4,736	0	3	92	980	2,414	370
Sri Lanka	0	93	0	3	905	617	8
Rest of South Asia	0	5	1,526	14	1,788	2,094	111
Other Asian countries	5	14	52	28,720	13,612	29,349	5,434
US	2	2	0	138	98,789	3,646	2,878
OECD	5	8	13	1,712	7,124	205,803	4,890
Rest of the World	0	5	0	114	9,757	20,385	77,601
D.5.4.3 Post Input Tax (Tax Revenue Transferred to the Representative Adult):							
India	4,736	0	3	92	980	2,414	370
Sri Lanka	0	93	0	3	905	617	8
Rest of South Asia	0	5	1,526	14	1,788	2,094	111
Other Asian countries	5	14	52	28,720	13,612	29,349	5,434
US	2	2	0	138	98,789	3,646	2,878
OECD	5	8	13	1,712	7,124	205,803	4,890
Rest of the World	0	5	0	114	9,757	20,385	77,601
D.5.4.4 Post- Subsidy:							
India	4,754	0	3	91	960	2,364	363
Sri Lanka	0	93	0	3	898	613	8
Rest of South Asia	0	4	1,530	14	1,766	2,068	110
Other Asian countries	5	14	53	28,793	13,580	29,283	5,432
US	2	2	0	140	98,779	3,657	2,892
OECD	5	8	13	1,722	7,132	205,782	4,906
Rest of the World	0	5	0	114	9,738	20,347	77,673

Table D.5.4: Trade Volumes of Other Goods by Scenario (millions of US$)