

# Economic Inequality and the Emergence of Child Labor Laws\*

Dirk Krueger	Jessica Tjornhom
Department of Economics	Department of Economics
Stanford University	University of Minnesota
dkrueger@leland.stanford.edu	jessicat@econ.umn.edu

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## Abstract

In this paper we construct a dynamic heterogeneous agent general equilibrium model to quantify the effects of child labor laws on human capital accumulation and the distribution of wealth and welfare. Key elements of our model include: a human capital externality in the market production sector; uninsurable idiosyncratic labor productivity risk of parents; and endogenous wages and interest rates that change over time as a result of transition dynamics induced by the adoption of child labor legislation. We find that the welfare consequences of a transition from no policy to a ban on child labor and/or mandatory education depends crucially on the main source of household income. Households with large asset holdings never gain and hence would never support government intervention. High-wage workers benefit most from a ban on child labor, while low-wage workers benefit most from mandatory education. Based on a utilitarian social welfare function, mandatory, publicly financed education increases welfare in the economy to a greater extent than either a child labor ban alone or a combination of both policies simultaneously.

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# 1 Introduction

Child labor laws are commonly justified on humanitarian grounds by pointing out that a child who works is less likely to receive an education. If education, and thus the accumulation of human capital, is associated with positive externalities, implying a divergence of private and social returns to human capital, then a benevolent government should possibly intervene in parents' private schooling decisions, even if the parents are altruistic.<sup>1</sup>

Several empirical studies, however, have found that working children contribute significantly to household income,<sup>2</sup> particularly in developing countries. If income from child labor is significant for some households, then policy makers deciding whether or not to adopt child labor legislation face important trade-offs between distorting private decisions and correcting potential inefficiencies arising from externalities. A further complication is that these trade-offs look very different to the poor laborer who can hardly afford to send his children to school, the wealthy member of the upper class whose children receive education whether or not child labor laws are in place, and the factory owner for whom children are a cheap production input.

In this paper we build a dynamic heterogeneous agent general equilibrium model to assess the quantitative importance of these trade-offs. We focus on the dynamic effects of three possible policy reforms on different groups of the population: (1) a ban on child labor, (2) a mandatory education law with tax-financed schooling, and (3) a child labor ban combined with mandatory education legislation. We study the consequences of these reforms for aggregate human capital accumulation, as well as the distribution of welfare and wealth. Our main objective is to analyze the role that economic inequality plays in the political support of child labor legislation. The paper's primary contribution is to provide a positive theory of child labor legislation by demonstrating which groups of the population would benefit from these measures and thus support them politically. We then relate our findings to the political debates surrounding the adoption of child labor legislation in the United States in the latter half of the 19th century.

We can summarize our main results as follows: political support for implementing child labor policies where none existed before depends crucially on the proportion of households in the economy that derive a substantial

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<sup>1</sup>Government intervention may also be justified if parents do not value the well-being of their children, whereas the social welfare function of the benevolent government does.

<sup>2</sup>See Psacharopoulos (1997) and Levison, et. al. (2001) for empirical work on the contribution of children to household income in developing countries and Ensign (1969) and Trattner (1970) for a historical discussion of this subject.

fraction of their income from interest earned on their assets versus those whose income comes primarily from labor. Households earning substantial income from asset holdings do not support any form of government intervention, because child labor legislation - at least initially - reduces the labor supply in the formal production sector. This results in a higher capital-labor ratio in equilibrium which drives down the real interest rate.

High wage earners with only small asset holdings, on the other hand, benefit from a ban on child labor (and, to a lesser degree, mandatory education) because it increases wages<sup>3</sup>. In contrast, low wage earners suffer from a child labor ban, which reduces household income<sup>4</sup>. They benefit, however, from mandatory education because their children can still work in the market sector. Moreover, the linear income tax used to finance free education implicitly induces redistribution towards low income families.

Overall, a mandatory education policy increases *steady state* welfare in the economy, based on a utilitarian welfare criterion, to a greater extent than either a child labor ban or a combination of both policies. It also receives the most political support, based on population-wide welfare comparisons between the status quo without any policy and transition paths induced by a particular reform. For our benchmark calibration, all three reforms yield steady state welfare gains; but, based on explicit computations of the transition paths, only a mandatory education law garners majority support of the current parents.

The rest of the paper is organized as follows. In Section 2, we discuss the U.S. historical debate on child labor legislation, with particular focus on the question which groups were instrumental in its adoption and which groups opposed it. Section 3 outlines the model's crucial elements and provides a discussion of the related literature. In Section 4 we present the model. Section 5 describes our policy experiments. Section 6 explains the calibration of the model for our numerical exercises. In Section 7 we present our main results, including a sensitivity analysis of key parameters. Section 8 concludes the paper. All figures and a description of the numerical algorithm used are contained in the Appendix.

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<sup>3</sup>The redistributive tax accompanying a mandatory education law makes high wage earners, who already may send their own children to school, pay for schooling of the poor. Thus, high wage earners benefit more from child labor laws, which have no redistributive consequences, than from mandatory education laws.

<sup>4</sup>This effect more than offsets the higher wages induced by a reduction in labor supply in the formal production sector.

## 2 The Historical Debate in the U.S.

To evaluate our model predictions in a historical context and to guide us in our calibration, we look to the United States of the nineteenth century - a scene of heated debates surrounding child labor legislation. In this context we discuss the main arguments for and against a child labor ban and mandatory education, focusing particularly on what groups supported and opposed such legislation. This focus seems justified since our model extends the existing literature (see below) by incorporating cross-sectional heterogeneity into a structural model, and therefore delivers as key predictions which groups we should expect to support a particular law.

In Colonial North America, work by children, especially those from poor households, was not only common but expected by society. Although Puritan influence in the Massachusetts and Connecticut colonies led to legislative provision for children’s basic education in the 1640’s, this early legislation did not incorporate the principles of either compulsory attendance or freeing of children from labor in order to attend school. Neither did legislation of the 1700s and early 1800s address these issues. In fact, it was not until the later 1800s and early 1900s that these were first embodied in state legislation. Table 1 in the appendix lists the dates on which these laws were passed in each state.

Child labor was especially common in poor households, although it was by no means exclusive to the poor. According to Ensign (p. 33), “Men who became prominent in the early textile industries had acquired the knowledge of the business as apprentices, and they did not hesitate to subject their own sons to the same experience.” Trattner (1970) cites an 1820 *Manufacturers’ and Farmers’ Journal* prediction that families would chose to remain in New England instead of moving west because they could thus ensure employment for all their children over age seven. By the mid-1800s child labor was used extensively in the Manufacturing Core<sup>5</sup>, and by the 1880 U.S. Census, over a million children (or one of every six from ages 10 to 15) were gainfully employed. This number grew to 1.5 million by the 1890 census (Trattner, 1970).

Manufacturing was not the only demand on children’s time. America also had long tradition of domestic industry or household production. As the Governor of New York declared in 1767, “every home swarms with children, who are set to spin and card.” (Abbott, 1938, p.272) The market and

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<sup>5</sup>The Manufacturing Core includes: Connecticut, Delaware, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, and Rhode Island.

household sectors thus competed for child labor, and the resulting time demand reduced the number of children who would attend school regularly, as evidenced by the following quote.

The consequences of calling considerable numbers of young children into steady, full-time employment were beginning to appear. It was clear that to avoid the lapse of a large portion of society into gross ignorance working children must be schooled. (Bagnall, 1893, p. 34)

It was in this environment, with a growing number of child workers and a dearth of educational opportunities for them, that the debates around child labor bans and mandatory education took root. As issues related to child labor and illiteracy became more pressing, the call for legislation to confront them gained momentum and the debates escalated.

Support for child labor bans and mandatory education came primarily from trade unions representing organized wage workers and from women's clubs representing middle class households. As the trade union movement grew throughout the Northeastern U.S., especially in the 1820s and 30s, child labor and schooling received more attention.

“This was a time when labor unions were forming, bringing to prominence a new phase of the child labor problem. As concerned with the problems of hours as it was with schooling, organized labor demanded a shorter work day for minors, probably in the hope of using it as an entering wedge to limit adult hours. And the unions correctly noted that competition from children depressed wage scales, an argument frequently used by later opponents of child labor. It was not surprising then, that the first proposal to establish a minimum age for factory workers was made at a National Trades' Union convention in 1836.” (Trattner, 1970, p. 29-30)

By 1876 the Working Men's party was proposing that children under 14 be barred from working in industry, and in 1881 the American Federation of Labor (AFL) adopted a resolution to bar children under 14 from gainful employment.

Other groups fighting to ban child labor included the National Consumers' League, founded in 1890, and the General Federation of Women's Clubs (GFWC), the nations largest nonpartisan and nondenominational

women's volunteer service organization, which was formed the same year. Both groups were led by working women: Florence Kelley, chief factory inspector for Illinois was general secretary of the National Consumer's League, while a newspaper woman, Jane Cunningham Croly, founded GFWC.

Labor unions and women's groups, along with a number of public officials, also supported mandatory education. In Ohio, during the country's first court case calling into question the constitutionality of a mandatory education law, it was argued

“that it would be for the public good to have universal diffusion of a certain amount of secular knowledge; that it is a function of the state to legislate for the general good; therefore it may legislate for this good and enforce it by compulsory education laws.” (Quigley, p. 345)

Proponents of child labor legislation encountered strong opposition. According to Perrin, “Society was divided into sects and classes, not all of which espoused the course of popular education. Some indeed antagonized such a system.” (1896 in Bagnall). This opposition came primarily from the owners of production who used child laborers and from poor parents who needed their income as evidenced from the following quote:

“Reports of the factory inspectors in state after state that working children born in the United States were frequently unable to read and write increased the demand for more schools, compulsory attendance laws, and child labor legislation. *But there was stubborn opposition to this program, especially from those who employed the children and from poverty-stricken parents who thought the sacrifice of their children necessary.*” (Abbott, 1938) [emphasis is our own].

Our review of the historical literature indicates that economic status was the key in determining which groups would support or oppose child labor bans and mandatory education laws in the U.S. We therefore aim to construct a model that incorporates such heterogeneity with respect to economic status, in order to provide a positive theory of group-dependent support or opposition of child labor legislation.

### 3 Model Elements and Related Literature

Our model contains six key elements designed to evaluate the economic trade-offs associated with child labor legislation: (1) parents are altruistic and paternalistic; (2) they face uninsurable idiosyncratic income risk, and are (3) borrowing constrained; (4) production takes place in a formal market sector and informal household sector; (5) there is a human capital externality in the market sector production function and (6) factor prices are determined in dynamic general equilibrium. We now consider each feature of the model and its relation to the existing literature.

#### 3.1 Key Features of the Model

The first feature of the model is parental altruism and paternalism. In the tradition of Ben-Porath (1967) and Becker and Barro (1988), we assume that parents care about their children’s future utility. Thus, instead of using them as a tools for generating household income (e.g., Gupta, 2000), parents may want to send their children to school out of concern for their future earnings potential and overall well-being. The altruism assumption has been used extensively in the literature on child labor, schooling and human capital accumulation, fertility and growth. Examples include Dessy (2000), Doepke (1999), Fernández-Villaverde (1999) and Moe (1998). Parents are also paternalistic in our model; they make all economic decisions for their children, including those that determine the proportion of time their children spend in school or at work in the market sector and the household sector<sup>6</sup>.

A second key feature, the presence of uninsurable idiosyncratic labor income risk of parents, induces a partial insurance role of child labor to stabilize family income.<sup>7</sup> As is clear from the historical debate in the U.S., child labor laws have radically different effects on different segments of society. Recent empirical studies show that lower-income parents often send their children to work instead of (or in addition to) school in order to supplement family income and smooth household income shocks. According to Grootaert and Kanbur, “Child labor can be part of a strategy to minimize

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<sup>6</sup>Glomm (1997), Dessy (2000), and Pallage and Zimmermann (2000) also use overlapping generation models with children that don’t make economic decisions; these being made by their parents for them.

<sup>7</sup>Uninsurable idiosyncratic income uncertainty was introduced into dynamic general equilibrium models by Huggett (1993) and Aiyagari (1994). Our model enriches that of Aiyagari by the elements we think are necessary to analyze the trade-offs associated with child labor legislation.

the risk of interruption of a household’s income stream, and hence to reduce the potential impact of job loss by a family member, of a failed harvest, etc.” (1995, p. 194). Jacoby and Skoufias (1997) found that child labor helps to smooth the income of rural Indian families, consistent with poorly developed markets for credit and risk. Uninsurable labor income risk also gives rise to a nondegenerate wealth distribution within the population in equilibrium of our model, allowing for meaningful analysis of child labor legislation’s distributional consequences. In addition, this feature enables us to identify the economic status of groups benefitting and groups suffering from child labor legislation, and allows us to put the results of our model into the U.S. historical debate about child labor legislation described in Section 2. In particular, our economy will endogenously generate both poor households whose only income comes from labor and wealthy households who derive a substantial fraction of their income from earned interest on their assets.

Third, we assume that adults are borrowing constrained; they cannot borrow against their children’s income to finance their children’s education or to increase current household consumption. Restricting parents from writing contracts that require their children to pay off their debt in effect rules out slavery. Access to credit markets is limited for most individual households in developing nations. Income from child labor thus plays an important role for poor households for which credit does not exist. In the U.S. historical context, it is debatable whether much of the population had easy access to credit markets. As a reasonable first approximation to the historical evidence, therefore, we may assume that households have no access to credit markets where loans are secured by potential labor income of future generations only. In making this assumption, which severely limits a households’ ability to self-insure<sup>8</sup>, we follow a large body of literature that studies optimal consumption and saving choices under uncertainty, and its implications for macroeconomic aggregates (e.g., Deaton (1991), Aiyagari (1994) and many others).

To distinguish bans on child labor from mandatory education laws in a meaningful way, we introduce as a fourth key ingredient of the model both a formal market and an informal household production sector. Their key distinguishing characteristics are that child labor bans are enforceable in the market sector, but not in the household sector, and that the market sector features a constant returns to scale technology whereas the household

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<sup>8</sup>Note that we *do* allow dynasties to self-insure against intergenerational labor income fluctuations by accumulating assets such as physical capital; we merely rule out selling these assets short.

sector exhibits decreasing returns to scale. Specifying a market sector is standard in any general equilibrium model; including an informal household production sector is necessary given our objective. To properly consider the allocation of children’s time between school and work, a model must allow them to be employed in activities besides working for wages. Many empirical studies find that a good portion of child labor occurs in the household sector. Micro-studies of several developing countries (e.g., Grootaert and Kanbur, 1995) report very high participation rates in family businesses, farms and housework (up to 68% of children under 15), while wage work and apprenticeships also have positive but lower participation rates (up to 44%). The household sector is thus an alternative source of work that parents consider when allocating a child’s time, especially in developing countries where the household sector is large. This distinction of household and market sectors, which is also used in Basu and Van (1998), Levison et. al. (2001), and Dessy (2000) allows us to evaluate the widespread conjecture that the sole effect of child labor bans is to drive children into less efficient production activities instead of increasing educational attainment, particularly among the poor.

A fifth key model feature is a human capital externality in production as proposed by Lucas (1988), which induces higher social than private returns from education. By focusing on the “traditional argument for government intervention in child labor markets” (Basu, 1999, p. 1084), we attempt to assess the quantitative importance of human capital externalities for the justification of child labor legislation<sup>9</sup>. Lucas (1988) argues that externalities in human capital may explain the divergence in growth rates across countries. His position is based on the work of Jacobs (1985)<sup>10</sup>, who claims that, the exchange of ideas which takes place in cities (especially between entrepreneurs and managers) creates external effects that are an engine of economic growth. Lucas models these external effects as a human capital externality in the market production function, enhancing both the marginal products of labor and capital. The human capital externality plays the same role in our model, although we abstract from human capital as an endogenous engine of growth to focus on the distributional consequences of child labor legislation.<sup>11</sup>

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<sup>9</sup>Government intervention to reduce child labor has been justified in the literature using four main arguments: no bargaining power of the child within the household (Gupta, 2000), multiple equilibria in the labor market (Basu and Van, 1998), human capital externalities, and hyperbolic discounting by parents (Dessy and Knowles, 2000).

<sup>10</sup>See also Borjas (1992), where the human capital production function has an externality in “ethnic capital”.

<sup>11</sup>It is straightforward to incorporate *exogenous* geometric population and/or labor pro-

Lastly, we place our households into an overlapping generations dynamic general equilibrium framework, implying the endogenous determination of factor prices over time. Because our model contains dynamic human capital and asset accumulation decisions and we compute the whole transition path induced by a change in child labor legislation, changing factor prices affect different groups of the population to a very different extent: an increase in wages and a fall in interest rates is supported by the poor laborer and opposed by the rich capitalist. Therefore, imposing the discipline of general equilibrium by endogenously determining prices prevents us from predetermining our results by appropriate choice of factor price time paths. As we intuitively argue above and quantitatively demonstrate below, the general equilibrium effects of changing wages and interest rates are crucial for determining the allocative and welfare consequences of policy reforms and the political support that they engender among various groups of the population.

In our analysis we abstract from endogenous economic growth and endogenous fertility. Although economic growth is obviously important in explaining child labor, including it in our model would only detract from our focus on the distributional effects of adopting child labor laws. Fertility is likely an endogenous choice that interacts with the presence of child labor laws in an interesting way. Including fertility, however, brings up issues regarding differential abilities and equal treatment of children. This would prohibitively complicate our analysis. As we are not trying to explain demographics in this model it seemed best to abstract from endogenous fertility to keep our model simple and tractable.

Finally, we assume that child labor legislation, once adopted, is perfectly enforceable. This means that under a child labor ban, children do not work in the market sector (although they can work in the household sector). Under a mandatory schooling law, it means that all children go to school. Perfect enforceability is certainly a strong assumption; but to fully study enforceability issues we would have to explicitly model enforcement technologies and punishments for breaking the law, which is a task beyond the scope of this paper.<sup>12</sup>

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ductivity growth into our model.

<sup>12</sup>For more on the issue of child labor laws their and enforcement see Weiner (1991) and Bequele and Boyden (1988), both referenced in Grootaert and Kanbur (1995).

## 3.2 Related Literature

Several recent studies on child labor relate to our analysis.<sup>13</sup> Basu and Van (1998) combine Stone-Geary preferences with the assumption that adult and child labor are substitutes to imply the existence of multiple equilibria in the labor market: one where children work and one where the adult wage is high enough so that children do not work. A ban on child labor can then be used to implement the good equilibrium. Baland and Robinson (2000) construct a model where child labor can occur when bequests are zero or when capital markets are imperfect. They find that a child labor ban can be welfare-improving in general equilibrium. Neither model, however, introduces heterogeneity, and thus cannot fully address the relationship between income and wealth inequality and child labor legislation.

Dessy and Knowles (2000) link income inequality to the emergence of child labor laws. In their model parents have time-inconsistent preferences, in that they are hyperbolic discounters with respect to their children's utility. Therefore, parents benefit from a commitment device such as a child labor ban. The authors show that child labor legislation is introduced when the median voter's income reaches a certain threshold. Our model differs from theirs in that our households have time-consistent preferences and child labor legislation is justified by the standard human capital externality argument. Also, we stress the importance of dynamic general equilibrium and distributional effects.

Doepke (1999), while focusing on the interaction of economic growth and fertility, also considers distributional effects of child labor legislation. In his model, heterogeneity is confined to a distinction between skilled and unskilled households, whereas in ours there is a nondegenerate income and wealth distribution that is key for our study of the distributional effects of child labor legislation. Dessy (2000) focuses on compulsory education measures to alleviate child labor. His is a model of growth with endogenous fertility where, as in Doepke (1999), human capital is the only source of heterogeneity. Moreover, distributional effects of child labor legislation are not analyzed. Pallage and Zimmermann (2000) create a two-country growth model to investigate the use of transfers from a rich to a poor country in order to secure compliance with a child labor ban. Heterogeneity in this model is also confined to differences in human capital and the within-country distributional effects of a child labor ban are not addressed. We add richness to the existing literature along the cross-sectional wealth distribution dimen-

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<sup>13</sup>See Basu (1999) for an excellent survey of the theoretical and empirical literature on this issue.

sion, at the expense of endogenous fertility and growth, and therefore view our analysis as complementary to the above references.

## 4 The Model

The economy is populated by two-period lived overlapping generations. Each household consists of one adult and one child, and there is continuum of measure one of both adults and children at each date  $t$ . In the first period of life, children split their non-leisure time between school, work in the market sector, and work in the household sector. In the second period of life, children become altruistic parents, make time allocation decisions for their children, work in the market sector and consume. Adults face uninsurable idiosyncratic labor income risk as well as borrowing constraints in that they cannot leave positive debt to their children.

The single good in this economy is produced in both the market sector and the household sector and can be used for either consumption or investment. The aggregate production function is adopted from Lucas (1988), where output is a function of the capital stock, effective labor units and aggregate (average) human capital, taken as exogenously given by each firm and household. The household technology, which uses child labor as its sole input, is specific to each household and all production goes to the household that owns the technology. Human capital production depends on the amount of time a child spends in school. A formal presentation of the model follows.

### 4.1 Technology

In the market sector the aggregate technology is given by,

$$F(K_t, N_t, \bar{H}_t) = AK_t^\theta N_t^{1-\theta} \bar{H}_t^\gamma \quad (1)$$

with  $A > 0$  and  $\theta \in (0, 1)$ .  $K_t$  is the aggregate level of physical capital at time  $t$  and  $N_t$  represents the aggregate labor input at time  $t$  measured in efficiency units.  $\bar{H}_t$  is average human capital in the economy; its value is taken as given by firms when choosing labor and capital input. Hence firms face constant returns to scale with respect to the production factors they choose. As is usual with constant returns to scale, the number of firms is indeterminate in equilibrium, and without loss of generality we can assume the existence of a single representative firm.

The parameter  $\gamma \in [0, \bar{\gamma}]$  measures the extent of the human capital externality, with  $\gamma = 0$  representing the case of no externality. Production can

either be used for consumption or investment into physical capital. As there is a continuum of individuals each period, the average human capital stock cannot be influenced by any finite number of agents, and households take the average level of human capital as given, beyond their direct control.

In the household sector the amount of labor supplied by a child,  $n_t$ , is used to produce the non-storable consumption good. The household technology is specific to and owned by each household, and all production accrues to that household. Production using this technology features decreasing returns to scale with respect to labor input and is given by

$$f(n_t) = B(n_t)^\alpha \tag{2}$$

where  $B > 0$  and  $\alpha \in (0, 1)$ .

The level of human capital of an adult person is a function of the time spent in school as a child,  $s_t l$ ,

$$h_{t+1} = 1 + \varphi s_t l \tag{3}$$

where  $\varphi > 0$  and  $l > 0$  are parameters, with  $l$  indicating the time necessary to go to school and  $s_t \in \{0, 1\}$  denoting the parent's discrete choice of whether or not to send their child to school.<sup>14</sup> The indicator variable  $s_t$  equals 1 if the parent sends the child to school and 0 otherwise. Thus we normalize the human capital of an adult with no education to 1. Given this specification there are two possible values of human capital,  $h_{t+1}$ , for adults in any period  $t + 1$ :  $h_{t+1} \in \{1, 1 + \varphi l\}$ . Note that  $\varphi l$  will equal the wage premium for educated workers.

## 4.2 Preferences and Endowments

Households face idiosyncratic shocks to labor productivity of the parent. The stochastic process for labor productivity for each dynasty follows a finite state Markov process with support  $Y = \{y^1, \dots, y^N\}$  and transition function  $\pi$ , where

$$\pi(y'|y) = \text{prob}(y_{t+1} = y' | y_t = y). \tag{4}$$

We assume that  $\pi$  has a unique invariant distribution  $\Pi$  and that  $\Pi$  gives the cross-sectional distribution of labor productivities at period 1 (and hence

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<sup>14</sup>The parameter  $\varphi$  captures effects on human capital formation from the amount of spending on each child, peer group effects, quality of teachers and the like that remain unmodeled in this paper.

at any future date)<sup>15</sup>. The idiosyncratic labor productivity of a dynasty is denoted by the sequence  $\{y_t\}_{t=1}^{\infty}$ . We assume that these shocks are uninsurable in that households can only self-insure by accumulating capital, but cannot write contracts that are contingent on the realization of  $y_t$ .

Adults in period  $t$  are indexed by  $(y_t, h_t, k_t)$ , where  $y_t$  is idiosyncratic labor productivity,  $h_t$  is the individual level of human capital, and  $k_t$  the level of individual asset holdings. Note that the only asset in this economy is physical capital  $k_t$ . We use  $\Phi_t(y_t, h_t, k_t)$  to denote the measure of adult agents of type  $(y_t, h_t, k_t)$  at date  $t$ , and  $\Phi_1(y_1, h_1, k_1)$  to denote the initial distribution of adults. Each adult in the economy is endowed with one unit of time, which he or she supplies inelastically to the market sector. The effective labor supply of an adult of type  $(y_t, h_t, k_t)$  then equals  $y_t h_t$ .

Adults of generation  $t$  have preferences over their own consumption in period  $t$  and the expected future utility of their child. We assume that preferences can be represented by

$$u(c_t) + \beta E_t [V_{t+1}(y_{t+1}, h_{t+1}, k_{t+1}; \Phi_{t+1}) | y_t] \quad (5)$$

where  $c_t$  is consumption of generation  $t$ , and  $y_{t+1}$ ,  $h_{t+1}$  and  $k_{t+1}$ , respectively, are the idiosyncratic labor productivity, individual level of human capital, and physical capital of generation  $t + 1$ . The function  $V_{t+1}$  denotes the maximal utility a child can obtain if he or she reaches adulthood with labor productivity shock  $y_{t+1}$ , human capital  $h_{t+1}$  and assets  $k_{t+1}$ .  $\Phi_{t+1}$  is the  $t + 1$  distribution over types of adults and  $E_t[. | y_t]$  denotes the conditional expectation, conditional on the realization of the idiosyncratic shock  $y_t$ . The parameter  $\beta$  is the rate at which parents discount the utility of their children and is thus a measure of altruism.

In the model each parent has one child. Children do not consume<sup>16</sup> but are endowed with one unit of non-leisure time. Parents allocate a child's time to school and work in the market and household sectors. Sending a child to school involves two costs: a direct cost of paying tuition (unless a mandatory schooling law is in place that finances public schools via income taxation) and the opportunity cost of time spent in school rather than at work in the market or household sector. The following time constraint must hold:

$$s_t l + m_t + n_t = 1 \quad (6)$$

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<sup>15</sup>That is, we assume the law of large numbers to hold. For a formal justification of this assumption see Feldman and Gilles (1985).

<sup>16</sup>Alternatively one may interpret  $c_t$  as total household consumption, given that the number of children is exogenously given.

where  $m_t$  denotes a child's time spent working in the market sector.

### 4.3 Government Policies

Potential inefficiencies of competitive equilibria arise for two reasons: the human capital externality in production, and incomplete credit markets that preclude of contracts in which the payoff is contingent on individual labor productivity realizations as well as uncontingent borrowing. Therefore, in this economy child labor legislation may be justified from a normative point of view.

We consider combinations of two types of child labor legislation. Let  $\nu_t$  be an indicator variable that equals 0 if there is no ban on child labor and 1 if there is a ban on child labor. Let  $\mu_t$  be an indicator variable that equals 1 if education is mandatory and financed via an income tax and 0 if no such law is in place. If there is mandatory free public education we denote by  $\tau_t$  the constant marginal income tax rate used to finance publicly provided education. We assume that  $\tau_t$  is set so as to obtain government budget balance in each period. We (as well as the agents in the model) take the sequence of government policies,  $\{\nu_t, \mu_t, \tau_t\}_{t=1}^{\infty}$  as exogenously given.<sup>17</sup>

### 4.4 The Household Problem

Individual state variables for an adult in period  $t$  are  $(y_t, h_t, k_t)$ . In period  $t$  parents choose their own consumption,  $c_t$ , the time their child spends in the market and household sectors,  $m_t$  and  $n_t$ , whether they send their child to school,  $s_t$ , the level of their child's human capital,  $h_{t+1}$ , and the size of their bequest,  $k_{t+1}$ , to solve

$$V_t(y_t, h_t, k_t; \Phi_t) = \max_{c_t, m_t, n_t, s_t, h_{t+1}, k_{t+1}} \left\{ u(c_t) + \beta \sum_{y_{t+1} \in Y} \pi(y_{t+1} | y_t) V_{t+1}(y_{t+1}, h_{t+1}, k_{t+1}; \Phi_{t+1}) \right\} \quad (7)$$

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<sup>17</sup>That is, we do not study the issue of optimal child labor legislation for a broader class of policies that may include type-specific education taxes and subsidies.

subject to the constraints (3), (6), the constraints

$$\begin{aligned}
0 &\leq m_t \leq 1 \\
0 &\leq n_t \leq 1 \\
c_t &\geq 0, k_{t+1} \geq 0 \\
s_t &\in \{0 + \mu_t, 1\}
\end{aligned} \tag{8}$$

and the budget constraints

$$c_t + \kappa(1 - \mu_t)s_t + k_{t+1} \leq (1 - \mu_t\tau_t)[(y_t h_t + (1 - \nu_t)m_t)w_t + r_t k_t] + k_t + f(n_t) \tag{9}$$

where  $w_t$  is the real wage per efficiency unit of labor in the market sector and  $r_t$  is the real interest rate. Note that the efficiency of a child working in the market sector is normalized to 1. Also note that the restriction  $k_{t+1} \geq 0$  imposes the assumption of non-negative bequests, ruling out parental borrowing against a child's labor income. The parameter  $\kappa$  denotes the real resource cost of education per pupil that parents must pay for their child's education. The household takes the government policies  $(\nu_t, \mu_t, \tau_t)$ , prices  $(w_t, r_t)$  and the distribution of types  $\Phi_t$  as exogenously given. We include  $\Phi_t$  as an aggregate state variable in the household's problem for the following reason: the aggregate distribution over types determines the aggregate stocks of physical and human capital as well as aggregate labor supply. These in turn imply the factor prices,  $r_t$  and  $w_t$ , which households need to know in order to solve their maximization problem. For the same reason, households need to forecast tomorrow's distribution over types,  $\Phi_{t+1}$ , as it affects the maximization problem that their children will solve (and hence the child's maximal utility given their individual state  $(y_{t+1}, h_{t+1}, k_{t+1})$ ).

We are now ready to define a competitive equilibrium for our economy.

## 4.5 Competitive Equilibrium

Define  $Z = Y \times \mathbf{R}_+ \times \mathbf{R}_+$  to be the set of all possible  $(y_t, h_t, k_t)$ . Let  $\mathcal{B}(\mathbf{R}_+)$  be the Borel  $\sigma$ -algebra of  $\mathbf{R}_+$  and  $\mathcal{P}(Y)$  be the power set of  $Y$ . Then let  $\mathcal{B}(Z) = \mathcal{P}(Y) \times \mathcal{B}(\mathbf{R}_+) \times \mathcal{B}(\mathbf{R}_+)$  and  $\mathbf{M}$  be the set of all finite measures on the measurable space  $(Z, \mathcal{B}(Z))$ .

**Definition 1** *Given the initial distribution  $\Phi_1$ , and child labor legislation  $\{\nu_t, \mu_t\}_{t=1}^\infty$  a competitive equilibrium is a sequence of individual functions for the household  $\{V_t, c_t, m_t, n_t, s_t, h_{t+1}, k_{t+1} : Z \times \mathbf{M} \rightarrow \mathbf{R}\}_{t=1}^\infty$ , sequences*

of production plans for the firm  $\{N_t, K_t\}_{t=1}^\infty$ , factor prices  $\{w_t, r_t\}_{t=1}^\infty$ , aggregate human capital levels  $\{\bar{H}_t\}_{t=1}^\infty$ , government taxes  $\{\tau_t\}_{t=1}^\infty$ , and a sequence of measures  $\{\Phi\}_{t=1}^\infty$  such that, for all  $t$ ,

1. (Maximization of Households): Given  $\{w_t, r_t, \bar{H}_t\}$  and  $\{\nu_t, \mu_t, \tau_t\}$  the functions  $\{V_t\}$  satisfy (7) and  $\{c_t, m_t, n_t, s_t, h_{t+1}, k_{t+1}\}$  are the associated policy functions
2. (Marginal Product Pricing): The prices  $w_t$  and  $r_t$  satisfy

$$w_t = A(1 - \theta) \left( \frac{K_t}{N_t} \right)^\theta \bar{H}_t^\gamma \quad (10)$$

$$r_t = A\theta \left( \frac{N_t}{K_t} \right)^{1-\theta} \bar{H}_t^\gamma - \delta. \quad (11)$$

3. (Government Budget Constraint): If  $\mu_t = 0$  then  $\tau_t = 0$  and if  $\mu_t = 1$  then

$$\tau_t = \frac{S_t \kappa}{w_t N_t + r_t K_t} \quad (12)$$

4. (Market Clearing):

$$\begin{aligned} & \int c_t(y_t, h_t, k_t) d\Phi_t + \kappa \int s_t(y_t, h_t, k_t) d\Phi_t + K_{t+1} \\ &= AK_t^\theta N_t^{1-\theta} \bar{H}_t^\gamma + \int B[n_t(y_t, h_t, k_t)]^\alpha d\Phi_t + (1 - \delta)K_t. \end{aligned} \quad (13)$$

$$N_t = \int (y_t h_t + m_t(y_t, h_t, k_t)) d\Phi_t \quad (14)$$

$$K_{t+1} = \int k_{t+1}(y_t, h_t, k_t) d\Phi_t \quad (15)$$

$$\bar{H}_{t+1} = \int h_{t+1}(y_t, h_t, k_t) d\Phi_t \quad (16)$$

$$S_t = \int s_t(y_t, h_t, k_t) d\Phi_t \quad (17)$$

5. (*Aggregate Law of Motion*):

$$\Phi_{t+1} = \Gamma_t(\Phi_t) \quad (18)$$

We can write the functions  $\Gamma_t$  explicitly as follows. Define the Markov transition functions  $Q_t : Z \times \mathcal{B}(Z) \rightarrow [0, 1]$  induced by  $\pi$ ,  $h_{t+1}(y, h, k; \Phi_t)$  and  $k_{t+1}(y, h, k; \Phi_t)$  as

$$Q_t((y, h, k), (\mathcal{Y}, \mathcal{A}, \mathcal{C})) = \sum_{y' \in \mathcal{Y}} \begin{cases} \pi(y'|y) & \text{if } h_{t+1}(y, h, k; \Phi_t) \in \mathcal{A} \text{ and } k_{t+1}(y, h, k; \Phi_t) \in \mathcal{C} \\ 0 & \text{else} \end{cases} \quad (19)$$

for all  $(y, h, k) \in Z$  and all  $(\mathcal{Y}, \mathcal{A}, \mathcal{C}) \in \mathcal{B}(Z)$ . Then

$$\Phi_{t+1}(\mathcal{Y}, \mathcal{A}, \mathcal{C}) = [\Gamma_t(\Phi_t)](\mathcal{Y}, \mathcal{A}, \mathcal{C}) = \int Q_t((y, h, k), (\mathcal{Y}, \mathcal{A}, \mathcal{C})) d\Phi_t \quad (20)$$

for all  $(\mathcal{Y}, \mathcal{A}, \mathcal{C}) \in \mathcal{B}(Z)$ .

A steady-state equilibrium is an equilibrium such that all elements of the equilibrium that are indexed by  $t$  are constant over time.

## 5 Policy Experiments

Our benchmark economy has no child labor legislation in place (i.e.  $\nu_t = \mu_t = \tau_t = 0$ ). We assume that the economy has lasted long enough to have settled down to the steady state equilibrium associated with the absence of child labor legislation. We denote by period  $t = 1$  this initial steady state.

We consider three policy reforms. A reform is carried out at the beginning of period  $t = 2$ , and the government is perfectly committed to this reform. The reform is not expected by any household, but once it is carried out, all agents of the economy correctly believe that it stays in place for all time. Hence we do not explicitly model the economic effects from a potential anticipation of reforms to come in the future. The three reforms that we consider are

- Adoption of a child labor ban only:  $\nu_t = 1$ ,  $\mu_t = 0$  and  $\tau_t = 0$  for all  $t \geq 2$ . The budget constraint of the parent then becomes

$$c_t + \kappa s_t + k_{t+1} \leq y_t h_t w_t + (1 + r_t)k_t + Bn_t^\alpha \quad (21)$$

Parents can no longer choose to have their child work in the market sector for the wage  $w_t$ , but can still have their children work in the household sector for their entire time allotment. With no mandatory education law, parents must pay the resource cost  $\kappa$  to send their children to school.

- Adoption of a mandatory schooling law only:  $\nu_t = 1$ ,  $\mu_t = 1$  and  $\tau_t = \frac{\kappa}{w_t N_t + r_t K_t}$  for all  $t \geq 2$ . The parental budget constraint becomes

$$c_t + k_{t+1} \leq (1 - \tau_t) [(y_t h_t + m_t) w_t + r_t k_t] + k_t + B n_t^\alpha \quad (22)$$

The government provides free schooling to each child, paying the resource cost  $\kappa$ , and imposing the restriction

$$s_t \equiv 1. \quad (23)$$

In this scenario all parents and children working in the market sector pay an income tax  $\tau_t$  which reduces the payoff of having a child work in the market sector. However, a child can now attend school without the parent paying tuition. The tax rate is set so as to balance the government budget, and all children (i.e. a measure 1 of pupils) attend school.

- Adoption of both laws simultaneously:  $\nu_t = 0$ ,  $\mu_t = 0$  and  $\tau_t = \frac{\kappa}{w_t N_t + r_t K_t}$  for all  $t \geq 2$ . The budget constraint becomes

$$c_t + k_{t+1} \leq (1 - \tau_t) (y_t h_t w_t + r_t k_t) + k_t + B n_t^\alpha \quad (24)$$

This policy combines the previous two policies, restricting the choice of parents even further. They must send their children to school, and the remainder of the children's time will, by default, be spent in the household sector.

To assess the welfare consequences of different policy reforms, we compute consumption equivalent variation measures for different groups of agents. We ask by what percentage a dynasty's consumption has to be increased, for all times and all contingencies, in the old steady state with no child labor legislation, in order to be indifferent to a policy reform inducing a transition to the new steady state. Note that this measure explicitly captures welfare along the transition path. Assuming CRRA utility with coefficient of relative risk aversion  $\sigma$ , we can easily compute this measure as

$$EV(y, h, k) = \left( \frac{V_2(y, h, k)}{V_1(y, h, k)} \right)^{\frac{1}{1-\sigma}}. \quad (25)$$

For example, an  $EV(y, h, k) = 1.05$  means that a dynasty starting with  $(y, h, k)$  experiences a welfare gain from a given reform equivalent to receiving 5% higher consumption for all time and all states in the old steady state.

Similarly, to compare *steady state* welfare between a regime with no policy and a regime with child labor legislation, we compute the consumption equivalent variation of a dynasty about to be born into the new as compared to be born into the old steady state, i.e. under the veil of ignorance, as

$$EV^{SS} = \left( \frac{\int V_T(y, h, k) d\Phi_T}{\int V_1(y, h, k) d\Phi_1} \right)^{\frac{1}{1-\sigma}} \quad (26)$$

where with  $T$  we index variables in the new steady state.

## 6 Model Calibration

The model parameters are calibrated so that the initial steady state without child labor laws replicates selected observations in the U.S. economy during the time before most states adopted such laws<sup>18</sup>. We calibrate to available data from around 1870 for this reason. As individuals live for only two periods, the duration of a period in the model is interpreted as being 20 years. This is consistent with U.S. data on average life expectancy (given successful birth), which estimates the average life span at this time to be approximately 40 years.

### 6.1 Technology

For the market sector we normalize  $A = 1$  and set the capital share of income to  $\theta = 0.4$ . This value is consistent with census data from 1890 (Spahr, 1970): aggregate income from labor was \$6,460 million and income from capital was \$4,340. It is also consistent with values used in business cycle studies for the post-war U.S. (e.g. Cooley and Prescott, 1995).

The value of the externality parameter  $\gamma$  cited in the literature falls in a fairly large interval  $\gamma \in [0, 0.417]$  where the upper end of the interval stems from Lucas (1988). Borjas (1992) and also Carpena and Santos (2000) find values of 0.18 and 0.15, respectively. Using the lower of these values as

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<sup>18</sup>According to the data in Landes and Solmon (1972) the only states that had passed mandatory education legislation before the 1869-70 school year were Massachusetts, which passed a law in 1852 requiring children of ages 8-14 to attend school for 20 weeks each year, and Vermont, which passed a law with the same requirements in 1867.

benchmark, we conduct sensitivity analysis on gamma to assess how the results change when there is no externality, and as the value of the externality is increased over the range  $\gamma \in [0, 0.15]$ . Finally, the chosen value for depreciation  $1 - \delta = (1 - 0.06)^{20} = 0.71$  is standard in business cycle research, as we do not have reliable data on capital stocks or investment for the U.S. economy before the turn of the century.

In choosing the scale parameter  $B$  and the curvature parameter  $\alpha$  for the household production function we note that parents, absent any child labor legislation, choose their child's labor supply so as to equate the return from the market and household sectors. Equality of the return to child labor in the market and household sectors implies the marginal condition

$$w = \alpha B(n)^{\alpha-1} \quad (27)$$

Solving for the household sector labor supply of the child as a function of the market sector wage  $w$  and taking logs of this function implies that the child labor elasticity in the household sector with respect to the wage in the market sector,  $\varepsilon_w$ , is given by

$$\varepsilon_w = \frac{d \log n(w)}{d \log w} = -\frac{1}{1 - \alpha}. \quad (28)$$

With an empirical estimate for  $\varepsilon_w$  we can pin down  $\alpha$ . This elasticity, however, is very difficult to estimate. The most closely related estimate we found in the empirical literature refers to the child labor elasticity in the *market* sector with respect to the market sector wage. Bhalotra (2000) estimated this own sector elasticity to be  $-1$ . As we would expect child labor in the household sector to increase with a decrease in the market sector wage the cross-sector elasticity should also be negative and of similar, possibly higher<sup>19</sup>, magnitude; for lack of better evidence we assume a value of  $\varepsilon_w = -1.25$  which implies  $\alpha = 0.2$ . The scale parameter  $B$  is then chosen to match the ratio of output in the household sector relative to total GDP of 0.53 in the benchmark steady state equilibrium. This number is motivated by the fact that the fraction of GDP produced in the agricultural sector, which we interpret as closest to our household production sector, was about 0.53 in 1870 in the U.S. This yields  $B = 2.0$ .

With respect to the technology parameters governing human capital accumulation, the chosen value of  $l = 0.2$  indicates that 20% of a child's time is spend in school if schooling is chosen by their parents or dictated by the

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<sup>19</sup>Because of the potential substitution of child labor in the informal sector with child labor in the formal sector.

government. This value is based on four key assumptions: (1) Children have 12 non-leisure hours five days a week to work or go to school. (2) If a child does go to school, time in class plus transportation time is equal to 6 hours. (3) Mandatory education laws in individual states specified the ages for which a child must attend school and the number of weeks of attendance per year. On average, these policies required children of ages 8-14 to attend school for 16 weeks per year (Landes and Solmon, 1972). This would imply that children attended school for 80 days per year. However, data from the Department of Education (1997) indicates that during the 1869-1870 school year, the average term length was 132 days. We assume that children are in school for the entire term if they attend. (4) If a child is sent to school, he or she attends for  $\frac{3}{4}$  of the 20 year period. Thus, given our assumptions, children that attend school spend approximately 20% of their time in school and have 80% of their time left for work in the formal or informal sector.

To calibrate  $\varphi$ , the multiplicative term in the human capital production function, we use the wage premium for education estimated by Acemoglu and Angrist (2000). They find an increase in the wage of approximately 8% per year of schooling. Assuming that a child who attends school does so for six full years yields a skill premium of 48%. Hence  $\varphi l = 0.48$ . With  $l$  calibrated to 0.2 we find  $\varphi = 2.4$ . School expenditures per child,  $\kappa$ , are derived from the annual cost of sending a child to school as a percentage of GDP per capita. The total annual expenditure per pupil in 1870 was \$15.55 in current dollars (U.S. Department of Education, 1997) and GDP per capita was \$170 in current dollars (U.S. Department of Commerce). Thus we select the per pupil schooling cost to be 9% of GDP per capita in our initial steady state where GDP is equal to output in the market sector. This requires  $\kappa = 0.035$ .

Table 2 summarizes our choices of technology parameters.

*Table 2: Technology Parameters*

$A$	1.0
$\theta$	0.4
$\gamma$	0.15
$B$	2.0
$\alpha$	0.2
$\varphi$	2.4
$l$	0.2
$\kappa$	0.035

## 6.2 Preferences and Endowments

We assume that the period utility function of an adult is of Constant Relative Risk Aversion (CRRA) form,

$$\frac{c^{1-\sigma}}{1-\sigma} \tag{29}$$

We choose a coefficient of relative risk aversion  $\sigma = 2$ , well within the values usually employed for business cycle and public finance studies<sup>20</sup>. The time discount factor  $\beta$  is chosen so that the annual risk free real interest rate,  $r$ , in the initial steady state is equal to 2%. This implies  $\beta = (0.979)^{20}$ .

We specify the stochastic component of labor productivity as a symmetric two-state Markov process. Hence the parameters to calibrate are the states of the income process,  $y_l$  and  $y_h$  and the conditional probability that children remain at the same productivity level as their parents,  $\pi$ . We use data on the spread of wages within an education group and intergenerational persistence of income to pin down  $y_h$ ,  $y_l$ , and  $\pi$ . Williamson and Lindert (1980), in studying intrasectoral wage differentials for common laborers in 1850, suggest a wage differential within an educational group of around 60%. Normalizing  $E(y) = 1$  and choosing  $y_l, y_h$  such that  $\frac{y_h}{y_l} = 1.6$  yields values (exploiting the symmetry of the Markov chain<sup>21</sup>) of  $y_l = 0.769$  and  $y_h = 1.231$ . Solon (1992) and Zimmerman (1992) estimate the elasticity of a son's income with respect to his father's income at 0.4. This provides an estimate of persistence. Since, conditional on same education, a lucky parent is 60% richer than an unlucky parent, this number implies that on average children of lucky parents should be 24% richer than children of unlucky parents. We have

$$\begin{aligned} E(y'|y = y_l) &= \pi y_l + (1 - \pi)y_h \\ E(y'|y = y_h) &= \pi y_h + (1 - \pi)y_l \end{aligned} \tag{30}$$

and thus

$$\frac{E(y'|y = y_h)}{E(y'|y = y_l)} = \frac{\pi y_h + (1 - \pi)y_l}{\pi y_l + (1 - \pi)y_h} = 1.24 \tag{31}$$

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<sup>20</sup>For a review of empirical estimates of the intertemporal elasticity of substitution  $\frac{1}{\sigma}$  see Engen et al. (1997).

<sup>21</sup>This symmetry implies that the unique invariant measure associated with the Markov transition matrix puts 50% probability on both states. The expectation of income is with respect to this probability measure.

which yields, conditional on the calibrated values for  $y_l$  and  $y_h$ , a value of  $\pi = 0.732$ .

We summarize our parameter choices governing preferences and endowments in Tables 3 and 4.

*Table 3: Preference Parameters*

$\beta$	$(0.979)^{20}$
$\sigma$	2.0

*Table 4: Endowment Parameters*

$y_h$	1.231
$y_l$	0.769
$\pi$	0.732

## 7 Results

All of the policy experiments that we considered start with an initial steady state with no child labor laws and end in a final steady state with a child labor ban, mandatory education, or both. We first discuss the properties of these four steady states. We then consider the properties of each of the three transitions induced by the various policy reforms. Finally, we discuss the sensitivity of our results to changes in the size of the human capital externality.

### 7.1 Steady State

Table 5 summarizes the values of model variables under a child labor ban, mandatory education, and both policies. For all steady states with child labor legislation we compute the percentage change of a particular variable with respect to the initial steady state with no legislation in place.

Table 5. Steady State Results

Variable	Initial SS	Child Labor Ban	Mandatory Ed.	Both
r (per annum)	0.02	-1.37%	4.81%	5.26%
w	0.3	4.93%	3.18%	3.05%
Y	0.79	-1.25%	9.52%	-3.03%
$Y_{inf}/(Y+Y_{inf})$	0.53	3.38%	-4.01%	4.23%
K/Y	4.09	0.29%	-1.0%	-1.1%
H	1.24	19.35%	19.35%	19.35%
N	1.57	-5.88%	6.18%	-5.88%
$C/(Y+Y_{inf})$	0.88	-0.71%	-1.38%	-0.28%
$EV^{ss}$		1.9%	3.3%	1.7%

### 7.1.1 Child Labor Ban

Comparing the no-policy steady state to the steady state with a ban on child labor in the market sector, we observe that labor supply in the market sector declines and production in the household sector increases significantly. This is because children who formerly worked in the market sector now spend part of their market time (apart from going to school) working in the household sector. This reallocation of child labor increases the real wage of adult workers in the market sector by about 5% and drives down the interest rate by 1.4%. The child labor ban also achieves its direct goal of increasing educational attainment in that every child now goes to school.<sup>22</sup> The steady state welfare effect of such a policy is positive as the increased level of human capital induces, via the human capital externality in the market sector, higher wages. On the other hand, making market labor illegal for children drives child labor supply into the less productive household sector. The marginal return to child labor is about 32% higher in the formal than in the informal sector in equilibrium with a child labor ban.<sup>23</sup> As a consequence, the steady state welfare gains from child labor bans are relatively modest compared to mandatory education laws, but nevertheless sizeable in absolute terms. The steady state equivalent variation amounts to 1.9%, indicating that one would have to raise steady state consumption, for any individual state and for all time, by 1.9% in the initial steady state in order to make

<sup>22</sup>Given our calibration the maximal level of average human capital is  $\bar{H}_{\max} = 1 + \phi l = 1.48$ .

<sup>23</sup>That is,  $w$  is 32% higher than the marginal return in the informal sector at  $n_t = 1 - l$ .

a dynasty *ex ante* indifferent to being born into the old as opposed to the new steady state.

### 7.1.2 Mandatory Education

A mandatory education law that includes free schooling financed by a proportional income tax achieves the same increase in educational attainment in the population as a child labor ban, this time by forcing parents to get their children educated. The steady state effects of mandatory education on factor prices, and hence distribution of wealth and welfare are, however, quite different. Children are allowed to work after school in the market or household sector, and the time now allocated to school is withdrawn from the less productive household sector. This is evident from the rows of Table 5 reporting output in the market and household sectors. Because child labor is still available to the market sector, total effective labor supply in that sector increases by 6% (compared to a 5% drop under a child labor ban). This in turn reduces the increase in the real wage in that sector, which is driven by the bigger externality induced by higher educational attainment and the associated higher average level of human capital.

The proportional tax that finances mandatory education also redistributes income from high-income households to low-income households (whereas a child labor ban with all children attending school is equivalent to a very regressive poll tax). This reduces the after-tax return on assets, which in turn decreases asset accumulation. The capital-output ratio declines with mandatory schooling, reflecting this distortion of the household saving (bequest) decision. In terms of steady state welfare, a mandatory schooling law that includes proportional income tax education financing has substantially larger welfare benefits than a ban on child labor. These bigger welfare gains stem in part from the partial insurance role that redistributive income taxation plays in our environment of uninsurable idiosyncratic labor productivity shocks and borrowing constraints. In this sense a mandatory schooling law partially offsets both inefficiencies present in our model, the human capital externality and incomplete credit markets, whereas a child labor ban only targets the inefficiency arising from the human capital externality.

### 7.1.3 Both Policies

Finally, comparing the steady state with no policy to the steady state in which both policies are in place, we find that, as with a child labor ban only, the labor supply in the market sector shrinks dramatically due to the

forced withdrawal of children from that market. In addition, the proportional income tax to finance outlays for education reduces the return on financial assets and hence capital accumulation. As a result, production in the market sector declines even further than it would under a child labor ban alone, and the relative size of the household sector increases even further (the absolute size remains as large as under a child labor ban alone). Wage increases are more modest than under either single policy and the interest rate increases even further. Roughly, one can conclude that a combination of both policies does not further enhance human capital accumulation (both policies alone result in the maximal average level of human capital technologically feasible), but combines the negative distortions arising from proportional income taxation and suboptimal allocation of a child's working time. Not surprisingly then, a combination of both policies leads to the smallest steady state welfare increase compared to having no policy, with a consumption-equivalent variation of 1.7%.

## 7.2 Transition Paths

The welfare analysis so far has ignored transitional dynamics and distributional details about which of the agents currently alive would benefit and who would suffer from each of the three policy reforms. In Figures 1 through 9 we plot the dynamic transition paths of our economy induced by unexpected policy reforms of the type described above. We also document the welfare consequences of these reforms, disaggregated by the economic status of agents currently alive. If we interpret a household's welfare gains arising from a specific reform as indicating political support for that reform, our model predicts the economic status of reform supporters and opponents. Seen from this perspective our model provides a positive theory for the introduction of child labor legislation.

### 7.2.1 Child Labor Ban

Let us start with the policy that bans child labor in the market sector. From Figures 2 and 3 we see that, upon impact of the (unexpected) reform, the real interest rate collapses and the real wage increases sharply. Both physical and human capital stock are predetermined from the previous period. Suddenly withdrawing children from the market sector sharply increases the capital-labor ratio, and as capital is abundant, its rental price falls and the real wage increases. In the next period the capital stock is able to adjust and declines sharply in reaction to its low return. Together with an increase in

human capital accumulation, and hence effective labor supply, this leads to an overshooting of the interest rate and a temporary decline of the real wage. After these two periods both factor prices converge quite rapidly to their new steady state levels, which is higher for the real wage (due to smaller labor supply and bigger human capital externality) and slightly lower for the real interest rate. Also, after an initial drop when the policy is introduced, both the capital stock as well as output in the market sector increase to their new steady state levels, which remain slightly below initial steady state levels.

The initial movements in factor prices are crucial to analyzing the distribution of welfare effects across the population (and hence to determining political support). Remember that current agents are altruistic, but that they discount the utility of their offspring at a high rate. Remember also that households differ according to three dimensions: labor productivity  $y$ , human capital  $h$  and physical capital  $k$ . From Figure 1 it is evident that, *ceteris paribus*, agents with high capital holdings suffer large welfare losses from a child labor ban. These losses arise because banning children from factories causes the capital in place in these factories to earn a lower return, thereby reducing a main source of income for this group of the population, which one may want to call capitalists.

The welfare effects along the adult's (or household's) labor productivity shock dimension and level of human capital dimension share some common features. A high  $h$  makes for a high current effective labor supply of adults, as does a high  $y$ . In addition, since labor productivity follows a *persistent* Markov process, a high  $y$  also indicates (probabilistically) a high labor productivity shock tomorrow. Hence high  $h$ -agents like reforms most that raise the *current* real wage, while high  $y$ -agents, courtesy of their altruism, like reforms that raise the real wage *persistently*. Remembering from Figure 2 that a child labor ban persistently raises the real wage, it is not surprising to see from Figure 1 that, for a given level of capital holdings, agents with both high current labor productivity and high current human capital profit most, followed by agents with high labor productivity and low human capital, and then those with low productivity and high human capital. However, those workers with low current labor productivity and low human capital are actually worse off under this policy regardless of assets, since an important source of household income, namely income from child labor in the formal sector, is missing in their budgets. Thus our empirical model prediction is that capitalists and low-skilled, low-productivity workers oppose child labor bans, while supporters should be found mainly among high-skilled, high-productivity workers with little capital income.

Our model determines the fraction of agents with particular character-

istics endogenously in any given point of time. Hence Figure 1 has to be “weighted” by the initial steady state distribution over types, in order to determine what fraction of the population would benefit from and hence support a transition of the economy without child labor legislation to an economy with a child labor ban, where the new legislation is introduced in period 1 and remains in place thereafter. Note again that, in their choice, agents fully consider transition dynamics effects on factor prices and hence their welfare. We find that only about 42% of the population would prefer to adopt a child labor ban, despite the *steady state welfare gains* associated with such a reform. These findings demonstrate that a steady state utilitarian welfare functional can mask significant distributional conflicts, and that a full analysis of the transition path induced by a policy reform seems necessary to assess that reform’s welfare consequences. Transitions can take time and may require economic sacrifices that make the reform undesirable from a normative perspective.

### 7.2.2 Mandatory Education

Turning to a mandatory education law we see from Figure 5 that factor prices react in a qualitatively similar, but quantitatively less pronounced fashion compared to a child labor ban. Again the physical and human capital stocks are initially predetermined, but there is a reduction in the labor supply as a certain fraction of schooling time comes from reducing the hours supplied to the market sector. The decline in labor supply with a constant stock of physical capital drives the interest rate down and the real wage up. As the change in the child labor supply in the market sector is modest under this reform and the reaction of the human capital accumulation due to forced schooling is rapid, the interest rate overshoots quickly and in a more pronounced fashion (when compared to a child labor ban) and then settles at the higher, new steady state level.

Mandatory education legislation causes wages to rise more modestly than they would in response to a child labor ban, and also settle at a higher level in the new steady state. Figure 4 shows how this quantitatively different reaction of factor prices affects the distribution of welfare along the three dimensions of heterogeneity. Corresponding to the smaller initial decline in interest rates, welfare losses increase only slowly with asset holdings and remain modest in size. Welfare gains of agents, for fixed assets, with different levels of productivity and human capital, do not diverge as much, due to the rather limited increase in the real wage. The welfare consequences of this reform seem more modest for all groups of the population; political support

for such legislation, however, is almost univocal as about 98% of the current population benefits from the reform. This sharp increase in political support is primarily due to the fact that, apart from agents who derive just about all their income from assets, all agents benefit more from increasing wages than they lose from lost capital income due to initially (modestly) lower returns on their assets.

### 7.2.3 Both Policies

Finally, shifting attention to Figures 7, 8 and 9 we see that the allocative and welfare consequences of simultaneously adopting both policies closely parallel those of a child labor ban, and the same intuition applies. It is worth pointing out, however, that, although a steady state welfare comparison favors a child labor ban over the adoption of both policies, counting political support with explicit consideration of the transition path shows that joint interaction of both policies would be supported by roughly 57% of the current population, while a child labor ban alone would be defeated. This is due to the fact that low productivity-low human capital-low asset families support both policies jointly, but not a ban on child labor separately since mandatory education comes with an effective education subsidy of the wage-poor whereas a child labor ban does not.

## 7.3 Sensitivity Analysis

The steady state and transition results outlined above are derived from the model, with a particular calibration described in detail in Section 6. One controversial model parameter is the human capital externality, which we set to  $\gamma = 0.15$ . We conducted sensitivity analysis for the range  $\gamma \in [0, 0.15]$  to determine how a weaker human capital externality would affect our results. The human capital externality is one of the reasons that child labor legislation has potentially positive welfare effects in our model. But even in its absence, policy interventions may be called for to offset the inability of households to write contracts contingent on idiosyncratic income shocks and, more importantly, to borrow against their children's income. Hence, although weakening the externality will weaken positive welfare effects and political support for child labor legislation, it is not clear *a priori* that even eliminating the human capital externality altogether will result in rejection of the reforms and/or negative welfare effects. Figure 10 shows the relationship between the size of the human capital externality and political support for the three reforms.

Looking first at the case of eliminating the externality ( $\gamma = 0$ ) we find that none of the three policies obtains majority support. Further, while mandatory schooling received the most support using the initial value of the externality, it now receives the least support, while a child labor ban is the most preferred policy. The main factor driving this result is that a policy change only induces very minor changes in the wage and interest rate when there is no human capital externality. Thus, the only household types that benefit from mandatory schooling are high-wage workers with little or no assets. These households, however, would prefer child labor bans that increase the real wage to a larger extent, as discussed above. A reform enacting both policies imposes redistributive taxes on this group as well, so a pure child labor ban finds more support among this group.

As gamma is increased over the range  $\gamma = (0, 0.05)$  support for a child labor ban and both policies grows, although at a very slow rate, as high productivity, high/low human capital workers with an increasing amount of assets now favor these policies. However, all other types continue to suffer because their children cannot work in the market sector for a wage. In contrast, support for mandatory education grows fairly rapidly. This is primarily due to the impact of the human capital externality on prices. Low-wage households and those with more than negligible asset holdings are still opposed to any legislation. Support for a child labor ban and mandatory education are nearly equal, at just over 20%, when  $\gamma = 0.05$ .

For the range  $\gamma = (0.05, 0.1)$  mandatory education attracts growing support as the effect of the externality on the wage increases and this begins to impact less productive households, as the wage increase starts to offset the cost (in terms of forgone income) of sending a child to school. This policy is now supported by low productivity, high skilled workers with little assets - a group that still does not support child labor bans or both policies because they force children out of the market sector. A child labor ban and both policies continue to have the support of high productivity, high/low human capital workers, now including those with larger asset holdings. At approximately  $\gamma = 0.075$ , mandatory education garners the support of 50% of all households. Further, at  $\gamma > 0.075$ , having both policies is preferred to a child labor ban alone.

Finally, for  $\gamma = (0.1, 0.15)$ , mandatory education gains the support of low productivity, low skilled workers. Now all households with low asset holdings support mandatory education. At this higher level of the externality, the combination of both policies is supported by the low productivity, high skilled types. Majority support for this policy comes at a gamma of approximately 0.125, because of the benefits of the mandatory education law.

Those households with low productivity and low skills continue to oppose a child labor ban for the reasons discussed above.

## 8 Conclusions

What role does economic inequality play in support for the adoption of child labor legislation? According to our findings, a decisive role. From our reading of the historical literature, those groups that supported or opposed child labor legislation in the late 19th century U.S. can be categorized into different types: factory owners, highly skilled labor union members, middle class households, where the women may have worked but were politically active, and poor households that needed the income from the labor of their children in the market sector. Historically, supporters of mandatory education and child labor bans were unions and women's groups; their biggest opponents were found among factory and mill owners who used child labor, and the poorest members of the population.

Using a dynamic heterogeneous agent general equilibrium model, we have investigated the welfare consequences of child labor policies for different groups of the population, both in the steady state and along the transition from a steady state with no policy to one with a child labor policy. Our basic finding is that the predications of the model regarding support for and opposition to child labor, as a function of economic status of households, are consistent with historical facts: the owners of capital in our model, *ceteris paribus*, are opposed to all policies; the wage-poor suffer whenever a policy keeps their children from earning a wage in the formal market sector; and the highly skilled, high-productivity workers always benefit the most from child labor legislation, which drives up their real wages and thus earns their support for reforms. Finally, middle class households (those with high productivity and low skills, and, hence, intermediate labor income) are not far behind, both with respect to the benefits they obtain from the reforms as well as support they lend to them.

Our study has abstracted from economic growth as a potential driving force for the introduction of child labor legislation.<sup>24</sup> A complete account for the historical experience of the U.S. with respect to child labor legislation may require a model combining growth and distributional aspects. We conjecture that the most interesting implications of growth relate to the

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<sup>24</sup>Alternatively, it would be quite intriguing to study the reverse causality, the effects that child labor legislation has (had) on economic growth by extending our human capital production function to allow for economic growth, as in Lucas (1988).

*timing* of the introduction of child labor legislation, but will leave our basic conclusions about the *distributional* consequences of and differential political support for reforms unchanged. Assessing the validity of this conjecture will require a model in which the wealth distribution changes endogenously along the growth process. We view this as the next step, left to future research, in our quest to understand the economic forces leading to the establishment of child labor legislation, historically in the U.S. and, later in other, economically less developed parts of the world.

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## A Computation

We discretize the state space by choosing a finite grid for assets,  $\mathcal{K} = \{0, \dots, k_{nk}\}$ . However, we do not restrict optimal asset choices to lie in the grid by using linear interpolation (see below). Individual human capital at period  $t$  can take on values in  $\mathcal{H} = \{1, 1 + \varphi l\}$  and idiosyncratic labor productivity falls into the finite set  $Y$ . The joint measure over labor productivity status, human capital and physical capital,  $\Phi_t$  can then be represented as a finite-dimensional array.

### A.1 Basic Algorithm

The structure of the algorithm to compute the equilibrium is as follows:

1. Compute initial steady state without child labor legislation.
  - (a) Guess  $r, N, H$  and compute  $K, w$  from the marginal conditions of the firm<sup>25</sup>
  - (b) Solve the functional equation of the household problem

$$V(y, h, k) = \max_{c, m, n, s, h', k'} u(c) + \beta \sum_{y' \in Y} \pi(y'|y) V(y', h', k')$$

s.t. (32)

$$c + \kappa s + k' \leq (yh + m)w + (1 + r)k + f(n) \quad (33)$$

and subject to the human capital production function and other non-negativity and time constraints.

- (c) Use decision rules  $h', k'$  and  $\pi$  to induce a Markov process on  $Z = Y \times \mathcal{H} \times \mathcal{K}$ . Compute the invariant measure  $\Phi$  associated with this Markov process.
- (d) Use  $\Phi$  and decision rules to compute

$$\begin{aligned} H_{new} &= \int h d\Phi \\ N_{new} &= \int (hy + m(y, h, k)) d\Phi \\ K_{new} &= \int k d\Phi. \end{aligned} \quad (34)$$

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<sup>25</sup>Like all models with externalities our model potentially has multiple equilibria. We assured that for the parameter values used this is not the case by starting with alternative guesses for  $H$  and finding that for all such guesses the algorithm always converges to the same equilibrium.

Note that by Walras law the goods market also clears (a useful check on the code).

- (e) Use marginal conditions to compute  $r_{new}, w_{new}$ .
- (f) If

$$\max\{|H_{new} - H|, |N_{new} - N|, |K_{new} - K|\} < \varepsilon \quad (35)$$

then stop and denote the solutions by  $V_1, \Phi_1, H_1, K_1$  and so forth. If not, then use  $(r_{new}, N_{new}, H_{new})$  to update the guesses for  $r, N, H$  and go to step (b).

2. Fix the horizon of the transition period,  $T$ .  $T$  should be large enough so that by reducing the transition length to  $T - 1$  does not affect the transition path.
3. Compute final steady state. This is the same as for the initial steady state, with budget constraint

$$c + \kappa(1 - \mu)s + k' \leq (1 - \mu\tau) [(yh + (1 - \nu)m)w + rk] + k + f(n) \quad (36)$$

for any combination of constant policies  $(\nu, \mu)$  and tax rate  $\tau$  satisfying

$$\tau = \frac{\kappa}{wN + rK}. \quad (37)$$

Denote the solution by  $V_T, \Phi_T, H_T, K_T$ .

4. Compute the Transition Path.
  - (a) Guess  $\{r_t, N_t, H_t\}_{t=2}^{T-1}$  and compute  $\{K_t, w_t, \tau_t\}_{t=2}^{T-1}$ .
  - (b) Working backwards from period  $T - 1$ , compute value functions and policy functions for all transition periods by using  $v_T(\cdot)$  from final steady state.
  - (c) Use the decision rules  $h_{t+1}, k_{t+1}$ , together with  $\pi$  to construct the laws of motions  $\Gamma_t$  as described in the main text. Then start with  $\Phi_2 = \Phi_1$  to compute  $\{\Phi_t\}_{t=3}^{T-1}$  recursively as

$$\Phi_{t+1} = \Gamma_t(\Phi_t). \quad (38)$$

- (d) Use  $\{\Phi_t\}_{t=2}^{T-1}$  and the decision rules to compute  $\{r_t^{new}, N_t^{new}, H_t^{new}, K_t^{new}, w_t^{new}\}_{t=2}^{T-1}$  as for the initial steady state.

(e) If

$$\max_t \max\{|H_t^{new} - H_t|, |N_t^{new} - N_t|, |K_t^{new} - K_t|\} < \varepsilon \quad (39)$$

then stop. If not, then use  $\{r_t^{new}, N_t^{new}, H_t^{new}\}_{t=2}^{T-1}$  to update guesses for  $\{r_t, N_t, H_t\}_{t=2}^{T-1}$  and go to step (b).

5. Compute welfare measures. Given the form of the utility function, welfare measures (consumption equivalent variation) are easily computed as:

$$EV(y, h, k) = \left( \frac{V_2(y, h, k)}{V_1(y, h, k)} \right)^{\frac{1}{(1-\sigma)}} \quad (40)$$

$$EV^{SS} = \left( \frac{\int V_T(y, h, k) d\Phi_T}{\int V_1(y, h, k) d\Phi_1} \right)^{\frac{1}{(1-\sigma)}}. \quad (41)$$

## A.2 Solution of the Household Problem

We now describe the step of solving for optimal policy functions in more detail. For simplicity we use notation for steady states, noting that along the transition path all relevant functions are indexed by  $t$  and  $t+1$ , respectively. Take  $w, r$  as given.

For fixed  $s \in \{0, 1\}$  we first solve for the optimal allocation of a child's time. Denote as  $\bar{n} = f^{-1}((1-\tau)w)$ . If  $\nu = 1$  (child labor law in place), then  $m(s) = 0$  and  $n(s) = 1 - sl$ . If  $\nu = 0$  then

$$n(s) = \min\{\bar{n}, 1 - sl\} \quad (42)$$

and  $m(s) = 1 - sl - n$ . Note that  $s$  uniquely determines  $h'(s) = 1 + s\varphi l$ . After substituting the budget constraint for  $c = c(s, k'; y, k, h)$  into the utility function we obtain as household maximization problem, for a given guess of the value function  $V^j$  (restricted to be piecewise linear, so that  $V^j$  can be represented by an  $(N, 2, nk)$ -array)

$$V^{j+1}(y, h, k; s) = \max_{k' \geq 0} \{u(c(s, k'; y, k, h)) + \beta \sum_{y' \in Y} \pi(y'|y) V^j(y', h', k')\}. \quad (43)$$

This is a one-dimensional maximization problem in  $k'$ , solved with a standard routine for constrained optimization. Let  $k'(s)$  denote the solution

to this problem; it is not constrained to lie on the grid  $\mathcal{K}$ . The optimal schooling decision is then

$$\begin{aligned}
s^* &= \arg \max_s V^{j+1}(y, h, k; s) & (44) \\
&= \arg \max_s \{u(c(s, k'(s); y, k, h)) + \beta \sum_{y' \in Y} \pi(y'|y) V^j(y', h', k'(s))\} & (45)
\end{aligned}$$

Standard value function iteration is used to solve for the value function in the initial and final steady state; for the transition, since  $V_T$  is known one can solve for  $\{V_t\}_{t=2}^{T-1}$  backwards.

Since we store the joint distribution  $\Phi$  only on the finite grid points for capital  $\mathcal{K}$ , an individual with choice  $k'(y, h, k) \in (k_j, k_{j+1})$  is interpreted to choose asset holdings  $k_j$  with probability  $p$  and asset holdings  $k_{j+1}$  with probability  $1 - p$ , where  $p$  solves  $k'(y, h, k) = pk_k + (1 - \kappa)k_{k+1}$ .

In our computations the number of grid points was chosen to be  $nk = 300$ . Experiments with larger grid sizes yielded results that were virtually indistinguishable from the ones reported in the text. Taking into account the concavity of the problem, we chose a grid in which the spacing between grid points increases with capital levels. Our grid is given as

$$k_j = b \left( \frac{j-1}{nk-1} \right)^c, \quad j = 1, \dots, nk. \quad (46)$$

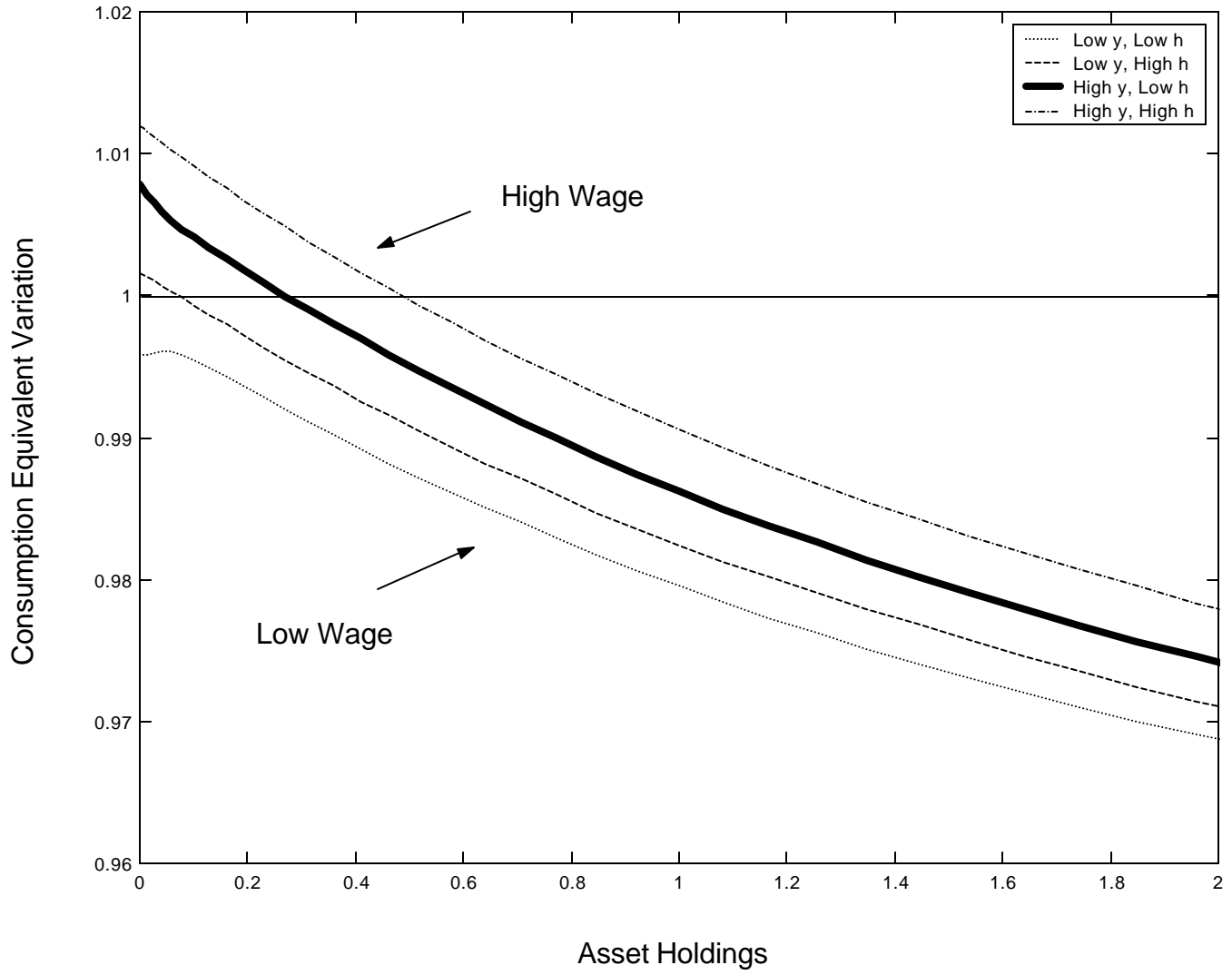
The parameter  $c$  controls the spacing between grid points and was chosen to  $c = 3$ , whereas  $b$  controls the scale of the grid and was chosen so that the implied upper bound for asset holdings was never binding ( $b = 10$  was sufficient for this).

**Table 1. Year of Child Labor Legislation for U.S. States**

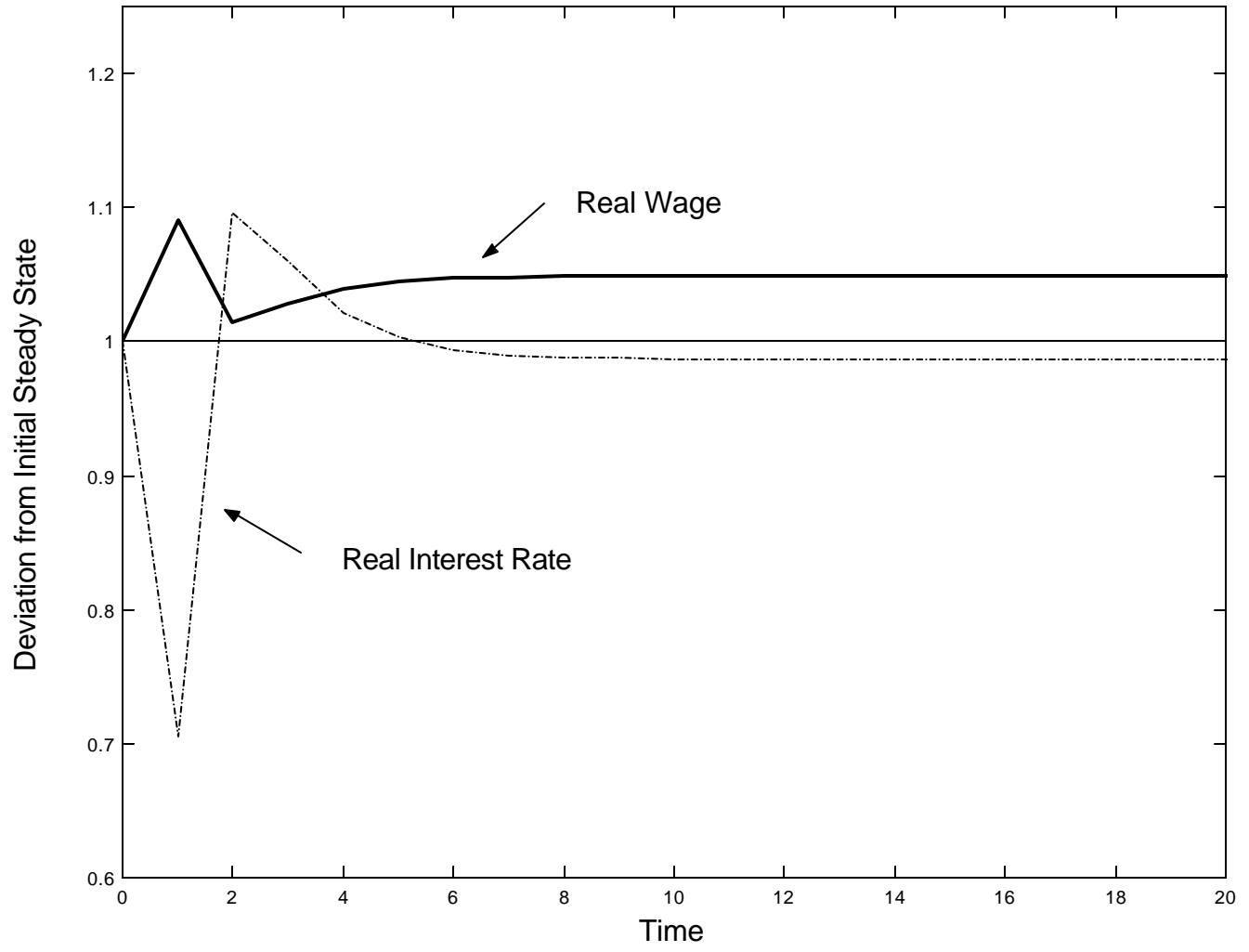
<b>State</b>	<b>Child Labor Ban</b>	<b>Mandatory Education</b>
Massachusetts	1860	1852
Vermont	1867	1867
New Hampshire	1846	1871
Michigan	1881	1871
Washington*	1888	1871
Connecticut	1842	1872
Nevada	1909	1873
New York	1865	1874
California	1868	1874
Kansas	1883	1874
New Jersey	1851	1875
Maine	1883	1875
Wyoming*	1886	1876
Ohio	1880	1877
Wisconsin	1867	1879
Rhode Island	1872	1883
Illinois	1877	1883
Montana*	1887	1883
North Dakota*	1890	1883
South Dakota*	1890	1883
Minnesota	1878	1885
Nebraska	1887	1887
Idaho*	1889	1887
Colorado	1876	1889
Oregon	1903	1889
Utah*	1891	1890
New Mexico*	1891	1891
Pennsylvania	1883	1895
Kentucky	1894	1896
Hawaii*	1901	1896
Indiana	1879	1897
West Virginia	1887	1897
Arizona*	1901	1899
Iowa	1874	1902
Maryland	1878	1902
Missouri	1887	1905
Tennessee	1893	1905
Oklahoma*	1890	1907
Delaware	1893	1907
North Carolina	1897	1907
Virginia	1890	1908
Arkansas	1893	1909
Louisiana	1886	1910
Alabama	1887	1915
Florida	1901	1915
South Carolina	1903	1915
Texas	1903	1915
Georgia	1882	1916
Mississippi	1908	1918
Alaska*	1899	1929

Note: data from Landes and Solmon (1972) and Ogburn (1912). \* indicates passage pre-statehood.

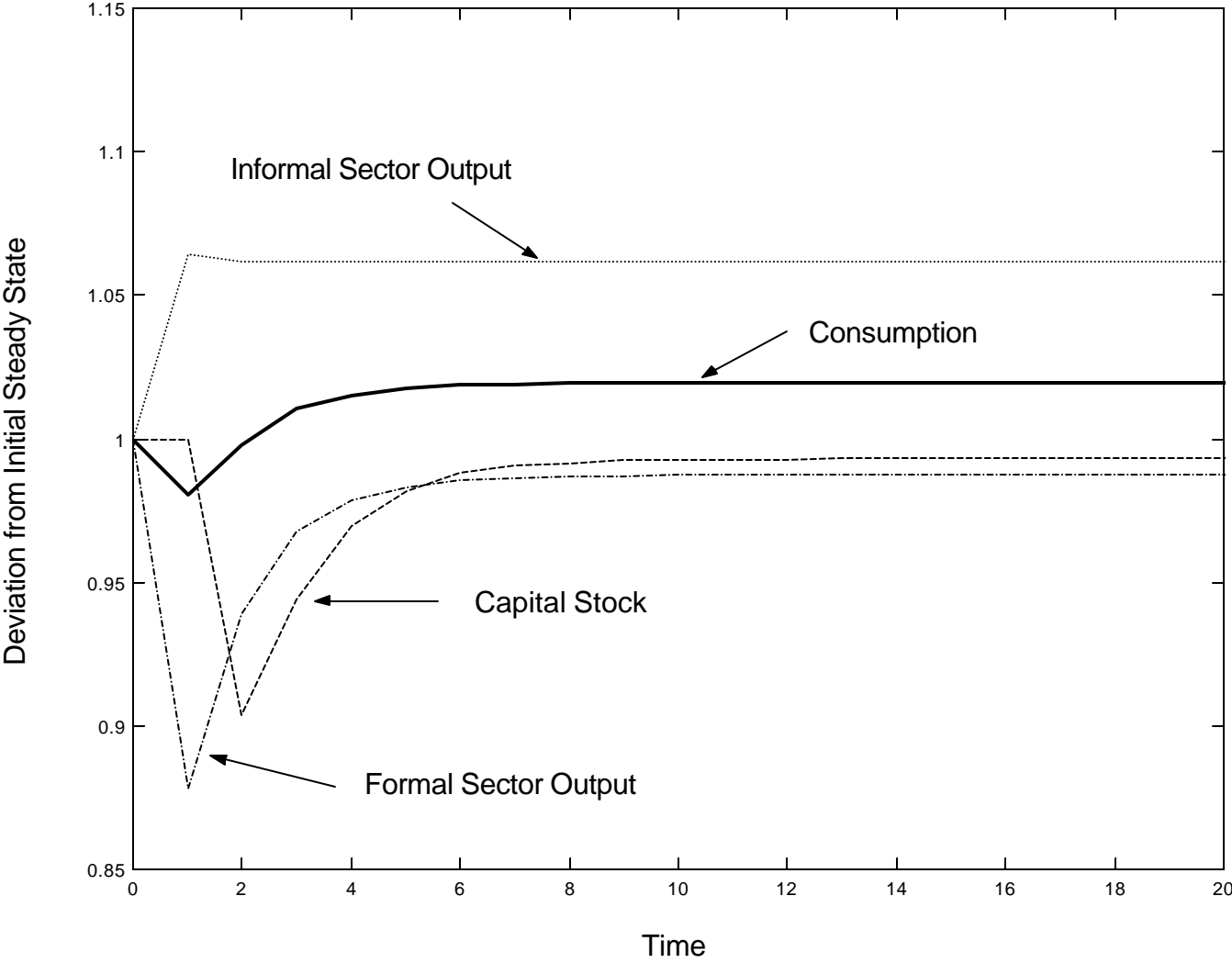
**Figure 1. Welfare Effects of Child Labor Ban**



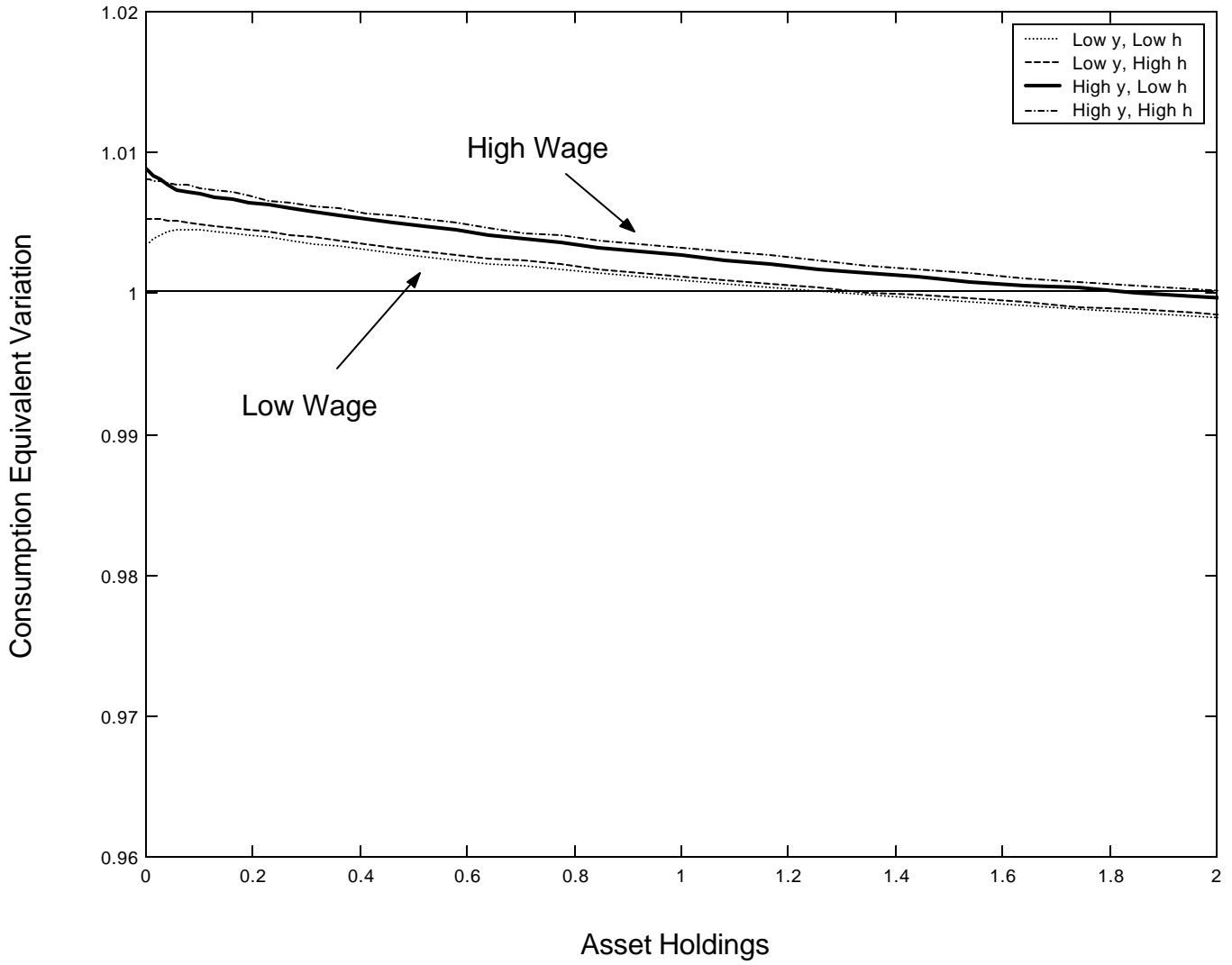
**Figure 2. Evolution of Prices with Child Labor Ban**



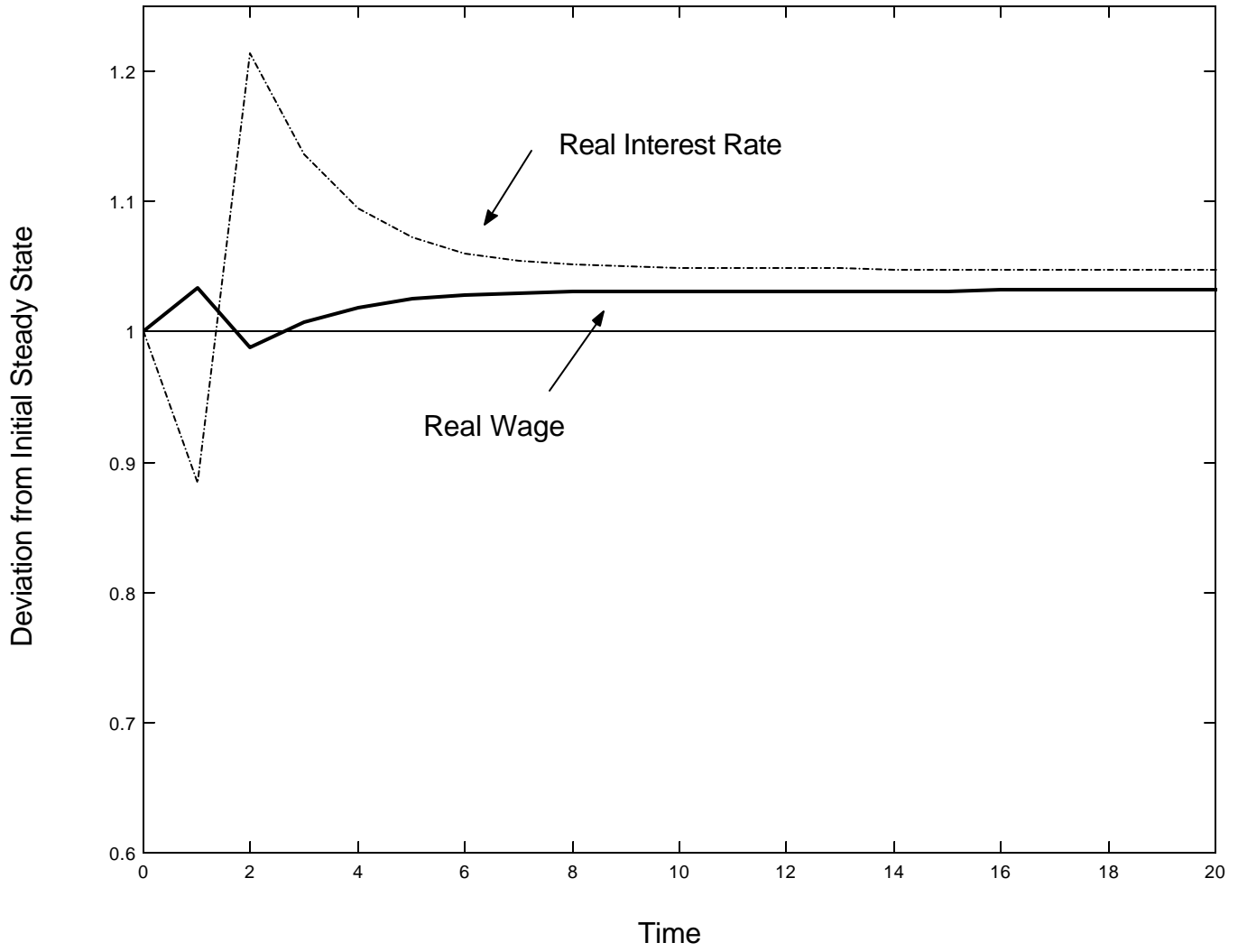
**Figure 3. Evolution of Aggregates with Child Labor Ban**



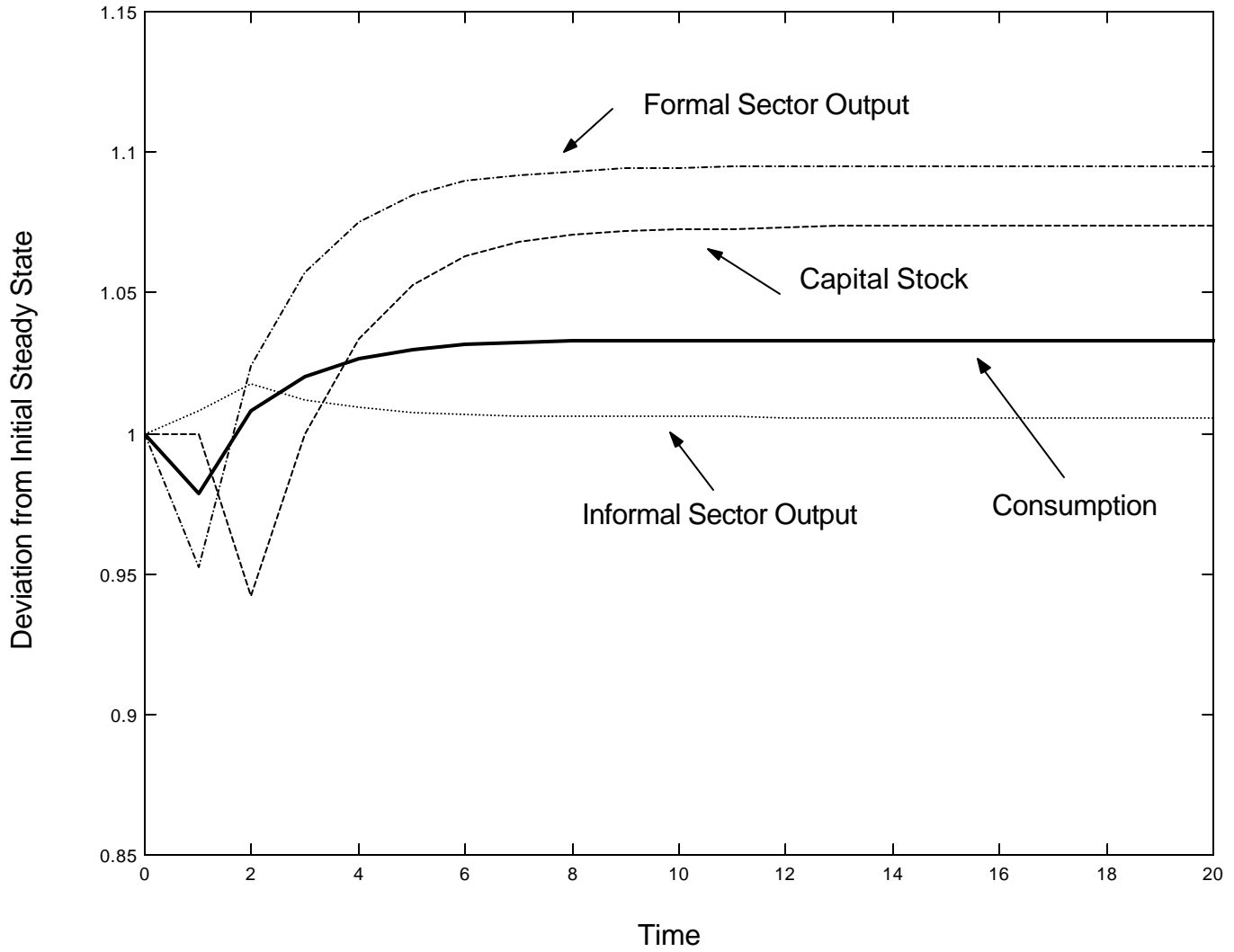
**Figure 4. Welfare Effects of Mandatory Education**



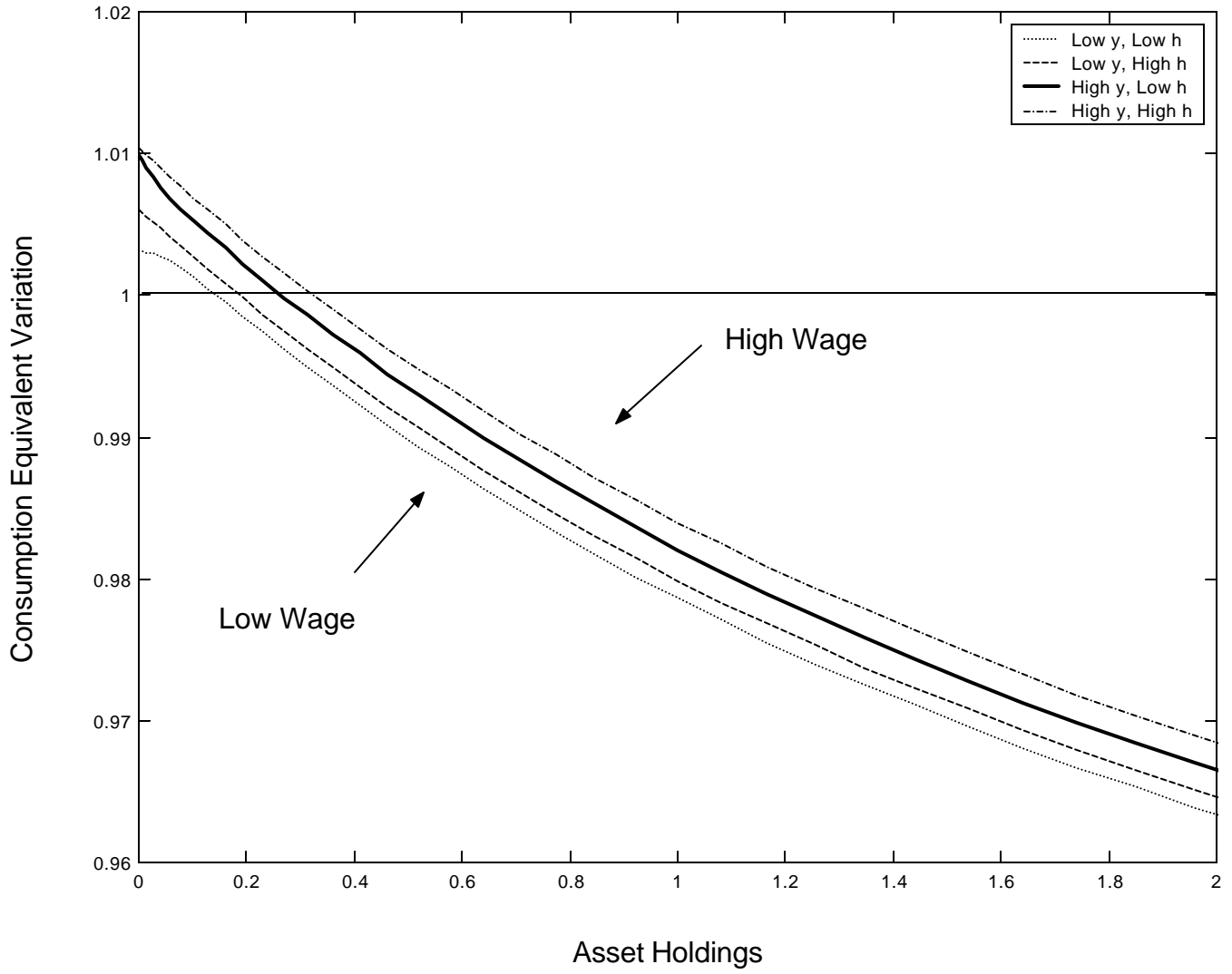
**Figure 5. Evolution of Prices with Mandatory Education**



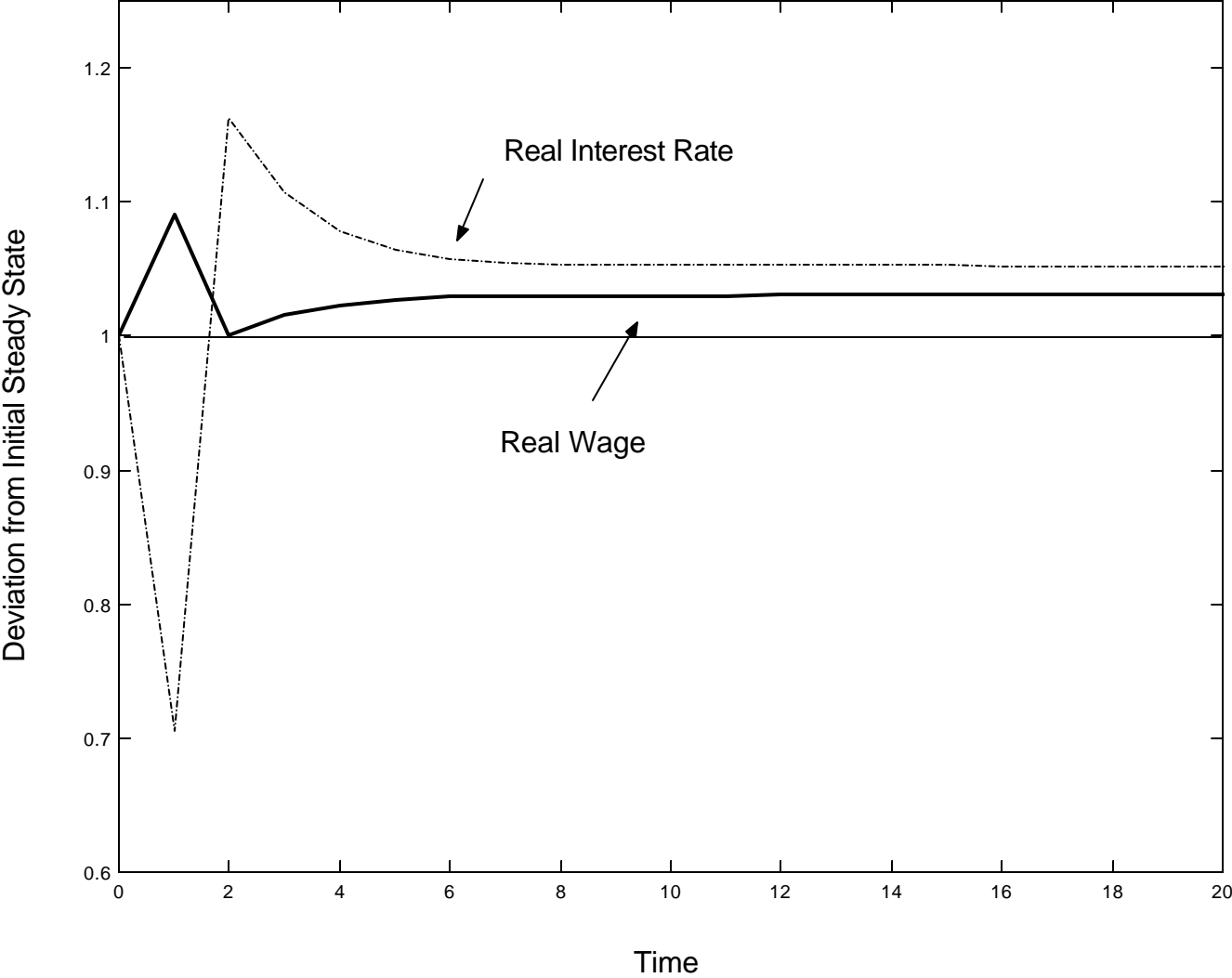
**Figure 6. Evolution of Aggregates with Mandatory Education**



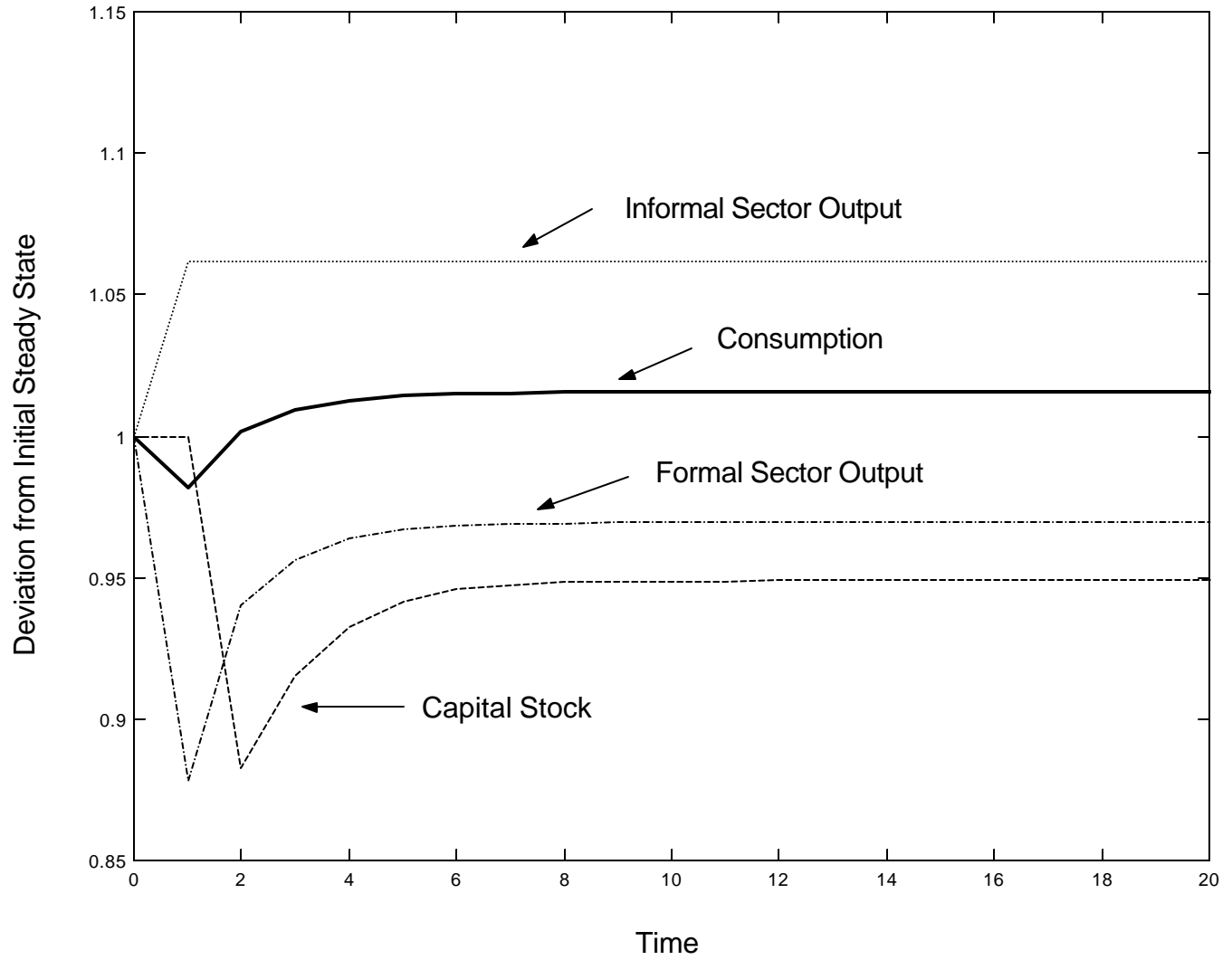
**Figure 7. Welfare Effects of Both Policies**



**Figure 8. Evolution of Prices with Both Policies**



**Figure 9. Evolution of Aggregates with Both Policies**



**Figure 10. Political Support and Human Capital Externalities**

