Private versus Social Returns to Human Capital: Education and Economic Growth in India

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Abstract

We investigate the micro-macro paradox that exists in the literature on education and growth: The effect of education growth on economic growth is debated, while at the same time, studies at the micro level consistently find that more education is economically beneficial for an individual. We suggest a way to resolve this paradox, using a study of the effect of education on economic growth in the context of India's experience with expanding levels of education 1961 to 2001. We hypothesize that educated people find privately rewarding jobs (which would contribute to the high estimates of returns to education at the micro level) in a sector in which social returns are low relative to the private returns (which would contribute to small or negative coefficients on education growth in regressions at the macro level), namely the government sector.

We conduct an empirical analysis using three different levels of data: household survey/census data, firm-level data, and state-level aggregate data. We first provide micro-evidence for our hypothesized mechanism: We show that a significant public-sector wage premium exists and that disproportionately large numbers of moderately- to highly-educated people in India work for the public sector. Firm-level data shows that public sector enterprises are less productive and that the average productivity gap between private and public sector enterprises in a state increases with the size of the government sector in that state. Turning then to state-level data, our findings indicate that the growth in educational capital in India in the period 1961 to 2001 had a positive effect on economic growth in states with small governments, but this effect decreases in the size of a state's government sector. Overall, the findings are consistent with a theory in which large governments are soaking up many educated individuals without those educated individuals having positive effects on economic growth.

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1 Introduction

Individuals with more education earn higher wages than individuals with lower levels of education and also receive other private benefits, for example with respect to health.[1] At the macro level, a common prior is that education is an important promoter of economic growth. However, both theoretical and empirical work provide no coherent picture about whether the *level* of education or the *growth* of education in the population matters for economic growth. We focus on the empirical aspects of this discussion: While the initial *level* of education has consistently been shown to have a positive association with subsequent economic growth (e.g. Barro 1991, Benhabib and Spiegel 1994), there is some debate about the effect of education *growth* on economic growth (e.g. Benhabib and Spiegel 1994; Krueger and Lindahl 2001, Pritchett 2001, Temple 2001). These findings generate a "micro-macro paradox" (Pritchett 2001) in the empirical literature: studies at the micro level consistently find that more education is economically beneficial for an individual (e.g. Psacharopoulos 1994), while at the macro level this is less clear, with some studies even finding negative effects of education growth on economic growth. A potential explanation of the micro-macro puzzle is that private and social returns to education differ.

In this paper we study the effect of education on economic growth in the context of India's experience during the years 1961 to 2001, a time period with, on average, a significant expansion of education. We suggest a specific mechanism that may explain a divergence of micro and macro findings: We hypothesize that educated people find privately rewarding jobs (which would contribute to the high estimates of returns to education at the micro level) in a sector in which social returns are low relative to the private returns (which would contribute to small or negative coefficients on education growth in regressions at the macro level), namely the government sector.[2] Particularly if incentives for rent-seeking are stronger in countries with high educational growth, this could explain the failure of educational growth to consistently show a significantly positive relationship with economic growth in cross-country regressions. There is significant anecdotal evidence for the importance of rent-seeking in economies in the developing world, where educational growth was highest during the period studied by many of the empirical cross-country studies on growth. Many researchers have noted the market distorting effects of the government sector, in which much rent seeking can take place. At the same time, the government sector in many developing countries is large, particularly as an employer for the well educated. For example, Murphy et al. (1991) note that in "many African countries in this century, government service, with the

[1] Policy makers are promoting education in prominent places, as for example evidenced by the fact that two of the eight Millennium Development Goals are related to education (universal primary education and gender equality in education).

[2] This idea is also motivated by theoretical work done by Murphy et al. (1991).

attendant ability to solicit bribes and dispose of tax revenue for the benefit of one's friends and family, was the principle career for the ablest people in the society" (Murphy et al. 1991, p. 505). Pritchett (2001, p. 384) cites the case of Egypt where government guarantees of employment lead to a government sector, that, in 1998, employed seventy percent of university graduates. This anecdotal evidence suggests that education may fail to promote economic growth because incentives are channeling educated workers into unproductive rent-seeking rather than productive employment. In the empirical work our main test is therefore whether in India the (initial) size of the government sector may have interacted negatively with education growth at the state level. To support the hypothesis regarding the mechanism, we additionally provide empirical evidence based on micro data from household surveys and census data, as well as micro evidence based on firm-level data.

By studying the effect of education on economic growth in the context of India, we can also make progress in a second dimension: The literature on the role of education in fostering economic growth is afflicted by the fact that education data are usually noisy and rarely comparable across countries (see Krueger and Lindahl 2001, and de la Fuente and Doménech 2006). By using variation across Indian states and measures of educational attainment from the census, we can drastically reduce problems of comparability that plague cross-country regressions, thus minimizing problems of measurement without having to resort to data correction techniques (as, e.g., in de la Fuente and Doménech 2006). The cleanest and most comparable data are usually obtained from developed countries, and it is rare to obtain data of the type that we have available for other developing countries. In India a census is conducted every 10 years, thus providing comparable data across states and over time. Further, the regular intervals between census years make interpolation, which is sometimes required even if census data exist, unnecessary. In addition, the education expansion was, despite frequent concerns about still relatively low average levels of education, remarkable, and the growth in the education data is thus less likely to be obscured by noise.[3]

We are not trying to argue against government generally. Instead, we hypothesize that India's bureaucracy undermined the potential of India's education growth to contribute to economic growth because of two of its particular attributes. First, it paid substantially above market wages and thus attracted much of India's educational capital. Second, perhaps the most important impact of the bureaucracy on India's economy was the creation of a mass of regulations whose effect was to inhibit India's economic growth. These specific attributes of India's public sector may well have allowed a critical mass of workers in that sector to be the well paid, but unproductive, professionals demanded by our theory.[4] Note that for the

[3] We further discuss the question whether years of education is a good proxy for quality of education (or human capital more generally) in the data section.

[4] Banerjee (2006) provides a recent example of informal observations about this: "[...] highly qualified engineers, educated at great public expense [...] cooled their heels as minor functionaries in the overfilled

government sector to reduce the effectiveness of education growth in promoting economic growth it is not a necessary condition that the government is economically destructive, but just that the social opportunity costs of having individuals employed by government, as opposed to the private sector, are significant.[5]

Before proceeding to the cross-state analysis, we provide extensive micro-evidence for the mechanism that we suggest. Bringing together evidence from household surveys and from firm-level survey data, we show that a substantial public-sector wage premium exists. Using the firm-level data, we also show that more government involvement is negatively correlated with productivity at the firm level (state-owned enterprises are less productive than privately owned enterprises) as well as across states (output per worker declines with increases in the government sector size, and the gap in output per worker between state-owned and privately owned enterprises that exists at the state level increases with the size of a state's government sector).

The baseline cross-state regression results presented in this paper resemble the findings of the cross-country literature. We demonstrate that in India, state-level educational expansion has no statistically significant relationship to state-level economic growth in the regression framework that resembles influential papers in this area, i.e. Benhabib and Spiegel (1994) and Pritchett (2001). We are also able to replicate findings of papers such as Krueger and Lindahl (2001), who show that the specification of human capital matters. As Indian educated workers earn higher wages than non-educated workers,[6] we face the puzzle of how education can both generate higher wages for individuals and fail to generate substantial economic growth for states according to the baseline results. We then show that accounting for the role of government changes the findings regarding education growth. Viewing parts of the public sector bureaucracy as rent-seeking implies the following: first, that educational expansion was effective in promoting growth in the absence of this effect of bureaucracy, and second, that the larger the bureaucracy in a given Indian state, the less effective educational expansion was in promoting growth. Our findings support these hypotheses. Our results indicate that the growth in educational capital in India in the period 1961 to 2001 has a positive effect on economic growth at the state level. We consistently find this effect once we control for an interaction term of government sector size and education growth. We also find

bureaucracies of large public companies" (p. 1021).

[5] This opportunity cost may actually increase in times when the role of government decreases, if at the same time the increase in the amount that the economy would benefit from educated individuals in the private sector is even larger. We will return to this point in the analysis of pre- and post-1991 reform periods.

[6] For example, for the year 1978, Psacharopoulos (1994) cites returns to education that are between 13.2 and 33.4%, while for 1993, estimated returns to education are between 7% and 17%, depending upon the level of education (Duraisamy, 2002). Our own estimates are within that latter range, namely 8-9% (see section 4.2).

a robust, negative interaction of government sector size and education growth, consistent with our theory. These estimates indicate that education growth was related to positive state-level economic growth in states with small governments.

We measure economic growth as the growth of per capita state domestic product (SDP). A potential concern is that the contribution of the government sector to SDP is measured at factor prices. For labor inputs in this sector we hypothesize that factor prices are larger than marginal products, and therefore growth in the total amount of wages paid in the government sector will lead mechanically to growth of SDP, although the measure that we are interested in, output, might not change, or at least not change as much as SDP at factor prices changes. However, if education growth leads to increases in the average level of education of workers in the government sector, and the gap between wages and marginal product of labor is larger for educated workers, then this mechanical effect on the interaction term between government sector size and education growth will be positive (the mechanical effect due to the fact that the government sector's contribution is measured at factor prices will be larger in states that have a large government sector), thus biasing the results in the direction opposite to the direction that our hypothesis predicts. Therefore, to the extent that we still find evidence for our hypothesis regarding the interaction term, it cannot be explained purely because of accounting issues. In addition, our data allow us to exclude the contribution of the public administration to SDP from the SDP growth calculations. The results are even stronger (i.e. more negative) when we exclude the contribution of public administration, giving some evidence for the (upward) bias on the interaction term that we hypothesize.

Although our basic regression framework follows the literature, which allows for direct comparability of the results to other important papers in this area, we are also aware of a potential endogeneity problem in regressions of economic growth on education growth (Benhabib and Spiegel 1994, Bils and Klenow 2000). We deal with this concern in a number of ways. Most importantly, we tackle endogeneity directly by using instrumental variable techniques: We exploit the panel structure of our data and use a dynamic panel estimator (Arellano and Bond 1991; Blundell and Bond 1998). This approach is advocated for cross-country regressions, for example, by Caselli et al. (1996). The specification tests cannot reject the validity of the instruments. In addition to the instruments that are directly coming out of the Arellano and Bond (1991) and Blundell and Bond (1998) approaches (lagged levels in a differenced equation and differences for the levels equation), we also use instruments based on the share of population in different age groups, and instruments that are due to changes in the number of administrative sub-divisions (districts) in Indian states over time.[7] To show the robustness of the results to other econometric specifications, we

[7] More specifically, we instrument for government sector size (and the government sector size / education

also show results in which we control for unobservable state effects that are fixed over time as well as unobserved time fixed effects that are common across states. Further, using the within-country/cross-states analysis keeps many other, usually unobserved variables constant, reducing the omitted variable problem of cross-country regressions. We also believe that the specific situation of India allows us to argue that the expansion of education was, to a considerable extent, exogenous. This is the case because for the leaders of India's young republic, as for many post-colonial leaders, educational expansion was a centerpiece of both social and economic policy. As we will argue further below, India's leaders believed that education was to provoke both social change by promoting mass literacy and economic growth by training a mass of skilled workers, and indeed India's educational expansion over the next few decades was impressive, generating growth in educational capital well above the world average. Variations in education expansion across states seem to be driven to some extent by historical differences in education policies and exogenous differences in initial conditions, including the number of educated individuals who could serve as teachers. It thus appears that education growth was not primarily a response to changing economic conditions, but to a large extent an exogenously determined process that is grounded in pre-independence differences in education and post-colonial policy goals that are not directly tied to economic conditions.

Similarly, one might be concerned about government size being endogenous, and we respond to this concern with the following arguments. First, and most importantly, our instrumental variables estimator (i.e. the Arellano and Bond 1991, and Blundell and Bond 1998, approach plus the additional variables based on district variation that we exploit as instruments) deals with potential endogeneity of all regressors, including not just education growth but also government sector size. As explained above, we can also simply control for unobserved state and time fixed effects. In addition, due to the legal environment, adjustment, i.e. hiring and firing, in the government sector is difficult and there are likely considerable inertia in the size of the government sector that make endogenous determination less likely than in countries with a less protected civil service.[8] [9]

growth interaction term), using the number of districts per person and/or square kilometer in a state as an instrument. The number of districts has changed quite substantially over the time period considered. The identification assumption is that the number of districts (or more specifically, districts per square kilometer) is (positively) correlated with the government sector size, mainly because each district requires additional administrative units, but that it is not directly correlated with growth of SDP. This seems plausible because changes in the number of districts appear to be driven by changes in the size of states, which in turn is driven by splits of existing states, and by population growth.

[8] Also note that we are using government sector sizes at the beginning of the period.

[9] In a previous version of this paper, we had also performed our analysis at the industry level, exploiting variation across industries within a state to deal with endogeneity concerns. This analysis of industrial growth gives similar results and it is even more difficult to think of mechanisms that would suggest endogeneity driving our results across different industries. The earlier version of this paper is available upon request.

The paper proceeds as follows. We first provide some theoretical considerations to explain the micro-macro puzzle that exists in the literature. We start our empirical work by providing evidence for the extent of India's educational expansion. We then present a large amount of micro-econometric evidence for our assertion that the government sector provided relatively unproductive but profitable jobs for educated workers, i.e. we show that a significant public sector wage premium exists, that the public sector attracts large numbers of educated individuals, and that public sector enterprises are less productive than privately owned enterprises. This reveals how India's bureaucracy could fit the demands of our rent-seeking theory. We then test the predictions of our theory formally in a cross-state regression framework. Finally, we conclude.

2 Education and growth: the basic framework

2.1 Hypotheses and empirical specification

Several approaches have been used to model the contribution of human capital in the form of schooling to economic growth. Previous research suggests that the specification matters significantly for whether an effect of education on growth is found or not. Our goal is to shed light on the macroeconomic effects of education growth, as well as its interaction with government sector size, and to use an approach that is robust to different specifications. Therefore, before moving on to our specific modeling approach, we begin with a short review of existing modeling approaches and the corresponding empirical setups.

On the one side, there are models in which human capital enters in an aggregate production function as a standard input but with the assumption of decreasing returns to reproducible factors, thus augmenting the standard Solow (1956) model (Mankiw et al. 1992). The rate of accumulation of human capital, which is a determinant of steady state income, is proxied by the percentage of the working-age population that is in secondary school, where the assumption is that this is proportional to the rate of human capital accumulation. Thus, a function of the *average level* of enrollment rates enters in the growth regressions in Mankiw et al. (1992). Similarly, in models of endogenous growth in which technological progress is a function of the existing stock of human capital (e.g. Romer, 1990a), countries with a high *level* of *initial* education will subsequently experience high growth.[10] Endogenous growth theories in the spirit of Lucas (1988), on the other hand, also add human capital to the aggregate production function framework but assume constant returns to scale to the reproducible factors. This modelling approach predicts that *growth* of human capital in the form of schooling creates growth in per capita GDP.

[10] A similar effect of levels of educations follows from the possibility of spillovers from human capital that Lucas (1988) allows for.

An alternative approach is to start from the standard (micro-)Mincer equation, which relates the log of wages to years of schooling, and aggregate up to a "macro-Mincer" equation (Heckman and Klenow 1997, Krueger and Lindahl 2001). The macro-Mincer equation relates the change in the mean of log earnings to schooling growth. Using the log of GDP per capita instead of the log of earnings is justified if labor's share of GDP is constant, e.g. because the aggregate production function is Cobb-Douglas and not changing over time (Krueger and Lindahl 2001).

Empirically, a number of papers, including one of the earliest contributions, Barro (1991), focus on the role of the initial level of human capital and the estimating equation is generally:

$$\Delta \log(y_t) = \pi_0' \log\left(h_{t-1}\right) + \pi_1' \log\left(y_{t-1}\right) + \pi_4' X_{t-1} + \varepsilon_t' \tag{1}$$

where $\Delta \log(y_t)$ is the change in the log of per capita GDP, y_{t-1} is the initial level of GDP per capita, h_{t-1} is the *initial level* of average human capital, and X_{t-1} is a vector of other controls.

Authors that focus on the *change* in average human capital, $\Delta \log\left(h_t\right)$, either include only human capital measures (i.e. the change as well as the level), as for example in equation 2, which is derived from a "macro-Mincer" wage equation

$$\Delta \log(y_t) = \pi_0'' \log\left(h_{t-1}\right) + \pi_2'' \Delta \log\left(h_t\right) + \pi_4'' X_{t-1} + \varepsilon_t'' \tag{2}$$

or include additionally the *change* in the physical capital stock per capita, such as in equation 3, which is derived from an aggregate production function (e.g. Benhabib and Spiegel, 1994, Pritchett 2001):

$$\Delta \log(y_t) = \pi_1''' \log\left(y_{t-1}\right) + \pi_2''' \Delta \log\left(h_t\right) + \pi_3''' \Delta \log\left(k_t\right) + \varepsilon_t'''. \tag{3}$$

There is an argument as to whether $\log\left(h_t\right)$ should be measured as the logarithm of average schooling in the population or whether $\log\left(h_t\right)$ equals the level of average schooling (Topel 1999, Krueger and Lindahl 2001). In the case of the macro-Mincer specification, the derivation from the micro-level wage equation immediately implies that the level of average schooling and not its log is the appropriate specification in that case, while the appropriate specification of human capital is less clear in the other estimating equations. Previewing our empirical work, we will consider both the log specification of human capital, i.e. $\log(h) = \log(S)$, where S=average years of schooling, as well as the linear specification $\log(h) = S$.

In empirical work, the positive effect of levels of education on economic growth is consistently found (e.g. Barro 1991, Benhabib and Spiegel, 1994). The role of education *growth*, however, continues to be debated in the literature. In an influential early paper, Benhabib and Spiegel (1994) find that, controlling for growth of population and physical capital accumulation, human capital accumulation is insignificant in all specifications and negative in all but one of their twelve specifications. Pritchett (2001) similarly finds that the effect of increasing education capital on GDP per worker is insignificant.[11]

Commenting on prior results, Krueger and Lindahl (2001) argue (referring in this case to Benhabib and Spiegel, 1994) that, controlling for changes in physical capital, there is "virtually no signal" (page 113) in the measure of change in human capital that is typically being used. They note that the poor quality of the data could bias the coefficients toward zero. Similarly, de la Fuente and Doménech (2006), who construct a new data set of educational capital measures that deals with, for example, reclassifications of education categories, argue that data quality can explain much of the empirical results in the literature. Further, Krueger and Lindahl (2001) argue that including the change in physical capital as a control could bias the results downward if, because of complementarities, educational growth increases economic growth in part by attracting physical capital. In their panel analysis they leave out the growth of physical capital measure. Using a linear specification of the human capital measure (i.e. $\log(h_t) = S$) they find a significant effect of growth of education over long periods (of at least ten years).

2.2 Introducing the role of government

In the standard models relating education growth to economic growth, the underlying assumption is that educated individuals undertake productive activities. However, Murphy et al.'s (1991) model demonstrates that where rent seeking is rewarded more highly than productivity, this assumption breaks down. Instead, workers may use their education to gain access to rent-seeking opportunities, with the result that educational growth has little or no effect on economic growth. Because these educated workers are earning high wages, the microeconomic relationship between educational level and wages remains.

To arrive at an estimating equation, we model the role of education growth in the presence of rent-seeking in the government sector by adjusting an aggregate Cobb-Douglas production function to take into account this possibility of unproductive human capital.[12] Consider an aggregate Cobb-Douglas production function with the inputs physical capital (K), labor (L), and human capital (H):

$$Y_t = (K_t)^{\alpha} (H_t)^{\beta} (L_t)^{\gamma} A_t$$

[11] Studies that focus on literacy expansion instead of more specific concepts of education also show no effect on GDP growth (e.g. Behrman 1987).

[12] We would end up with a similar estimating equation if we followed the macro-Mincer wage equation approach that we referred to in the previous section. For expositional purposes we focus on one approach. In the empirical work, however, we will estimate models that include both the level and the change of schooling.

Assuming constant returns to scale, i.e. $\alpha+\beta+\gamma=1$,[13] we can rewrite this in per capita terms,

$$\frac{Y_t}{L_t} = \left(\frac{K_t}{L_t}\right)^{\alpha}\left(\frac{H_t}{L_t}\right)^{\beta} A_t$$

Now, assume that the economy's total existing human capital H can be of two types: Human capital that is being used productively, H^p, and human capital that is idle, H^{idle}, such that $H = H^{idle} + H^p$. Only the productive human capital, H^p, enters the aggregate production function:

$$\frac{Y_t}{L_t} = \left(\frac{K_t}{L_t}\right)^{\alpha}\left(\frac{H_t^p}{L_t}\right)^{\beta} A_t$$

Taking logs and differencing, and using lower case letters to denote variables in per capita terms, we get:

$$\Delta\log(y_t) = \alpha\Delta\log(k_t) + \beta\Delta\log(h_t^p) + \Delta\log(A_t)$$

Without the assumption that only a part of the total human capital enters the production function, this equation could be taken to the data as is done in similar form in a number of papers, including Benhabib and Spiegel (1994), Krueger and Lindahl (2001) and Pritchett (2001). In our case, however, we first need to be more specific about how the productive part of human capital is determined as opposed to the idle part. Our underlying hypothesis is that a large government absorbs at least some educated individuals without employing them in a productive activity. This suggests to model the growth in the productive human capital per capita as a function of the growth of total human capital, but decreasing in the size of government (gov) at the beginning of the period. Our specific functional form assumption for the empirical work is as follows:

$$\Delta\log(h_t^p) = \zeta\Delta\log(h_t) + \gamma gov_{t-1}\Delta\log(h_t) \tag{4}$$

where we hypothesize that γ is negative (and $\zeta \leq 1$). This formulation then allows us to use a standard measure of human capital in empirical work, as it implies:

$$\Delta\log(y_t) = \alpha\Delta\log(k_t) + \beta[\zeta\Delta\log(h_t) + \gamma gov_{t-1}\Delta\log(h_t)] + \Delta\log(A_t)$$

or, defining $\widetilde{\zeta} = \beta * \zeta$ and $\widetilde{\gamma} = \beta * \gamma$:

$$\Delta\log(y_t) = \alpha\Delta\log(k_t) + \widetilde{\zeta}\Delta\log(h_t) + \widetilde{\gamma} gov_{t-1}\Delta\log(h_t) + \Delta\log(A_t) \tag{5}$$

[13] We assume constant returns to scale to all factors to be able to easily express variables in per capita terms. This approach allows for a direct comparison of our empirical work with standard growth regressions that have *levels* of human capital (e.g. average years of schooling or enrollment rates) as the main right hand side education variable. Alternatively, if we were not willing to assume constant returns to scale, we could follow closely Benhabib and Spiegel (1994), who in their baseline regressions use absolute values instead of per capita terms:

$$\Delta\log(Y_t) = \alpha\Delta\log(K_t) + \beta\Delta\log(H_t) + \gamma\Delta\log(L_t)$$

and proceed from here as is being done in the text under the assumption of constant returns to scale.

The main hypotheses that we are going to test is that $\widetilde{\gamma}$ is negative and that $\widetilde{\zeta}$ is positive.

2.3 Estimation

Equation (5) is the specification that we take to the data. We will add the initial level of output, $\log(y_{t-1})$, to allow for conditional convergence. We will also add the initial level of human capital, $\log(h_{t-1})$, in an alternative specification, because the level and not the change of human capital is the focus in many of the empirical macro growth regressions that successfully show a role of human capital. In our main specifications, we investigate 10 year intervals and use annualized growth rates. As Caselli et al. (1996) point out, in cross-country or cross-state regressions, like the present one, it is hard to think of truly exogenous variables. Although, as discussed before, the potential endogeneity of growth of education and government sector are less likely to be a first-order problem in the specific Indian context than in other contexts, it is reasonable to be concerned about this, and we explicitly address this concern by using a dynamic panel estimator. More specifically, we use the augmented version of the Arellano and Bond (1991) estimator described in Blundell and Bond (1998) and initially suggested by Arellano and Bover (1995). The basic idea is to instrument endogenous variables with lags of levels and differences of these variables. This estimator, also known as the "system GMM", has a number of attractive features. The estimator allows for arbitrarily distributed fixed effects. Moreover the approach allows for endogenous regressors and errors that may be heteroskedastic and serially correlated with an AR(1). It is also designed for samples with only few time series observations. The set of instruments created in this "system GMM" requires that error terms in differences do not follow an AR(2) process, an assumption which we will test in the empirical implementation. Indeed, we cannot reject the validity of this assumption in any of our results.[14] In the baseline system GMM results (labelled "IV") we use all available lags of levels and differences. Because there are many instruments, which may, for example, lead to implausibly large p-values of the Hansen overidentification test, we also report results in which we drastically restrict the number of instruments by using only one lag of levels, and collapse the system of lags of the differences into one instrument per lag (see Roodman 2006). The results based on this specification are reported in the columns labeled "IV2". Generally, the results, especially regarding the key variable of interest, the government sector-education growth interaction, are robust to using the smaller set of instruments. In none of the regressions we can reject the overidentification restrictions, supporting the validity of the instruments.

Unfortunately, state-level physical capital data are unavailable for Indian states (see, e.g., EPW Research Foundation 2003, 2004), so none of the regressions at the state-level will include physical capital growth as a control. This does not create a problem in the "macro-

[14] For implementation, we use a stata command written by Roodman (2006).

Mincer" framework, that does not call for capital stock as a control. But this omission creates the possibility of omitted variable bias in the regressions derived from the aggregate production function framework. Physical capital growth may be positively correlated with educational capital growth. On the other hand, as Krueger and Lindahl (2001) argue, omitting capital may be justified if physical capital growth and educational capital growth are correlated because educational capital growth attracts physical capital.[15] Thus, to omit physical capital risks biasing the estimates upward, but to include it risks biasing the estimates downward. Because the question here considers the failure of educational capital growth to influence economic growth, omitting capital as a control ensures that any failure to find a relationship between these two variables is not the result of a downward bias. To partly deal with the problem that capital stock data do not exist at the state level, we use data on electricity (in kwh per capita) as an additional control in our regressions. Arguably, electricity use and capital stock are highly correlated.

3 Data

3.1 Background on education in India

A comprehensive analysis on the history of education in India can be found elsewhere (e.g. Blaug et al. 1969, Pandey 1992, Panchamukhi 1996, Mukhopadhyay and Parhar 1999). Here we only want to summarize some evidence that a large part of India's significant educational expansion during the studied period was driven by political, rather than economic factors, reducing concerns about the possibility of endogeneity in our empirical work.

India's nationalists came to power in 1947 promising a complete revolution from the British colonial regime. Where the British had restricted education to an elite, the new Indian constitution promised universal, compulsory primary school. Specifically, the intention was to achieve universal free, compulsory education for all children under fourteen, to be achieved within ten years of independence. This was enshrined as a Directive Principle of the Indian Constitution (Constitution of India, Article 45). While this grand goal was not achieved in that time period – and, indeed, remains unfulfilled today – the Indian government nonetheless made substantial progress. For example, the percentage of children (age 6-11) enrolled in grades I-V rose from 42.6% in 1951 to 62.4% in 1960 alone (Panchamukhi 1996, p. 128).

Yet, India's history presents a paradigmatic case of the effect that is found in some of the empirical papers cited above: a country with substantial educational growth (despite still low absolute levels of education) yet relatively paltry economic growth, in particular in the pre-reform period. We estimate, based on data from Barro and Lee (1993), that the worldwide

[15] Krueger and Lindahl (2001) also lack capital stock data for their regressions that use 5 or 10 year intervals (i.e. for results reported in their table 3).

average annual growth rate of educational capital was 2.6 percent between 1960 and 1985. India's growth rate of educational capital during this period was 3.4 percent. Over the whole period, this suggests that India's educational capital increased by a factor of 2.3; whereas, worldwide educational capital increased by a factor of 1.9. Despite this great educational expansion, India's annual average growth rate of per capita real GDP over this period was just over 1.8 percent, compared to a world average of 2.3 percent. Even controlling for India's below-average rate of physical capital accumulation, India was a merely average performer in economic growth despite its relatively impressive educational capital growth.

3.2 State-level data

The main data used for the analysis come from the Indian census in the years 1961, 1971, 1981, 1991, and 2001. For each of these years, reliable data are available about the educational level of India's residents, from which we derive our measures of human capital growth: the annualized change in $log(S)$ in the log schooling specification, and the annualized change in S in the linear schooling specification, where S=average years of education. Table 1 presents summary statistics for changes in the human capital measures used at the state level.

		log schooling specification: Δlog(S)		linear schooling specification: ΔS	
Time period	Observations	Mean	Standard deviation	Mean	Standard deviation
1961-2001	27	0.051	0.018	0.073	0.020
1961-1971	27	0.112	0.062	0.089	0.047
1971-1981	29	0.031	0.015	0.051	0.027
1981-1991	29	0.036	0.015	0.081	0.032
1991-2001	31	0.023	0.011	0.067	0.029

Table 1: Summary statistics for annual human capital changes at the state level

The primary dependent variable in our analysis is net real per capita state domestic product (SDP). Per capita SDP data come from Özler et al. (1996) and India's Ministry of Statistics and Programme Implementation and are corrected for inflation (the details are in appendix B). Summary statistics for per capita SDP growth are presented in table 20 of appendix B; SDP figures are in Rupees with base year 1973.

As indicated in the introduction, accounting issues lead to a potential concern. SDP measures the contribution of the government sector at factor prices, which we hypothesize are not reflecting the marginal product of inputs in this sector. Therefore growth in the government sector might lead mechanically to growth of SDP that is not reflecting output growth. First, we note that, as explained in the introduction, the bias on the interaction term of government sector size and education growth is expected to go in the opposite direction to what our hypothesis predicts. However, we will also be able to deal with this concern directly, since we have separate data for the contribution of the public administration to SDP, which allows us to exclude the public administration's contribution from the SDP growth calculations.

Population figures are from census data and data on government employment come from the Statistical Abstracts published by India's Central Statistical Organization. The proxy for government sector size (*gov*) is government employment as a percentage of total population (details are in appendix B). Not all variables exist for all state-year observations. However, missing are mostly small states and territories, and for our key results, we end up with a sample of states that covers in 2001, for example, 93.3% of the total Indian population. Summary statistics for state/decade observations of the key variables employed in the regression analysis shown in columns (4)-(8) of tables 11 and 12, which presents the central results of this paper, are in table 21 in the appendix .

3.3 Education quality

As pointed out before, the linear schooling specification addresses some concerns about the measurement of human capital. One may be still concerned at a more general level about the possibility that schooling quality is heterogeneous in India, in which case years of schooling is not a good measure. First, it is important to note that data quality concerns are more likely to be unrelated to state characteristics in cross-state than in cross-country analyses. As we have mentioned before, the use of comparable census data over time and across states minimizes measurement issues that are due to difficulties in comparing different education systems, or the use of different ways of data collection, or due to the need for interpolation of inconsistently spaced census data, or the need to extrapolate years of schooling based on enrollment rates. Moreover, to the extent that quality differences exist across states but are constant over time, these will be picked up in part by fixed effects that we include into our specifications.

To further convince the reader of the usefulness of the schooling measure, we also calculate simple correlations between the schooling variable and other proxies for schooling quality, namely educational expenditure and numbers of teachers, using data from Statistical Abstracts (Central Statistical Organization, various years). We find that the correlation between the level of average years of education and the number of teachers (at all levels) per student is 0.22, while the correlation between the level of average years of education and the expenditure per student and expenditure per capita is 0.28 and 0.44, respectively. The correlation between the growth in average years of education and the growth of expenditure per student and per capita is 0.35 and 0.56, respectively (all highly statistically significant with p-values<0.01). The correlation between education growth and growth of total teachers per student is somewhat lower, namely 0.19, but still significant at the 5% level. While arguably neither the student-teacher ratio nor educational expenditure is a perfect measure of quality, the significant correlations between these two measures and mean schooling in a state's population is reassuring.

We have also cross-checked our education data with recent measures of the quality of education from Kremer et al. (2005).[16] Using a cross-section of data on teacher absence from early 2003, we find a negative correlation between average years of education in a state in 2001 and teacher absence rates (the correlation coefficient is -0.39, with p-value 0.10), and a strong positive correlation between years of education and the share of teachers being present *and* teaching (correlation coefficient 0.55, p-value=0.01).[17] Overall, we find some significant evidence that average years of education in a state are positively correlated with measures of schooling quality, and changes in average years of schooling are positively correlated with changes in measures of schooling quality in a state. Nevertheless, we acknowledge the existing differences in education quality and we will take differences in education quality explicitly into account in our econometric analysis. To that end, we will calculate quality-adjusted schooling measures for robustness checks in our regression analysis.

4 Micro evidence on public-private wage differentials and the hypothesized mechanism

4.1 The Indian bureaucracy's absorption of educational capital

In 1961, India had 188 million workers. Of those, only 12 million worked in what is termed the "organized sector," that is, in the public sector or in private firms with more than twenty-five workers (Blaug et al., 1969). The percentage of workers in the organized sector increased only slightly over the period studied here: in 1981, total employment was 250 million and 23 million workers were in the organized sector (Joshi and Little, 1994). Throughout this period, a majority of workers in the organized sector worked for the government. For instance, in 1981, 70% of workers in the organized sector were in the public sector (Joshi and Little, 1994). Thus, in a very large working population, few Indians worked for the organized sector, which was government-dominated.

Importantly, for the educated population, the picture was very different. For example,

[16] We thank Karthik Muralidharan for making these data available to us.

[17] We also use data for 2006 from an NGO that tests children for reading and math skills at the household level (Pratham 2007). We find that, at the state level, the correlation of average years of education in 2001 with the percentage of children in lower grades (Std I-II) in rural areas who can read (at the age appropriate level) is 0.39 (p=0.03) and the correlation with the percentage of children who can "recognize numbers" is 0.31 (p=0.09).

in 1961, two-thirds of workers with graduate degrees and almost as many workers with secondary educations worked in the public sector (Blaug et al., 1969). These workers were employed at wages that were more than competitive with their private sector counterparts.[18]

The importance of the government sector as an employer is also reflected in our government sector employees data: On average, in states that enter our core sample, 2.9% of the total population work in the government sector. However, using the total population as the base group understates the importance of the government sector: The number of adults in their prime working years can be approximated from the data by using the number of individuals that are between 15 and 59 years old. Out of this population, 5.3% are employed by the government sector (see table 21 with the summary statistics in the appendix).

The workings of the labor market and the methods of promotion in the public sector also suggest that productivity was not commensurate with wages. Blaug et al. (1969) suggest the existence of a queue system, where public sector jobs, for which the supply was too large because the wage was set above market levels, were - at least to some extent - allocated by waiting times. Further, employment was often secured not by added qualifications or even time but rather by means of personal contacts. Indeed, this was the most often cited means of securing a job in a study of graduates of Delhi University in 1960 (Blaug et al., 1969).

Adding to the existing evidence that we cite in this section, we now provide additional quantitative micro evidence, based mainly on our own analyses, on the facts and underlying forces regarding the absorption of educational capital in the public sector.

4.2 Micro evidence on public-private wage differentials and returns to education

India's National Sampling Survey Organization regularly collects household level data through the National Sample Survey (NSS). In this section, we use this micro data for 1993 (Round 50) and 1999/2000 (round 55) to provide state-level evidence on public-private wage differentials and returns to education.

Unfortunately, micro data exist for research only beginning with the 1980s, so for results from earlier surveys we can only use information that is reported as part of summary reports. Because of this limitation of the NSS, we also resort to an analysis of data from the Annual Survey of Industries (ASI), which allows us to give additional evidence from one specific

[18] The data suggest that wage differentials were substantial and increased over the studied period. Bardhan (1984) summarizes the changes in wages of public sector workers, noting, "the salary demands on the budget, largely from white-collar workers, [grew] staggeringly" between 1950 and 1980 (Bardhan, 1984, p. 62). Bardhan notes that during the 1960s and 1970s, real wages of public sector employees grew at a rate that was more than twice the growth of overall wages. These indirect indications can be supplemented with direct evidence of wage differentials from the end of the period under study. We provide a number of pieces of evidence on the public-private wage differentials below.

sector of the economy, that goes back further in time and is consistent over the years. The estimated public-private wage differential in the manufacturing sector, estimated from the ASI enterprise-level data, is reported in the appendix D

4.2.1 The public-private wage differential in 1958/59

A summary report for the 1958-59 survey (Indian Statistical Institute 1964) allows us to make some statements about public-private wage differentials at the beginning of our sample period. This report lists the distribution of total earnings of individuals in several occupation groups in urban areas (table 3-56, p. 138). We compare the two occupation groups "5. administrative and executive officials (government)" and "6. directors, managers and working proprietors in private enterprises (excluding working proprietors in trade)". Both groups presumably contain highly educated individuals. The former occupation group is the only one in the list of 38 groups that captures directly public sector employees, while the latter occupation group appears to be the counterpart from the private sector. In the report, wages are reported in intervals. Assuming that wages are uniformly distributed within these intervals, we can estimate an expected wage for these two groups from the private and the public sector.[19] Based on this assumption, we estimate expected weekly earnings of 39.1 Rupees in occupation group 5 (the public sector), and 35.2 Rupees in occupation group 6 (the private sector), i.e. a premium of about 11% in the public sector.

4.2.2 Results at the state level for the 1990s

To provide evidence on public-private wage differentials at the state level we perform additional analyses using NSS micro data. Every five years the National Sample Survey Organization uses an additional questionnaire ("schedule 10") with detailed information on employment. We can use data from 1993 (Round 50) and 1999/2000 (round 55) to provide state-level evidence. The two earlier rounds (rounds 38 and 43) with detailed employment data for which micro data are available do not contain information that allows researchers to identify whether individuals work for a public or a private employer. In addition, note that for 1993 there is a direct question about public/private sector (namely about the "nature of employer", which has the three options: public/semipublic/private, and is answered by almost all individuals whose "principal status" is "worked as regular salaried wage employee"); in 1999 it is more difficult to distinguish public versus private sector employees: the question is mainly referring to enterprises (in 1999/2000, the question is about the "enterprise type",

[19] We also need to make an assumption about average earning in the highest category ("50.1 & above"); we assume 55 Rupees. Making a slightly different assumption of 65 Rupees average earnings in the highest category results in only minor differences, as the fraction of individuals in the highest category is approximately similar in both of the categories considered here. The analyis refers only to individuals who report earnings.

with 8 answer categories). The focus of the analysis is therefore on 1993 data. The samples are restricted to those individuals whose "principal status" is "worked as regular salaried wage employee" and who report a wage (cash or in-kind).

Table 2 shows the estimates of the public-private wage differences for all of India and by state based on our own analysis of NSS round 50 (1993) data. Each analysis is performed for three groups, namely for the full sample of individuals whose "principal status" is "worked as regular salaried wage employee" and who report a wage, as well as for individuals with at least a secondary school education (completed secondary school or above), and for holders of graduate degrees. The first three columns ("public-private wage ratio") show the simple ratio, i.e. the mean of all public sector wages divided by the mean of all private sector wages. One is subtracted from this ratio to make it more easily comparable to the estimated public-private differential. The public-private differential in the second set of three columns is estimated using Mincer-type regressions. In the column "full sample" the public-private differential is the estimated coefficient on the public ownership dummy variable, which we call *public*, in the following cross-sectional regression

$$\log(wage) = \alpha + \beta\ public + \gamma S + \delta_1 age + \delta_2 age^2 + \delta_3 male + \delta_4 urban + \varepsilon$$

here S is years of schooling, and *male* and *urban* are gender and urban/rural indicator variables, respectively.

In the column "for secondary (or above) educated" the public-private differential is estimated based on the following regression

$$\begin{aligned} \log(wage) &= \alpha + \beta\ public + \gamma\ secondary + \mu\ (public * secondary) \\ &\quad + \delta_1 age + \delta_2 age^2 + \delta_3 male + \delta_4 urban + \varepsilon_{is} \end{aligned}$$

here *secondary* is an indicator variable that is equal to one if the individual has secondary education or above. The estimated public-private differential is the sum of the estimated coefficients on the *public* sector dummy variable and the coefficient on the interaction term between the *public* sector dummy variable and the *secondary* indicator variable ($\beta + \mu$). The public-private differential for holders of graduate degrees is estimated analogously.

Looking at the results for India (all states pooled) we find that the public-private wage ratio is highest in the full sample and decreases once we restrict the sample to individuals with higher levels of education. The ratio for India ranges between approximately 1.2 and 1.7 (note again, that in the table 1 is subtracted from the ratio, so that numbers larger than zero imply a positive public sector premium). Once we control for other individual characteristics, the estimated public sector premium is between 33% in the full sample and 22% for holders of graduate degrees.

Analyzing the public sector premium across states (where the analysis is done separately for each state), we see that in almost all states individuals in the public sector are paid more than individuals in the private sector. Only one state (Mizoram) has consistently negative estimates for the public-private wage ratio -1 and the differential. In only a few other instances do the estimates have a negative sign and those are all for individuals with secondary education or graduate degrees. It should be noted that some of these estimates are relatively imprecise because of small sample sizes once the sample is analyzed by state.

The last two rows of the table analyze the correlation between state-level public sector premia and the size of government in that state (i.e. individuals working for the government divided by total population of working age). The estimated coefficients are generally small and all statistically insignificant. Thus, using NSS data from 1993, we do not find evidence for a systematic relationship between size of the government sector and the public sector premium.

Table 3 shows the analogous results based on the analysis of Round 55, i.e. the years 1999/2000. Note again that the identification of public sector employees is more difficult based on the questionnaire used in round 55. Keeping that caveat in mind, we note that again all public sector premia for the full sample are positive. Only for a few states, mostly those with small sample sizes, do we estimate a negative public sector premium for individuals with higher education. The levels are generally higher than estimated based on the 1993 data, but the decreasing public-private wage differential that we found earlier as we move from the full sample to higher levels of education can also be found in 1999/2000. The main difference is that here we find a significantly negative correlation between public sector size and public sector premium.

	public-private wage ratio - 1			public-private differential		
	full sample	for secondary (or above) educated	for holder of graduate degrees	full sample	for secondary (or above) educated	for holder of graduate degrees
India	0.727	0.330	0.196	0.330	0.331	0.225
Andaman and Nicobar Is.	0.512	0.247	-0.114	0.253	0.393	0.078
Andhra Pradesh	1.355	0.744	0.453	0.573	0.568	0.437
Arunachal Pradesh	0.604	0.026	0.138	0.087	0.145	0.234
Assam	1.089	-0.023	-0.082	0.348	0.118	0.152
Bihar	0.259	-0.032	-0.064	0.194	0.077	0.006
Chandigarh	1.243	1.113	0.582	0.305	0.497	0.216
Dadra and Nagar Haveli	0.600	0.428	0.178	0.233	0.245	-0.312
Delhi	0.759	0.437	0.243	0.341	0.391	0.273
Goa	0.509	0.570	0.493	0.175	0.260	0.339
Gujarat	0.837	0.555	0.367	0.335	0.416	0.280
Haryana	0.572	0.445	0.191	0.054	0.057	-0.153
Himachal Pradesh	0.650	0.354	0.133	0.049	0.121	-0.049
Jammu and Kashmir	0.882	0.583	0.382	0.279	0.448	0.446
Karnataka	0.893	0.493	0.412	0.399	0.450	0.381
Kerala	0.806	0.502	0.396	0.371	0.417	0.341
Lakshadweep	0.731	0.515		0.571	0.394	0.578
Madhya Pradesh	0.812	0.395	0.222	0.413	0.426	0.321
Maharashtra	0.441	0.169	0.098	0.206	0.178	0.074
Manipur	0.682	0.565	0.430	0.276	0.318	0.180
Meghalaya	0.790	0.400	0.204	0.278	0.301	0.192
Mizoram	-0.055	-0.188	-0.162	-0.246	-0.384	-0.464
Nagaland	0.207	0.091	0.182	0.114	-0.002	-0.118
Orissa	0.847	0.441	0.508	0.357	0.302	0.301
Pondicherry	1.325	1.072	0.710	0.546	0.656	0.520
Punjab	1.108	0.710	0.462	0.529	0.642	0.576
Rajasthan	0.727	0.261	-0.058	0.222	0.267	0.016
Sikkim	0.801	0.234	-0.033	0.208	0.155	-0.127
Tamil Nadu	1.281	0.651	0.453	0.396	0.479	0.380
Tripura	0.875	0.302	0.455	0.328	0.393	0.741
Uttar Pradesh	0.924	0.540	0.470	0.436	0.446	0.404
West Bengal	0.627	0.123	0.009	0.344	0.229	0.073
correlation with *gov* (government sector size) in 1991	-0.105	0.166	-0.064	-0.211	0.022	-0.174
p-value	0.603	0.409	0.750	0.301	0.915	0.396

Notes: results are based on an analysis of NSS round 50 (1993) data; the "public-private wage ratio" is the simple ratio of the mean of all public sector wages divided by the mean of all private sector wages from which one is subtracted to make it comparable to the estimated public-private differential; the public-private differential is the estimated coefficient on the public sector dummy variable in a Mincer-type regression of the log(wage) on years of schooling, age, age squared, gender, urban/rural indicator and the public sector dummy variable

Table 2: Public-private wage differential in 1993, based on NSS data

	public-private wage ratio - 1			public-private differential		
	full sample	for secondary (or above) educated	for holder of graduate degrees	full sample	for secondary (or above) educated	for holder of graduate degrees
India	1.408	0.674	0.376	0.590	0.616	0.443
Andaman and Nicobar Is.	0.676	0.389	-0.136	0.381	0.455	-0.110
Andhra Pradesh	1.719	0.797	0.413	0.577	0.655	0.415
Arunachal Pradesh	1.109	-0.405	-0.478	0.485	-0.205	-1.340
Assam	1.548	0.266	0.194	0.503	0.425	0.325
Bihar	1.330	0.316	0.089	0.661	0.553	0.351
Chandigarh	1.301	0.837	0.304	0.474	0.536	0.313
Dadra and Nagar Haveli	0.680	0.441	0.272	0.172	0.417	0.363
Delhi	0.905	0.496	0.150	0.379	0.452	0.253
Goa	0.694	0.337	0.079	0.265	0.287	0.211
Gujarat	1.338	0.676	0.464	0.509	0.545	0.410
Haryana	1.405	0.979	0.624	0.583	0.678	0.529
Himachal Pradesh	1.218	0.615	0.153	0.474	0.519	0.201
Jammu and Kashmir	1.402	0.766	0.591	0.510	0.677	0.653
Karnataka	1.455	0.664	0.348	0.555	0.582	0.409
Kerala	1.405	1.047	0.459	0.566	0.724	0.533
Lakshadweep	0.407	0.172	0.315	0.238	0.061	0.287
Madhya Pradesh	1.724	0.755	0.497	0.665	0.654	0.516
Maharashtra	0.869	0.405	0.152	0.457	0.427	0.197
Manipur	0.642	0.461	0.327	0.444	0.512	0.429
Meghalaya	1.396	0.483	0.283	0.474	0.319	0.182
Mizoram	0.855	0.439	0.345	0.483	0.470	0.366
Nagaland	0.591	0.174	0.170	0.402	0.285	0.146
Orissa	1.871	0.703	0.579	0.638	0.664	0.661
Pondicherry	1.520	1.208	1.411	0.620	0.749	0.893
Punjab	1.720	1.064	0.551	0.690	0.786	0.535
Rajasthan	2.016	1.066	0.772	0.728	0.830	0.725
Sikkim	2.495	1.215	1.117	0.661	0.955	0.942
Tamil Nadu	1.595	0.860	0.513	0.569	0.673	0.571
Tripura	0.913	-0.078	-0.081	0.247	-0.061	-0.116
Uttar Pradesh	1.802	0.854	0.549	0.715	0.729	0.597
West Bengal	1.312	0.439	0.319	0.546	0.453	0.330
correlation with *gov* (government sector size) in 2001	-0.562	-0.337	-0.390	-0.610	-0.484	-0.455
p-value	0.002	0.079	0.040	0.001	0.011	0.017

Notes: results are based on an analysis of NSS round 55 (1999/2000) data; the "public-private wage ratio" is the simple ratio of the mean of all public sector wages divided by the mean of all private sector wages from which one is subtracted to make it comparable to the estimated public-private differential; the public-private differential is the estimated coefficient on the public sector dummy variable in a Mincer-type regression of the log(wage) on years of schooling, age, age squared, gender, urban/rural indicator and the public sector dummy variable

Table 3: Public-private wage differential in 1999/2000, based on NSS data

4.2.3 Returns to education

A very closely related question is whether there is a difference in the returns to education between public and private sectors. To focus on the returns to an additional year of education (as opposed to the difference in returns at different - discrete - education levels, as was the focus in the analysis in the last section) We estimate

$$\log(wage) = \alpha + \beta\ public + \gamma S + \mu\ (public * S) + \delta_1 age + \delta_2 age^2 + \delta_3 male + \delta_4 urban + \varepsilon$$

and report estimates of $\gamma + \mu$, and μ in table 4. The returns to education in the public sector (i.e. $\gamma + \mu$) are estimated to be 7.8% (1993) and 8.7% (1999). However, the difference in the returns to education between the public and the private sector (i.e. μ) is small. In both years for which we have data, we estimate it to be only 0.002.[20] There is no significant correlation between the returns to education or the difference in the returns to education between public and private sector and the size of the public sector in a state.

[20] There is a large literature that is concerned about the endogenous choice of schooling levels. Obtaining an unbiased estimate of the returns to education in India would be a separate project. Here the focus is on whether returns differ between sectors and whether there is a systematic variation across states. Estimating a simple OLS regression is appropriate for this purpose if we assume that all potential biases are constant across sectors and states.

	returns to education in the public sector (based on full sample)		returns to education: public-private sector difference	
	1993	1999/2000	1993	1999/2000
India	0.078	0.087	0.002	0.002
Andaman and Nicobar Is.	0.075	0.070	0.030	0.003
Andhra Pradesh	0.077	0.096	0.002	0.025
Arunachal Pradesh	0.046	0.093	0.001	-0.018
Assam	0.049	0.077	-0.038	0.011
Bihar	0.037	0.068	-0.041	-0.020
Chandigarh	0.103	0.077	0.060	0.016
Dadra and Nagar Haveli	0.058	0.154	0.004	0.065
Delhi	0.070	0.093	0.021	0.019
Goa	0.070	0.087	0.028	0.020
Gujarat	0.093	0.103	0.028	0.030
Haryana	0.070	0.104	-0.009	0.045
Himachal Pradesh	0.092	0.086	0.016	0.011
Jammu and Kashmir	0.088	0.108	0.058	0.065
Karnataka	0.110	0.102	0.028	0.025
Kerala	0.114	0.123	0.027	0.063
Lakshadweep	0.093	0.079	-0.117	-0.004
Madhya Pradesh	0.075	0.067	0.001	-0.004
Maharashtra	0.080	0.078	-0.012	-0.009
Manipur	0.080	0.090	0.027	0.019
Meghalaya	0.086	0.059	-0.007	-0.011
Mizoram	0.084	0.098	-0.087	0.010
Nagaland	0.085	0.054	0.006	-0.024
Orissa	0.095	0.098	0.004	0.012
Pondicherry	0.111	0.129	0.014	0.075
Punjab	0.080	0.090	0.046	0.037
Rajasthan	0.066	0.078	0.011	0.036
Sikkim	0.111	0.108	0.001	0.059
Tamil Nadu	0.135	0.135	0.051	0.061
Tripura	0.108	0.065	0.042	-0.046
Uttar Pradesh	0.057	0.069	0.012	0.016
West Bengal	0.054	0.077	-0.028	-0.010
correlation with current government sector size	0.282	0.071	0.295	-0.257
p-value	0.163	0.726	0.144	0.196

Table 4: Returns to education and differences in the returns to education between public and private sectors

4.3 Educated workers choose to work for the government sector

We have demonstrated in different data sets that a significant public sector wage premium exists throughout the time period under investigation. The next step of our analysis investigates whether this public sector premium (and potentially other reasons such as higher job security in the public sector) induces educated workers to enter the public sector in disproportionately large numbers. Here we provide two pieces of evidence in addition to the earlier discussion based on the existing literature.

First, we use census data for "degree holders and technical personnel" in 1971. Unfortunately, the demographic census data do not in general allow us to distinguish between individuals employed in the private sector and those employed in the public sector. One exception is the 1971 census, which published a specific volume on "degree holders and technical personnel" (India, Office of the Registrar General 1975). This publication summarizes some information about the approximately 1.3 million degree holders in 1971, i.e. mostly individuals with a Bachelor or a Master degrees.[21] These individuals with the highest level of education constitute approximately 4% of the 32.6 million Indians in 1971 that had at least a matriculation degree. For these most highly educated individuals we find that overall, 64% of "degree holders and technical personnel" work in the public sector (see the first column in table 5). There is variation across states, but even in the state with the smallest share of educated individuals working in the public sector (Maharashtra), still 48% of degree holders work for the public sector.

Secondly, we look at the household survey data from NSS again. As before, we restrict the NSS sample to those individuals working for a wage for which the public/private distinction can be made. Columns 2-5 of table 5 show the results. Overall, we note that the share of degree holders and those with at least a secondary education in the public sector remains high in the 1990s, with some decline from 1993 to 1999/2000. We estimate these shares to be between 51 and 63%. In most states more than half of the most educated individuals work in the public sector. The last two rows of the table show that the share of the most highly educated (graduate degree holders) working for the government is strongly correlated with government sector size. For individuals with at least a secondary education the correlation coefficient and the statistical significance of the positive correlation are somewhat smaller (with p-values around 0.1 and 0.15).

[21] Out of a total of 1,294,133 employed individuals with degrees, approximately 838,000 have a Bachelor or equivalent degree, 300,000 have a Master or Post Graduate degree, 121,000 have a "Diploma", 20,000 have a "Certificate" and 14,000 hold a "Doctorate".

state	share of degree holders working in the public sector			share of individuals with education secondary and above working in the public sector	
	1971	1993	1999/2000	1993	1999/2000
India	0.64	0.63	0.54	0.61	0.51
Andaman and Nicobar Islands	0.94	0.91	0.84	0.87	0.82
Andhra Pradesh	0.75	0.65	0.50	0.60	0.45
Arunachal Pradesh	0.97	0.72	0.71	0.75	0.72
Assam	0.68	0.79	0.74	0.80	0.70
Bihar	0.62	0.66	0.49	0.66	0.47
Chandigarh	0.85	0.74	0.69	0.59	0.56
Dadra and Nagar Haveli		0.50	0.14	0.54	0.14
Delhi		0.68	0.55	0.60	0.44
Goa		0.51	0.40	0.53	0.37
Gujarat	0.52	0.52	0.42	0.45	0.43
Haryana	0.72	0.59	0.50	0.56	0.45
Himachal Pradesh	0.90	0.83	0.78	0.84	0.73
Jammu and Kashmir	0.93	0.84	0.76	0.82	0.73
Karnataka	0.64	0.59	0.47	0.56	0.45
Kerala	0.58	0.64	0.55	0.61	0.47
Lakshadweep		0.70	0.96	0.97	0.92
Madhya Pradesh	0.81	0.33	0.59	0.68	0.57
Maharashtra	0.48	0.89	0.40	0.32	0.37
Manipur	0.73	0.91	0.70	0.87	0.69
Meghalaya	0.79	0.94	0.88	0.84	0.83
Mizoram		0.91	0.79	0.94	0.76
Nagaland	0.85	0.66	0.82	0.91	0.88
Orissa	0.77	0.71	0.68	0.69	0.68
Pondicherry		0.69	0.48	0.63	0.44
Punjab	0.69	0.77	0.57	0.62	0.48
Rajasthan	0.80	0.88	0.66	0.70	0.61
Sikkim		0.59	0.89	0.87	0.92
Tamil Nadu	0.60	0.89	0.41	0.54	0.36
Tripura	0.87	0.63	0.47	0.85	0.46
Uttar Pradesh	0.59	0.50	0.53	0.62	0.48
West Bengal	0.54	0.49	0.45	0.53	0.46
correlation with current government sector size (government employees/working age population)	0.45	0.39	0.40	0.29	0.32
p-value	0.047	0.052	0.038	0.155	0.101

Notes: 1971 data are calculated from census publications; 1993 and 1998 data are calculated base on NSS sample data (Rounds 50 and 55) using only individuals whose primary status is "wage earner"; for correlations with NSS data from 1993 and 1999/2000 government sector sizes from 1991 and 2001, respectively, are used

Table 5: Share of individuals with the highest levels of education in the public sector

4.4 Activities and occupations of highly educated workers in the public sector

Our hypothesis suggests that highly educated individuals are more likely to end up in relatively unproductive positions when the a state's government sector is large. We cannot identify unproductive occupations or occupations with large rent-seeking potential based on available data. In particular, any skill or other premium that may be paid for certain occupations or skill levels does not necessarily allow us to infer something about productivity if public sector jobs are rationed. We nevertheless make an attempt to show how occupations of the educated Indians change, depending on the size of the government sector of a state.

To investigate the differences in activities and occupations of educated workers between states with small government sectors and those with big government sectors we exploit information provided in the NSS micro data. For each individual, information about the occupation is recorded based on India's National Classification of Occupations (in the 1968 version). We identify the 10 occupations (occupational codes) in the 1993 NSS data in which the largest numbers of educated people in the public sector work. We separately analyze highly educated individuals (defined as those with a graduate degree) and individuals with at least a secondary education. We then study whether the share of these occupations relative to the total size of the public sector is related to the size of the public sector.

The results of this analysis are reported in table 6. There is significant evidence that the share of teachers (at various levels, i.e. tertiary as well as primary and middle school) is negatively correlated with government sector size in the 1990s. That is, in states with smaller government sectors, a larger fraction of public employees are teachers than in states with a large government sector size. Similarly, the share of book keepers/cashiers employed by the public sector relative to total public sector size is significantly negatively correlated with public sector size. Especially teaching is arguably an occupation with a priori low potential for rent seeking, thus we find some (negative) correlation of size of government and occupations not associated with rent seeking. The only significant positive association we find is between upper division clerks/office assistants as a fraction of total government employees and size of government. For all other main occupations (by number of observations with that occupation in the sample) we cannot reject that their share of total government employees grows at the same rate as government sector size grows.

NCO code	occupation	correlation of occupation's share of public sector and current government sector size for 10 most frequent occupations in 1993			
		graduates		secondary plus	
		1991/93	1999/2001	1991/93	1999/2001
120	accountant	0.005	0.273		
		(0.980)	(0.169)		
150	teacher - tertiary level	-0.378	0.067	-0.532	0.028
		(0.057)	(0.739)	(0.005)	(0.888)
151	teacher - secondary level	0.08	0.097	0.049	0.064
		(0.695)	(0.631)	(0.812)	(0.75)
152	teacher - middle school	-0.124	-0.061	-0.356	-0.042
		(0.546)	(0.761)	(0.075)	(0.837)
153	teacher - primary school	-0.098	-0.514	-0.389	-0.274
		(0.633)	(0.006)	(0.049)	(0.167)
230	financial sector manager	0.219	-0.24		
		(0.284)	(0.229)		
300	clerical supervisor	0.084	0.292	0.196	0.297
		(0.685)	(0.139)	(0.336)	(0.133)
302	office assistants/upper division clerk	0.102	0.641	0.225	0.501
		(0.620)	(0.001)	(0.269)	(0.008)
330	book keeper/cashier	-0.496	-0.581	-0.581	-0.526
		(0.010)	(0.002)	(0.002)	(0.005)
350	clerk	-0.26	-0.022	0.012	0.187
		(0.200)	(0.914)	(0.557)	(0.352)
358	office helper (lower level)			-0.169	0.031
				(0.409)	(0.889)
571	police, inspector etc			-0.112	0.038
				(0.587)	(0.851)

Note: calculated based on NSS rounds 50 and 55; p-values in brackets

Table 6: Correlation of occupation's share of government sector and government sector size

4.5 Government size, regulation and economic outcomes

4.5.1 Evidence from the existing literature

The second aspect of our hypothesis demands that a significant part of activities of government be of relatively low productivity (relative to worker's potential productivity in the private sector), unproductive, or perhaps even anti-productive, thus driving a wedge between private and social returns to education. Some evidence of this comes from the previous discussion of the incentives of the labor market for public sector jobs, which suggests that the government hired and promoted individuals for reasons unrelated to productivity. Further consideration of the activities of the educated workers and the Indian bureaucracy supports this claim.

Basu describes India as attempting social revolution by "legislative fiat" (Basu, 1999, p. 24). Much of this legislative fiat took the form of labor regulations, the most important of which was the Industrial Disputes Act of 1947. Besley and Burgess (2004) provide direct statistical evidence of the effect of this legislation. In particular, Besley and Burgess consider state-level amendments to the Industrial Disputes Act during 1958 to 1992. They find effects consistent with the self-defeating thesis advanced by Basu: pro-worker laws led to reduced formal manufacturing output, productivity, and employment. Further, they also find that pro-worker legislation led to higher levels of urban poverty.

The second grand area of bureaucratic regulation of the economy was industrial licensing (which was gradually eliminated during the reform period of the 1980s and 1990s). The legislative centerpiece of this project was the Industries Act of 1951, under which firms were required to get licenses in order to make such elementary changes as entering a new market or setting up, relocating, or expanding a factory.[22] It is very likely that the regulations related to industrial licensing required large numbers of government employees for their implementation.

The cumulative effect of all of such controls was twofold. First, the regulatory scheme provided ample room for the creation, distribution, and extraction of rents by the public sector. Bardhan (1984) states that the collective effect of the regulations as well as the agricultural loans and business bailouts that accompanied them was that, in 1984, "the Indian public economy [had] thus become an elaborate network of patronage and subsidies" (p. 64). Second, the controls and politically motivated misallocation of capital inevitably

[22] These licenses were certainly not perfunctory; most applications entailed substantial delays, and as many as half were denied (Joshi and Little, 1994). Joshi and Little (1994) report that the results were predictably detrimental: "firms frequently put in bogus applications simply to forestall competition. No consistent economic criteria were ever employed. [. . .] First come first served, and lobbying by large industrial concerns were probably the most important determinates [of application success]" (p. 37). Basu and Pattanaik (1997) explain, "whatever might have been the original rationale for many of these regulations, often their cumulative effect was to reduce competition drastically and to generate monopoly rent" (p. 124).

reduced competition, productivity, and employment. Thus there is evidence that a significant number of India's bureaucrats used their skills in well-paid but socially (in an economic sense) unproductive and often socially destructive activities. Additional evidence based on the existing literature is provided in appendix A. We add to this evidence by our own empirical analysis of micro-level data in the next section.

4.5.2 Micro evidence from the manufacturing sector

In this section we present some evidence based on the manufacturing firms' micro data from the Annual Survey of Industries (ASI) to support our claim that more education in the government sector does not necessarily imply better aggregate economic outcomes. The ASI is a comprehensive survey of manufacturing enterprises. It is a census of all large firms and covers a subsample of the universe of small firms. This survey only covers registered businesses. The ASI distinguishes between privately and publicly owned enterprises as well as jointly held enterprises. Using enterprise-level data, as opposed to using household level data, has the advantage that real outcomes and their correlation with public sector variables can be measured directly.

State-level analysis We first use the firm micro data to simply split all firms in the sample into (fully) publicly owned and (fully) privately owned enterprises. Then we calculate the output per employee at the state-level in public and private enterprises separately. We find a significant negative correlation between output per employee in publicly owned enterprises and the size of the state's government sector.[23] The correlation coefficient is -0.32, with a p-value of 0.013. The correlation between output per employee in private enterprises and the size of the state's government sector is negative, too. But this correlation is smaller (in absolute value) and insignificant: the correlation coefficient is -0.15 and the p-value is 0.26. Thus, we find both evidence for a negative correlation of output per employee with government sector size as well as variation in this correlation depending on whether we are considering the public or the private sector. Both findings are consistent with our hypothesis, suggesting direct effects of government ownership, and indirect effects of government sector size on privately and publicly owned enterprises.

Firm-level analysis In a second step of this part of the analysis, we investigate the role of government ownership directly at the firm-level. For this purpose, we estimate production

[23] There are a number of states with only few state-owned enterprises in the sample. To avoid having results influenced by states in which only one or a small number of enterprises determine output per employee, I use only state-year observations with a minimum of 10 public sector enterprises. Relaxing the sample restrictions and excluding only state-year observations in which less than 5 public enterprises are in the sample does not change the results in meaningful ways.

functions and include a dummy variable for public (i.e. government) ownership. More specifically, we estimate the parameters of

$$\begin{aligned} \log(output) &= \alpha + \beta_1 \log(capital) + \beta_2 \log(worker) + \beta_3 \log(non\text{-}worker\ employees) \\ &\quad + \beta_4 \log(materials) + \gamma\ public + industry_s + \varepsilon \end{aligned}$$

Here, *output*, *capital*, *worker*, *non-worker employees*, and *materials* are measures that are taken directly from the survey, while *public* is a dummy variable which is one if a business is fully publicly-owned and zero if it is fully privately-owned. We control for differences across industries by including a full set of $industry_s$ dummies at the two-digit level. We estimate simple OLS regression and abstract from potential problems of endogeneity to focus on the correlation between public ownership and output (after controlling for inputs).

We start out with an analysis separately for each of the census years 1981, 1991 and 2000/2001.[24] Table 7 shows that fully publicly owned firms are less productive than fully privately owned firms. The estimates of the difference between private and public sector enterprises range between about -18% and -33%, and this gap between public and private increases over time (possibly reflecting the fact that more productive enterprises are more likely to be privatized during the reform period of the 1980s and 1990s). We also estimate a specification in which we let the degree of government ownership vary, i.e. construct additional dummy variables for "joint, majority public" (the majority is publicly owned) and "joint, majority private" (the majority is privately owned). Using these dummies, columns (2), (4), and (6) demonstrate a monotone relationship between public ownership and productivity: The larger the share of a firm that is publicly owned, the smaller the firm's productivity.

To be able to make a connection between public ownership and levels of education, we also investigate how the share of non-worker employees varies with public ownership. The underlying assumption here is that non-worker employees are generally higher educated individuals, while workers are, on average, individuals with lower levels of education.[25] Thus, in a separate, not reported analysis, we regress the share of non-worker employees on firm characteristics and a public ownership dummy. The unconditional share of high-level employees is 15.6% of all employees in 1981 and increases to 18.1% in 1991 and reaches 22.2% in 2000 for all firms. Using regressions to control for firm characteristics, we find that the publicly-owned enterprises have higher shares of "non-worker employees" (i.e. the presumably more highly educated). This share is between about 1.7 percentage points (only controlling for in-

[24] The census data is from 2001; we only have ASI data for 2000.

[25] According the ASI documentation non-workers are "persons holding positions of supervision or management or employed in administrative office, store keeping section and welfare section, sales department as also those engaged in the purchase of raw materials etc. and in production of the fixed assets for the factory and watch and ward staff."

Dependent variable: log(output)						
	1981		1991		2000	
	(1)	(2)	(3)	(4)	(5)	(6)
log(workers)	0.260	0.260	0.300	0.299	0.214	0.213
	(0.004)***	(0.004)***	(0.004)***	(0.004)***	(0.005)***	(0.005)***
log(non-worker employees)	0.176	0.173	0.208	0.208	0.249	0.246
	(0.004)***	(0.004)***	(0.004)***	(0.004)***	(0.006)***	(0.006)***
log(capital)	0.062	0.061	0.061	0.062	0.134	0.134
	(0.002)***	(0.002)***	(0.002)***	(0.002)***	(0.003)***	(0.003)***
log(materials)	0.473	0.474	0.458	0.459	0.440	0.442
	(0.002)***	(0.002)***	(0.002)***	(0.002)***	(0.003)***	(0.002)***
fully public	-0.178		-0.240		-0.332	
	(0.014)***		(0.014)***		(0.026)***	
joint, majority private		-0.083		-0.038		-0.014
		(0.035)**		(0.027)		(0.045)
joint, majority public		-0.173		-0.081		-0.223
		(0.026)***		(0.022)***		(0.034)***
fully public		-0.175		-0.235		-0.332
		(0.014)***		(0.014)***		(0.026)***
log(workers)*public						
log(non-worker emp. *public						
log(capital)*public						
log(materials)*public						
Industry dummies	yes	yes	yes	yes	yes	yes
constant	5.926	5.912	6.611	6.587	6.640	6.583
	(0.026)***	(0.025)***	(0.026)***	(0.026)***	(0.052)***	(0.050)***
observations	38113	39109	39805	41177	21534	22216
R-squared	0.88	0.88	0.90	0.90	0.90	0.90

The omitted category in columns (2), (4) and (6) is “fully privately owned”.
Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Table 7: Production function estimates on the role of public ownership

dustry dummies) and 2.5 percentage points (controlling for industry dummies, log of capital, and log of total employment) larger for public owned enterprises in 1981. This difference in the share of high-level employees increases to between 2.3 and 4.3 percentage points in 1991, and between 2.8 and 8.8 percentage points in 2000. This provides some additional evidence that the public sector attracts a disproportionately large share of the more highly educated individuals.

After this investigation of trends over time, we now pool again ASI data from the years 1981, 1986, 1991, 1995, and 2000 to further investigate differences between the public and the private sector, as well as differences across states with different public sector sizes. Table 8 shows, first, that we obtain similar results as in the previous analysis for the negative correlation between public ownership and productivity in the pooled data. Here, we now also add specifications in which we show results using total employees, instead of splitting up into workers and non-working employees. In addition, we also control for a full set of state-year dummies in most-specifications. In all of the first four specifications the negative coefficient on the "fully public" dummy variable is very robust.

In columns (5) and (6) we investigate whether the input elasticities change with public ownership. With respect to the worker/employees variables, we find that an increase in the number of workers increases output by more in public enterprises than it increases output in private enterprises. However, the opposite is true for non-worker employees, i.e. those that are likely to be more educated. Regarding the other production function inputs, we find that the capital elasticity is larger in public enterprises, while the materials elasticity is smaller in public enterprises. Together this is suggestive of less efficient use of some inputs, notably high-level employees and materials, in public sector enterprises.

In column (7) we also study whether the difference between productivity in public and private enterprises varies with the overall size of the public sector in a state. We find that productivity in public enterprises is even lower, relative to private enterprises, in states that have a large public sector over all.

Dependent Variable: log(output)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
log(total employees)	0.466			0.467	0.468		0.472
	(0.001)***			(0.015)***	(0.002)***		(0.015)***
log(workers)		0.278	0.279			0.278	
		(0.002)***	(0.002)***			(0.002)***	
log(non worker employees)		0.205	0.208			0.211	
		(0.002)***	(0.002)***			(0.002)***	
log(capital)	0.088	0.077	0.076	0.088	0.085	0.072	0.085
	(0.001)***	(0.001)***	(0.001)***	(0.008)***	(0.001)***	(0.001)***	(0.008)***
log(materials)	0.457	0.461	0.460	0.458	0.460	0.464	0.454
	(0.001)***	(0.001)***	(0.001)***	(0.009)***	(0.001)***	(0.001)***	(0.009)***
fully public	-0.178	-0.209	-0.203	-0.171	-0.029	-0.054	-0.065
	(0.007)***	(0.007)***	(0.007)***	(0.018)***	(0.021)	(0.024)**	(0.051)
joint, public majority				-0.114			
				(0.029)***			
joint, public minority				-0.025			
				(0.035)			
log(total employees)* fully public					0.008		
					(0.005)		
log(non-worker emp)*fully public						-0.038	
						(0.007)***	
log(workers)*fully public						0.032	
						(0.007)***	
log(capital)*fully public					0.028	0.036	
					(0.003)***	(0.003)***	
log(materials)*fully public					-0.046	-0.052	
					(0.003)***	(0.003)***	
fully public*gov size							-4.011
							(1.668)**
Industry dummies	yes	yes	yes	yes	yes	yes	yes
State dummies	yes	yes					
Year dummes	yes	yes					
State*year dummies			yes	yes	yes	yes	yes
Observations	211272	189664	189664	216307	211272	189664	195017
R-squared	0.89	0.89	0.89	0.90	0.90	0.89	0.90

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Table 8: Production function estimates on the role of public ownership

4.6 Summing up the micro-evidence on wages, education, and productivity in the public sector

Summing up the micro-evidence that we present in this section regarding wages, education, and productivity in the public sector, we find the following: First, a large and economically significant public-private sector wage difference exists. We present evidence from household surveys spanning the period from 1958 to 1999, using NSS, and (in the appendix) evidence from the manufacturing sector, based on ASI data, spanning the years from 1981-2001. There is some evidence that the public-private differential is negatively correlated with government sector size, at least in the 1990s. The evidence that we present based on NSS data also confirms that the public-private sector differences exist across all levels of education.

We further find that a large share of educated Indians work in the public sector. For those with the highest levels of education, we find that in 1971 in some states up to 90% work in the public sector. We also show that a large share of individuals with medium to high levels of education (i.e. secondary schooling and above) work in the public sector. The shares of educated individuals working for the public sector are larger than 50% in most states, with shares being positively correlated with total government sector size in a state. Further, the number of teachers relative to the total size of public sector workers is negatively related to size of the government sector, suggesting that one important occupation with lower potential for rent-seeking is underrepresented in states with larger governments. The number of educated individuals in other occupations grows at the same rate as the total government sector size grows, except for clerks, whose number is increasing faster.

We then focus in some more detail on the industrial sector, because that allows us to demonstrate not just the existence of wage differentials, but also differences in real outcomes (i.e. output differences) between the private and public sectors. Using ASI micro/firm-level data, we find that publicly owned enterprises are less productive than privately owned enterprises. The absolute difference in productivity between private and public firms increases with the level of public ownership (i.e. from joint public/private with majority private, over joint with majority public to fully public). This difference is also larger in states with a larger government sector overall. We also provide some evidence that suggests that public sector firms employ a larger share of non-workers (i.e. more highly educated individuals), and that these non-workers are used inefficiently.

Together, the available evidence suggests that the Indian bureaucracy fulfills the requirements set out in our hypothesis. During a significant part of the period under study, the public sector employed the majority of educated Indians at wages far higher than competing private sector wages. The structure of the labor market indicates that the allocation of these jobs was often political, and that they were well paid in a way unrelated to their productivity.

5 Results from the cross-state regressions

After providing micro evidence for our main hypotheses, we now proceed to testing the main hypothesis using cross-state analyses. We start with the standard framework, in which we do not take into account the role of government. In the second subsection we will then include variables to measure the size of the government sector and, importantly, the interaction between government sector size and growth of human capital.

5.1 Baseline results

As explained above, we use different specifications in our empirical work: In the logarithmic specification of human capital, $log(h)$ is proxied by the logarithm of average years of schooling, i.e. $log(h) = \log(S)$.[26] In the linear schooling specification, $log(h)$ equals the average years of schooling ($log(h) = S$). Our goal is to focus on the role of human capital growth (which is the area of research that yields inconclusive and even counterintuitive negative results so far), and we do not consider further the specifications in which only the initial level of human capital enters. However, for the linear specification, we also show results in which we include both the level and the growth of schooling, which is the "macro-Mincer" specification. As pointed out before, the "macro-Mincer" specification implies $log(h) = S$, and thus we only show results from macro-Mincer-type regressions in the case of the linear schooling specification.

In our main regressions, we will use the fixed effects panel estimator, which allows us to control for unobserved state-fixed effects, and the dynamic panel estimator (based on Blundell and Bond 1998) that instruments endogenous variables with lags of levels and differences. To make our econometric approach comparable to Krueger and Lindahl (2001), we also use pooled data, in which we correct for correlation of the standard errors within a state, in a subset of the regressions. All regressions include decade fixed effects to control for unobserved time effects.

Tables 9 and 10 present the first sets of results from these regressions. Recall that S is the average years of education, SDP is state domestic product and E is electricity consumption. In the log-specifications, the parameter estimates on growth in educational capital are statistically insignificant, and they are actually negative in one of the instrumental variables regressions (column 5). In the linear specification (table 10) we find significant effects only for the pooled regressions but not for the fixed effects or dynamic panel estimators. Once again, one of the estimates on education growth, based on the fixed effects, is negative. In the uninstrumented regression specifications we find strong decadal effects, with the exception of

[26] The use of $\Delta \log(S)$ as the key right hand side variable can be derived from an aggregate production function framework (as for example Benhabib and Spiegel 1994, and Pritchett 2001).

the macro-Mincer setup in columns 3 and 4 of table 10. We also find in most specifications a negative relationship between initial SDP and subsequent SDP growth; that is, there seems to be (conditional) convergence within India.

The key result from the regression of SDP growth on education growth presented here is that there is no significant effect of education growth on SDP growth when education is specified in logarithms, as is most common in the literature, while the evidence for an effect of education growth on SDP growth is weak at best in the linear schooling specification. Together with the high returns to education in India that we cited above, this indicates that the micro-macro puzzle also exists within India.

Dependent variable: annual SDP growth, 10 year intervals						
	(1) pooled	(2) FE	(3) FE	(4) IV	(5) IV	(6) IV2
$\Delta\log(S)$	0.083	0.070	0.073	0.211	-0.248	0.375
	(1.25)	(1.06)	(0.77)	(0.69)	(1.17)	(0.91)
$\log(SDP_{t-1})$	0.003	-0.088	-0.095	-0.004	0.010	-0.016
	(0.31)	(4.92)***	(4.26)***	(0.29)	(1.07)	(1.02)
$\Delta\log(E)$			0.059		0.109	0.124
			(0.98)		(1.18)	(0.90)
1970s	0.012	0.021	0.023	0.021	-0.003	0.038
	(2.10)**	(3.38)***	(3.68)***	(0.95)	(0.19)	(1.51)
1980s	0.015	0.038	0.040	0.024	-0.003	0.039
	(2.85)***	(5.35)***	(5.28)***	(1.05)	(0.20)	(1.53)
1990s	0.037	0.080	0.087	0.049	0.017	0.074
	(4.79)***	(6.64)***	(5.95)***	(1.59)	(0.79)	(2.03)*
Constant	-0.002	0.195	0.207			
	(0.11)	(4.84)***	(4.18)***			
Observations	92	92	86	92	86	86
R-squared	0.33	0.59	0.61			
test for AR(2) in first differences (p-value)				0.620	0.260	0.802
Hansen test of overid. restrictions (p-value)				0.652	0.352	0.347

Note: Heteroskedasticity-robust t-statistics are in parentheses. Regressions labeled as "pooled" are OLS regressions where standard errors are corrected for pooling. FE indicates the fixed effects estimator. IV regressions are using the Blundell and Bond (1998) system GMM estimator. For results reported under "IV2" the number of instruments is reduced by restricting the number of lags to 1. The omitted decade is always 1961-1971. ***, **, * indicates significance at 1%, 5%, 10%

Table 9: Education growth and SDP growth by decade: log specification

Dependent variable: annual SDP growth, 10 year intervals								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	pooled	FE	pooled	FE	FE	IV	IV	IV2
ΔS	0.122	-0.030	0.113	0.146	0.194	0.172	0.045	0.042
	(2.12)**	(0.50)	(1.84)*	(1.61)	(1.53)	(1.42)	(0.49)	(0.52)
S_{t-1}			0.010	0.026	0.030	0.009	0.011	0.010
			(3.36)***	(2.71)***	(2.52)**	(3.24)***	(3.75)***	(2.89)***
$\log(SDP_{t-1})$	-0.001	-0.089	-0.015	-0.108	-0.112	-0.005	-0.008	-0.008
	(0.16)	(4.84)***	(1.62)	(7.11)***	(6.31)***	(0.84)	(1.54)	(1.13)
$\Delta\log(E)$					0.053		0.177	0.190
					(1.01)		(2.96)***	(2.00)*
1970s	0.012	0.014	0.005	0.001	0.003	0.008	0.009	0.009
	(2.71)**	(2.79)***	(1.18)	(0.12)	(0.32)	(0.86)	(1.44)	(1.44)
1980s	0.013	0.033	0.004	0.006	0.003	0.003	0.002	0.003
	(2.72)**	(4.91)***	(0.71)	(0.48)	(0.14)	(0.31)	(0.38)	(0.49)
1990s	0.036	0.074	0.022	0.033	0.030	0.021	0.024	0.025
	(4.54)***	(5.79)***	(2.84)***	(1.57)	(1.03)	(1.63)	(2.43)**	(2.47)**
Constant	0.003	0.207	0.026	0.214	0.211			
	(0.15)	(5.15)***	(1.35)	(6.37)***	(4.73)***			
Observations	92	92	92	92	86	92	86	86
R-squared	0.36	0.59	0.42	0.66	0.68			
test for AR(2) in first differences (p-value)						0.261	0.492	0.541
Hansen test of overid. restrictions (p-value)						0.443	0.627	0.428

Note: Heteroskedasticity-robust t-statistics are in parentheses. Regressions labeled as "pooled" are OLS regressions where standard errors are corrected for pooling. FE indicates the fixed effects estimator. IV regressions are using the Blundell and Bond (1998) system GMM estimator. For results reported under "IV2" the number of instruments is reduced by restricting the number of lags to 1. The omitted decade is always 1961-1971. ***, **, * indicates significance at 1%, 5%, 10%

Table 10: Education growth and SDP growth by decade: linear specification

5.2 The role of government

We now proceed to test the hypothesis that the government sector has absorbed much of the human capital in unproductive positions. As pointed out in the theoretical considerations section above, this implies a negative interaction of government size and human capital growth. The proxy for government sector size, *gov*, is government employment as a percentage of the total population (at the beginning of the period). Tables 11 and 12 present the central results of the paper. Note that government employment figures are not available for all states, so baseline results (i.e. as in column 2 of table 9 and column 3 of table 10) are repeated in these tables for those states for which government employment numbers are available to make results more comparable across specifications.

First, consider the specification of schooling in logarithms (table 11). In the baseline results (columns 1 and 2), the effect of education growth is insignificant, even after controlling for the linear effect of government sector size. However, once we include the government sector size interacted with education growth, the effect of education growth is positive and significant. Equally important in the context of our two hypotheses, the interaction term itself is negative and significant in all specifications.[27] The IV results, based on the dynamic panel/system GMM estimator, confirm the findings of the fixed effects and pooled regressions. Both the parameter estimate for schooling growth and for the interaction term increase in absolute size in the IV estimates. We also follow other researchers in the growth literature (e.g. Barro and Lee, 1994; see also the Monte Carlo evidence in Hauk and Wacziarg, 2004) and employ the seemingly unrelated regressions (SUR) estimator. The advantage of the SUR estimator is that it allows for different within-state correlations of the error term across different states. The SUR estimates, which are reported in column 6, indicate that the findings are robust to using different estimators.

A very similar picture emerges in the specification with linear schooling (table 12).[28] The parameter estimate on education growth in the baseline regressions is insignificant (columns 1 and 2), while it increases and becomes significant once the interaction term is included. Again, the interaction term is negative throughout, and significant in the fixed effects and IV regressions.

[27] Note that the interpretation of the coefficient on the education growth variable changes once we include the interaction of education growth with government sector size, which partly accounts for the change in the size of the coefficient from model 2 to model 3.

[28] Here we focus on the macro-Mincer specification, i.e. the one that includes both growth and inital value of schooling.

Dependent variable: annual SDP growth, 10 year intervals								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	FE	FE	FE	FE	pooled	SUR	IV	IV2
Δlog(S)	0.060	0.064	0.229	0.230	0.151	0.113	0.303	0.510
	(0.92)	(0.97)	(2.63)**	(1.83)*	(2.01)*	(1.96)*	(1.82)*	(1.72)*
gov_{t-1}		0.258	0.506	0.427	0.440	0.392	0.525	0.622
		(0.72)	(1.55)	(1.29)	(3.61)***	(3.51)***	(5.19)***	(3.13)***
Δlog(S)*gov_{t-1}			-11.910	-11.437	-4.786	-3.457	-5.823	-8.169
			(3.60)***	(3.42)***	(1.80)*	(2.33)**	(2.84)***	(2.60)**
Δlog(E)				0.053	0.077	0.093	0.157	0.114
				(0.87)	(1.56)	(1.93)*	(1.94)*	(0.99)
log(SDP_{t-1})	-0.078	-0.078	-0.083	-0.091	-0.001	0.001	-0.015	-0.021
	(4.46)***	(4.37)***	(4.72)***	(3.78)***	(0.11)	(0.16)	(2.86)***	(1.74)*
1970s	0.018	0.017	0.015	0.018	0.014	0.011	0.025	0.034
	(3.03)***	(2.68)***	(2.56)**	(3.15)***	(2.07)**	(1.69)*	(3.34)***	(2.16)**
1980s	0.034	0.032	0.032	0.034	0.017	0.014	0.028	0.037
	(4.92)***	(4.49)***	(4.84)***	(4.68)***	(2.87)***	(2.63)***	(3.76)***	(2.44)**
1990s	0.073	0.072	0.070	0.078	0.042	0.038	0.059	0.070
	(6.07)***	(5.88)***	(5.83)***	(4.87)***	(4.79)***	(5.31)***	(5.12)***	(2.92)***
Constant	0.176	0.168	0.181	0.196	-0.011	-0.014		
	(4.44)***	(3.98)***	(4.43)***	(3.60)***	(0.47)	(0.57)		
Obs.	84	84	84	78	78	78	78	78
R-squared	0.56	0.57	0.60	0.62	0.49			
test for AR(2) in first differences (p-value)							0.846	0.459
Hansen test of overid. restrictions (p-value)							0.967	0.724

Note: Heteroskedasticity-robust t-statistics are in parentheses. Regressions labeled as "pooled" are OLS regressions where standard errors are corrected for pooling. FE indicates the fixed effects estimator. IV regressions are using the Blundell and Bond (1998) system GMM estimator. For results reported under "IV2" the number of instruments is reduced by restricting the number of lags to 1. The omitted decade is always 1961-1971. ***, **, * indicates significance at 1%, 5%, 10%

Table 11: Education growth, government sector size, and SDP growth: log specification

Dependent variable: annual SDP growth, 10 year intervals								
	(1) FE	(2) FE	(3) FE	(4) FE	(5) pooled	(6) SUR	(7) IV	(8) IV2
ΔS	0.112	0.111	0.223	0.307	0.177	0.178	0.235	0.248
	(1.21)	(1.19)	(1.97)*	(1.80)*	(1.69)	(1.87)*	(1.91)*	(1.45)
S_{t-1}	0.023	0.023	0.023	0.028	0.007	0.005	0.008	0.006
	(2.36)**	(2.32)**	(2.38)**	(2.35)**	(2.92)***	(4.14)***	(2.40)**	(1.74)*
gov_{t-1}		0.035	0.326	0.292	0.418	0.325	0.471	0.661
		(0.11)	(1.01)	(0.82)	(2.33)**	(2.29)**	(2.67)**	(2.33)**
$\Delta S*gov_{t-1}$			-4.041	-4.892	-2.706	-2.442	-3.817	-5.723
			(2.63)**	(2.40)**	(1.25)	(1.28)	(2.06)**	(2.35)**
$\Delta \log(E)$				0.048	0.089	0.113	0.143	0.080
				(0.85)	(1.92)*	(2.41)**	(2.28)**	(0.87)
$\log(SDP_{t-1})$	-0.099	-0.099	-0.102	-0.108	-0.011	-0.003	-0.015	-0.012
	(6.05)***	(6.00)***	(6.11)***	(5.39)***	(1.58)	(0.50)	(2.71)**	(1.59)
1970s	0.001	0.000	0.001	0.002	0.010	0.011	0.012	0.009
	(0.09)	(0.07)	(0.09)	(0.25)	(1.99)*	(2.05)**	(2.77)**	(1.54)
1980s	0.007	0.007	0.007	0.003	0.008	0.010	0.008	0.008
	(0.55)	(0.54)	(0.56)	(0.15)	(1.34)	(1.91)*	(1.48)	(1.47)
1990s	0.034	0.034	0.034	0.031	0.031	0.033	0.032	0.032
	(1.64)	(1.62)	(1.64)	(1.01)	(3.63)***	(4.62)***	(3.97)***	(2.97)***
Constant	0.200	0.198	0.196	0.201	0.002	-0.017		
	(5.64)***	(5.43)***	(5.30)***	(3.97)***	(0.08)	(0.84)		
Obs.	84	84	84	78	78	78	78	78
R-squared	0.62	0.62	0.64	0.67	0.54			
test for AR(2) in first differences (p-value)							0.645	0.645
Hansen test of overid. restrictions (p-value)							0.999	0.713

Note: Heteroskedasticity-robust t-statistics are in parentheses. Regressions labeled as "pooled" are OLS regressions where standard errors are corrected for pooling. FE indicates the fixed effects estimator. IV regressions are using the Blundell and Bond (1998) system GMM estimator. For results reported under "IV2" the number of instruments is reduced by restricting the number of lags to 1. The omitted decade is always 1961-1971. ***, **, * indicates significance at 1%, 5%, 10%

Table 12: Education growth, government sector size, and SDP growth: linear specification

In sum, the results in tables 11 and 12 support both our hypotheses: in the specifications that include the interaction term, educational expansion has a statistically significant positive sign in most specifications, while the interaction term is negative and significant in all of the fixed effects and the IV specifications. Thus, we find evidence that suggests that education growth promotes economic growth, but that this effectiveness diminishes as the government sector size increases.

Strictly speaking, the results indicate that education growth has a significant effect if the government sector size is equal to zero. To illustrate the magnitude within sample, consider the effect at the smallest government sector size in the sample: at that size of the government sector (namely, where gov=0.013), using the IV results of column 7 in tables 11 and 12, the results imply that moving from the 25th percentile of the education growth distribution (2.2% growth in logs, 4.5% in the levels specification) to the 75th percentile (4.1%, 9.3%, respectively), implies an increase in per capita SDP growth of 0.43 percentage points (in the log specification) and 0.9 percentage points (in the linear specification).[29]

A different way of illustrating the economic magnitude of the effect of education growth at different government sizes is presented in the appendix (see tables 23 and 24). There, we first provide for each state the actual average annual SDP growth per capita for each decade. In the next column, we calculate the contribution of education growth to SDP growth, given our estimates (again, using the IV results of column 7 in tables 11), i.e. we calculate $0.303^{*}\Delta\log(S) - 5.823 * \Delta\log(S) * gov$ using the actual values for $\Delta\log(S)$ and gov for each state and decade. The first counterfactual column then calculate the contribution of education that would have occurred if gov had been relatively small, namely at the 25th percentile of the government size distribution of the respective decade. The final column then compares this to the counterfactual effect if gov had been large, namely at the 75th percentile of the government size distribution of the respective decade. The last row of the table indicates that according to the estimated relationship, annual state domestic product growth would have been 1.2-1.0=0.2 percentage points larger on average than it actually was, if all states had a relatively small government size (i.e. at the 25th percentile of the actual distribution). On average, moving from the 25th percentile to the 75th percentile reduces state domestic product growth by 1.2-0.8=0.4 percentage points.

[29] A note on the effect of the pure government size is in order: in both tables in column 2, which does not include the interaction, the parameter estimate for government size indicates an insignificant effect of government size. On the other hand, the significant parameter estimates for the government size variable that we find in the pooled regressions need to be interpreted in the same way as the education growth variable, i.e. together with the interaction term. Thus, the significant parameter estimates imply simply that if education capital growth is equal to zero, government size is significantly positively correlated with SDP growth. However, as pointed out, education growth is significantly larger than zero for most state/decade observations.

5.3 The role of government: alternative specifications

To investigate the robustness of our results, we follow a number of different strategies. (1) We use working age population figures instead of total population figures. (2) We use additional instruments that come from outside the list of variables in our baseline specifications. (3) We adjust education for quality differences across states. (4) We exclude government's contribution to SDP from our total SDP measure.

We start from the standard specification, which expresses all per capita terms in values relative to the total population. Arguably, studying output and input changes per working age adult is more appropriate. Therefore, we now use data on population sizes within several broad age groups for our further analyses of the robustness of our results. More specifically, we divide all values (SDP, total years of schooling, government sector size as well as electricity use) by population in the age group of 15-59 old individuals, which proxies the group of working-age adults. The results based on working-age population in table 13 confirm our earlier results.

We also use three additional variables as instruments: Districts per square kilometer and districts per capita, respectively, and shares of the population in the age groups 0-14 and 15-34. The number of districts has changed quite substantially over the time period considered. The identification assumption is that the number of districts (or more specifically, districts per square kilometer or per person) is (positively) correlated with the government sector size, mainly because each district requires additional administrative units, but that it is not directly correlated with growth of SDP. This seems plausible because changes in the number of districts appear to be driven by changes in the size of states, which in turn is driven by splits of existing states, and by population growth. Similarly, the argument for using the shares of the two population age groups is that the age distribution predicts education growth but is exogenous to current economic growth. In using this instrument we follow Ciccone and Perri (2006), who also use the demographic structure of the population as instruments. The results using the additional instruments are reported (here and in the following robustness checks in tables 14 and 15) in columns 3, 4, 7, and 8. Using these additional instruments does not change the results in important ways.

Dependent variable: annual SDP growth (per working age adult), 10 year intervals								
	log schooling				linear schooling			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	FE	IV	IV – additional instr. 1	IV – additional instr. 2	FE	IV	IV – additional instr. 1	IV – additional instr. 2
Δlog(S)	0.206	0.414	0.452	0.416				
	(1.80)*	(2.44)**	(1.76)*	(2.16)**				
ΔS					0.115	0.152	0.139	0.139
					(1.36)	(2.10)**	(1.99)*	(1.98)*
S_{t-1}					0.010	0.004	0.004	0.004
					(1.41)	(1.77)*	(1.78)*	(1.78)*
Δlog(S)	-5.482	-4.121	-4.848	-5.466				
*gov $_{t-1}$	(3.40)***	(2.41)**	(2.01)*	(2.18)**				
ΔS*gov $_{t-1}$					-1.389	-1.612	-1.440	-1.449
					(2.78)***	(3.05)***	(2.82)***	(2.80)***
gov $_{t-1}$	0.004	0.313	0.376	0.357	-0.002	0.268	0.258	0.254
	(0.03)	(4.41)***	(2.69)**	(3.14)***	(0.01)	(3.09)***	(3.05)***	(3.03)***
ΔE	0.059	0.156	0.008	-0.013	0.061	0.141	0.126	0.119
	(1.00)	(1.86)*	(0.09)	(0.14)	(1.12)	(2.06)*	(2.05)*	(2.10)**
log(SDP $_{t-1}$)	-0.105	-0.015	-0.012	-0.009	-0.111	-0.011	-0.011	-0.011
	(5.11)***	(2.83)***	(1.14)	(1.66)	(5.60)***	(2.42)**	(2.43)**	(2.45)**
1970s	0.018	0.028	0.023	0.018	0.006	0.009	0.010	0.009
	(2.84)***	(2.94)***	(1.21)	(1.46)	(0.64)	(1.68)	(1.82)*	(1.77)*
1980s	0.033	0.031	0.030	0.025	0.012	0.007	0.008	0.008
	(4.96)***	(3.42)***	(1.63)	(2.07)**	(0.69)	(1.14)	(1.53)	(1.47)
1990s	0.075	0.062	0.056	0.049	0.045	0.031	0.032	0.032
	(5.86)***	(4.74)***	(2.01)*	(2.84)***	(1.58)	(3.81)***	(4.00)***	(3.92)***
Constant	0.303				0.297			
	(5.07)***				(4.76)***			
Observations	78	78	78	78	78	78	78	78
test for AR(2) in first differences (p-value)		0.620	0.665	0.785		0.685	0.529	0.531
Hansen test of overid. restrictions (p-value)		0.958	0.539	0.731		0.999	0.998	0.999

Note: Heteroskedasticity-robust t-statistics are in parentheses. The omitted decade is always 1961-1971. IV regressions are using the Blundell and Bond (1998) system GMM estimator. For results reported under "IV additional instr. 1" the additional instruments are share of 0-14 year olds in the population, the share of 15-34 year olds, and the logarithm of the number of districts per square kilometer in a state (all three instruments are lagged, i.e. at the beginning of the decade). In columns labelled "IV additional instr. 2" the log of the districts per square kilometer is replaced by the number of districts per working-age population in a state (again lagged). ***, **, * indicates significance at 1%, 5%, 10%

Table 13: Education growth, government sector size, and SDP growth, using working age population instead of total population

We also exploit the fact that we can exclude the public administration's contribution to SDP from our total SDP measure. Keeping all other measures as in the previous table, i.e. relative to the working-age population, we find that results do not change significantly if we exclude the public administration's contribution to SDP from the SDP growth calculations; those results are reported in table 14. We hypothesized above that an upward bias may be present if we use total SDP. Indeed, we find only small differences and the results are even stronger (i.e. more significantly negative) when we use the alternative SDP measure, giving some evidence for the (upward) bias on the interaction term.[30] The coefficient on the education growth variables is somewhat larger in the log-schooling specification for the regressions that exclude public administration's contribution to SDP. For the further robustness checks in this section, we focus on the SDP measure that excludes the public administration's contribution to SDP.

[30] This statement is also true if the regressions are run on the same samples. (The results in tables 11/12 and 14 are not strictly comparable because sample sizes differ slightly because of missing public administration SDP data.)

Dependent variable: annual growth of SDP excluding public administration's contribution (per working age adult)								
		log schooling			linear schooling			
	(1)	(2)	(3)	(5)	(6)	(7)	(8)	(10)
	FE	IV	IV – additional instr. 1	IV – additional instr. 2	FE	IV	IV – additional instr. 1	IV – additional instr. 2
Δlog(S)	0.350	0.476	0.509	0.418				
	(2.01)*	(2.75)**	(1.62)	(1.81)*				
ΔS					0.135	0.151	0.153	0.151
					(1.24)	(1.93)*	(1.84)*	(1.83)*
S_{t-1}					0.010	0.004	0.004	0.004
					(1.20)	(1.78)*	(1.81)*	(1.79)*
Δlog(S)	-8.308	-5.079	-6.987	-7.558				
*gov_{t-1}	(4.01)***	(3.12)***	(3.09)***	(3.11)***				
ΔS*gov_{t-1}					-1.957	-1.727	-1.701	-1.689
					(3.17)***	(3.00)***	(2.73)**	(2.70)**
gov_{t-1}	-0.005	0.336	0.426	0.385	-0.020	0.284	0.279	0.279
	(0.03)	(5.00)***	(2.97)***	(3.90)***	(0.11)	(3.73)***	(3.61)***	(3.65)***
ΔE	0.038	0.122	0.079	0.057	0.046	0.135	0.130	0.132
	(0.56)	(1.74)*	(0.85)	(0.60)	(0.75)	(2.00)*	(2.02)*	(2.08)**
log(SDP_{t-1})	-0.110	-0.014	-0.013	-0.008	-0.115	-0.011	-0.011	-0.011
	(5.24)***	(2.98)***	(1.26)	(1.41)	(5.38)***	(2.19)**	(2.29)**	(2.28)**
1970s	0.022	0.025	0.021	0.013	0.006	0.007	0.006	0.007
	(2.92)***	(2.92)***	(1.15)	(0.99)	(0.49)	(1.23)	(1.31)	(1.27)
1980s	0.036	0.028	0.025	0.017	0.010	0.004	0.003	0.003
	(5.06)***	(3.10)***	(1.45)	(1.43)	(0.49)	(0.62)	(0.58)	(0.58)
1990s	0.078	0.058	0.053	0.043	0.042	0.028	0.027	0.027
	(6.41)***	(4.55)***	(2.00)*	(2.40)**	(1.25)	(3.52)***	(3.52)***	(3.43)***
Constant	0.312				0.308			
	(4.95)***				(4.37)***			
Observations	76	76	76	76	76	76	76	76
test for AR(2) in first differences (p-value)		0.925	0.904	0.938		0.437	0.438	0.441
Hansen test of overid. restrictions (p-value)		0.948	0.685	0.663		0.999	0.999	0.999

Note: Heteroskedasticity-robust t-statistics are in parentheses. The omitted decade is always 1961-1971. IV regressions are using the Blundell and Bond (1998) system GMM estimator. For results reported under "IV additional instr. 1" the additional instruments are share of 0-14 year olds in the population, the share of 15-34 year olds, and the logarithm of the number of districts per square kilometer in a state (all three instruments are lagged, i.e. at the beginning of the decade). In columns labelled "IV additional instr. 2" the log of the districts per square kilometer is replaced by the number of districts per working-age population in a state (again lagged). ***, **, * indicates significance at 1%, 5%, 10%

Table 14: Education growth, government sector size, and SDP growth, excluding the public administration's contribution to SDP

Next, we also adjust the schooling variables for differences in the quality of education. While we do not have direct measures of education quality, following our previous argument we will proxy quality with either expenditure per student or teacher-student ratios. Since expenditure is directly related to SDP, we focus on the teacher-student ratio. To adjust schooling for quality differences in each census year, we multiply our average years of schooling variable by the teacher-student ratio, where higher ratios suggest higher quality. This measure is our new quality adjusted schooling measure, S^q.

See table 15 for the results when we use the quality adjusted schooling measure in addition to the working-age population, and the SDP measure that excludes the public sector's contribution to SDP. Again, our main results regarding the schooling variables and their interaction with government sector size are quite robust.

Finally, the simple theoretical framework from which we derive our empirical specification (and that builds on previous papers that pointed towards the micro-macro puzzle) suggests that education growth and not levels of education is the relevant variable for our regressions, i.e. the one that interacts with size of the government sector. Nevertheless, a different theoretical framework may suggest that (initial) levels of education interact with the size of government. To investigate this empirically, we also run regressions in which we add the initial level of education and an interaction term between initial level of education and initial size of the government sector to the set of explanatory variables. In results that are not shown, we find that initial years of education (both in levels and logs) and the interaction term are positive, but not close to significant.[31]

[31] Similarly, in a different theoretical framework, one may be able to argue that lagged values of education growth are the relevant education growth variable. In unreported regressions we have investigated this and found that the lagged education growth values and the lagged values interacted with government sector size have the same sign as the contemporaneous ones in almost all regressions.

Dependent variable: annual growth of SDP excluding public administration's contribution (per working age adult)								
	log schooling				linear schooling			
	(1)	(2)	(3)	(5)	(6)	(7)	(8)	(10)
	FE	IV	IV – additional instr. 1	IV – additional instr. 2	FE	IV	IV – additional instr. 1	IV – additional instr. 2
$\Delta\log(S^q)$	0.282	0.431	0.493	0.415				
	(2.08)**	(2.49)**	(2.31)**	(2.22)**				
ΔS^q					0.025	0.020	0.021	0.023
					(2.40)**	(1.51)	(1.57)	(1.99)*
S^q_{t-1}					0.002	0.000	0.000	0.000
					(2.73)***	(0.34)	(0.37)	(0.37)
$\Delta\log(S^q)$	-4.202	-3.048	-3.691	-3.485				
$*gov_{t-1}$	(2.74)***	(1.93)*	(2.09)**	(2.12)**				
ΔS^q*gov_{t-1}					-0.204	-0.167	-0.175	-0.194
					(2.01)*	(1.20)	(1.29)	(1.69)
gov_{t-1}	-0.112	0.282	0.346	0.281	-0.371	0.179	0.174	0.174
	(0.72)	(3.56)***	(2.82)***	(3.27)***	(2.50)**	(1.89)*	(1.82)*	(1.83)*
ΔE	0.019	0.095	0.083	0.026	0.035	0.072	0.061	0.049
	(0.27)	(0.82)	(0.69)	(0.27)	(0.51)	(0.82)	(0.72)	(0.70)
$\log(SDP_{t-1})$	-0.103	-0.014	-0.016	-0.010	-0.124	-0.004	-0.004	-0.003
	(4.97)***	(4.46)***	(2.07)**	(2.50)**	(5.85)***	(1.97)*	(2.52)**	(2.44)**
1970s	0.025	0.027	0.029	0.021	0.015	0.007	0.006	0.006
	(3.61)***	(4.73)***	(2.41)**	(2.64)**	(1.91)*	(1.45)	(1.61)	(1.49)
1980s	0.038	0.030	0.032	0.026	0.024	0.008	0.008	0.008
	(5.34)***	(4.91)***	(2.83)***	(2.96)***	(2.98)***	(1.48)	(1.48)	(1.43)
1990s	0.080	0.058	0.061	0.052	0.059	0.031	0.030	0.030
	(6.47)***	(7.47)***	(3.63)***	(4.98)***	(3.75)***	(3.62)***	(3.76)***	(3.82)***
Constant	0.289				0.348			
	(4.75)***				(5.92)***			
Observations	76	76	76	76	76	76	76	76
test for AR(2) in first differences (p-value)		0.656	0.520	0.677		0.456	0.512	0.521
Hansen test of overid. restrictions (p-value)		0.954	0.538	0.606		0.999	0.999	0.999

Note: Heteroskedasticity-robust t-statistics are in parentheses. The omitted decade is always 1961-1971. IV regressions are using the Blundell and Bond (1998) system GMM estimator. For results reported under "IV additional instr. 1" the additional instruments are share of 0-14 year olds in the population, the share of 15-34 year olds, and the logarithm of the number of districts per square kilometer in a state (all three instruments are lagged, i.e. at the beginning of the decade). In columns labelled "IV additional instr. 2" the log of the districts per square kilometer is replaced by the number of districts per working-age population in a state (again lagged). ***, **, * indicates significance at 1%, 5%, 10%

Table 15: Education growth, government sector size, and SDP growth, using quality-adjusted education figures

5.4 Can alternative arguments explain the results?

Previous research has shown the importance of labor market regulation in India (Besley and Burgess 2004). One might expect that the type of regulation (pro-worker versus pro-employer) is correlated with the size of government and it could therefore be that size of government just proxies for the type of regulation. To investigate this possibility, we test for an alternative way in which the general political regime may have influenced under what circumstances education is effective in promoting growth, namely through labor market regulation. Note that, in principle, both pro-worker and pro-employer regulation could imply a larger bureaucracy and that educated individuals in the government sector are employed in low productivity jobs (and thus implying a negative interaction term between education growth and government sector size), even if just one type of regulation has a direct negative impact on growth.

The variable that proxies for labor market regulation comes from Besley and Burgess (2004). They consider India's national Industrial Disputes Act of 1947, and study state level amendments to this legislation to develop a numerical measure of labor market regulations by state and year for 1958 to 1992. They code each pro-worker change in legislation as positive one in their variable – here called "pro-worker" – and code each pro-employer change as negative one. Their results show that pro-worker legislation – such as making it more difficult to fire employees – decreased employment, investment, and productivity in the formal manufacturing sector. The pro-worker variable used for our purposes uses the value of their measure at the beginning of each decade.

Results are in table 16. We find a sign of the results as one might expect based on the previous research: the interaction term indicates that education is effective in promoting growth if legislation is pro-employer (i.e. if pro-worker < 0); however, the interaction term upon which this result relies is statistically significant only for two of the six specifications, which are based on levels. But, most importantly for our interests, the education growth variable is not a statistically significant positive predictor of SDP growth; indeed, the coefficient is negative, and significant in one specification.

Dependent variable: annual SDP growth, 10 year intervals						
	log schooling			linear schooling		
	(1)	(2)	(3)	(4)	(5)	(6)
	FE	IV	IV2	FE	IV	IV2
Δlog(S)	0.008	-0.174	-0.166			
	(0.10)	(2.64)**	(1.43)			
Δlog(S)*Pro-worker$_{t-1}$	0.005	-0.056	-0.144			
	(0.06)	(0.29)	(0.71)			
ΔS				-0.053	-0.003	-0.101
				(0.61)	(0.02)	(0.80)
ΔS*Pro-worker$_{t-1}$				-0.124	-0.139	-0.220
				(1.17)	(1.95)*	(2.17)**
S_{t-1}					0.007	0.006
					(4.82)***	(3.00)***
Δlog(E)	0.050	0.128	0.040	0.028	0.081	0.041
	(0.42)	(1.11)	(0.23)	(0.27)	(0.90)	(0.34)
log(SDP $_{t-1}$)	-0.049	0.008	0.011	-0.042	0.001	0.006
	(1.38)	(1.82)*	(2.25)**	(1.09)	(0.08)	(0.71)
1970s	0.011	-0.002	-0.006	0.008	0.001	-0.003
	(1.72)*	(0.30)	(0.72)	(0.88)	(0.17)	(0.25)
1980s	0.026	0.005	0.001	0.022	0.005	0.002
	(2.40)**	(0.77)	(0.20)	(1.67)	(0.71)	(0.20)
1990s	0.050	0.012	0.008	0.043	0.008	0.004
	(2.12)**	(1.08)	(0.80)	(1.57)	(0.89)	(0.30)
Pro-worker$_{t-1}$	-0.002	<0.001	-0.001	0.004	0.006	0.009
	(0.42)	(0.00)	(0.15)	(0.55)	(1.55)	(1.75)*
Constant	0.110			0.101		
	(1.53)			(1.34)		
Observations	55	55	55	55	55	55
R-squared	0.49			0.53		
test for AR(2) in first differences (p-value)		0.451	0.413		0.975	0.654
Hansen test of overid. restrictions (p-value)		0.999	0.989		0.999	0.999

Note: Heteroskedasticity-robust t-statistics are in parentheses. FE indicates the fixed effects estimator. IV regressions are using the Blundell and Bond (1998) system GMM estimator. For results reported under "IV2" the number of instruments is reduced by restricting the number of lags to 1. The omitted decade is always 1961-1971. ***, **, * indicates significance at 1%, 5%, 10%

Table 16: Education growth, labor regulation, and SDP growth

Another potential concern is whether migration could explain our findings. The answer, in our view, is no: first, migration is generally considered to be low in India. Secondly, our state-level measures of human capital are based on census data which records the level of education in a particular state at the time of the census. Thus, unlike in cases where education capital is calculated based on enrollment numbers, if migration across state borders occurs and the location in which education is received and education is used differ, census data will pick up these effects.

5.5 The effect of the reforms during the 1980s and the 1990s

Starting in the 1980s and peaking in the early 1990s, the Indian economy underwent significant reforms, including liberalization of the trade regime and large scale deregulation. We investigate whether these reforms implied a different role of education in the growth process. We hypothesize that education becomes more important when an economy opens up and deregulates. Thus, we expect the coefficient on education in our baseline regressions to increase in size, relative to the pre-reform period.

The effect of the reforms on the interaction term of education and government sector size is less clear: Our basic argument is that education growth does not translate into economic growth if the added human capital is sitting idle or is otherwise prevented from going into full effect. So far we have focused on the role of government, and our argument was that significant amounts of human capital are not employed productively in the government sector. It is important to note, though, that what is measured by the interaction term is the difference between the social return of educated individuals in government positions and social returns of individuals employed outside of government. We expect that after the reforms social returns to education have increased in the private sector. We also expect that the social returns to education in the public sector increased in the 1990s as a consequence of the reforms. The net effect of this on the difference in the social returns to education in government sector and private sector is ambiguous.

Previously, we noted the difference in coefficients of decade indicator variables, without being able to disentangle what was underlying those effects. For example, we restricted the effect of education to be constant across periods. In this subsection, we consider the 1990s separately. We pool all data and interact each variable with a 1990s indicator variable, thus allowing all parameters in our regressions to differ across the two periods.

The results are reported in table 17. For the baseline education growth variables we again find positive and significant coefficients in the IV regressions. The point estimate for the coefficient on the education growth variable interacted with the 1990s dummy is positive, suggesting that the effect of education growth is larger during the reform and post-reform period of the 1990s, but the difference between the coefficient in the 1990s and earlier periods is not statistically significant. However, there is no clear pattern in the coefficient on the government-schooling interaction term. We find point estimates for this term for the 1990s that are positive as well as one negative estimate for the log schooling specification and negative estimates throughout in the linear specification. However, none of these estimates is close to being statistically significant at conventional levels.

In sum, while there is some (statistically weak) evidence that education growth has a larger impact on state domestic product growth in the 1990s, our analysis cannot reject the null hypothesis of no change of the effect of government sector size intermediating education growth during the reform period. However, this may simply be due to the lack of variation in the data once we include 1990s dummies and interaction terms and this will likely remain an open question until more post-reform period data becomes available. But we note that after allowing the coefficients to change during the reform period, we find statistically stronger evidence than before for the positive role of education growth during the full period 1961-2001, and for the negative interaction with the government sector size during that period.

Dependent variable: annual SDP growth, 10 year intervals

	log schooling			linear schooling		
	(1)	(2)	(3)	(4)	(5)	(6)
	FE	IV	IV2	FE	IV	IV2
Δlog(S)	0.088	0.381	0.548			
	(1.07)	(2.29)**	(2.27)**			
Δlog(S)*1990s	0.142	0.170	1.443			
	(0.16)	(0.20)	(0.88)			
gov_{t-1}	0.499	0.409	0.519	0.386	0.607	1.140
	(1.78)*	(2.97)***	(3.44)***	(1.47)	(2.67)**	(3.59)***
gov_{t-1}*1990s	0.510	-0.009	0.533	1.073	0.709	1.012
	(0.79)	(0.02)	(0.56)	(1.30)	(1.04)	(1.20)
Δlog(S)*gov_{t-1}	-5.155	-4.148	-4.862			
	(1.26)	(1.56)	(1.58)			
Δlog(S)*gov_{t-1}*1990s	10.555	12.035	-6.865			
	(0.44)	(0.52)	(0.17)			
ΔS				0.101	0.283	0.605
				(1.10)	(2.27)**	(2.97)***
ΔS*1990s				0.523	0.395	0.264
				(1.24)	(1.23)	(0.66)
S_{t-1}				0.008	0.001	-0.006
				(1.43)	(0.22)	(1.10)
S_{t-1}*1990s				0.010	0.012	0.018
				(1.96)*	(2.45)**	(2.47)**
ΔS*gov_{t-1}				-2.413	-6.294	-10.858
				(1.12)	(3.10)***	(3.33)***
ΔS*gov_{t-1}*1990s				-9.430	-6.142	-9.339
				(0.85)	(0.81)	(0.90)
Δlog(E)	0.001	0.095	-0.007	-0.001	0.042	-0.103
	(0.03)	(1.13)	(0.08)	(0.03)	(0.58)	(1.13)
Δlog(E)*1990s	0.469	0.422	0.341	0.508	0.579	0.750
	(3.43)***	(3.27)***	(1.51)	(3.77)***	(4.09)***	(3.63)***
log(SDP_{t-1})	-0.090	-0.016	-0.019	-0.099	-0.009	-0.014
	(5.70)***	(3.27)***	(1.83)*	(6.55)***	(1.95)*	(1.94)*
log(SDP_{t-1})*1990s	0.024	0.036	0.031	-0.001	-0.008	-0.010
	(1.31)	(2.25)**	(1.52)	(0.05)	(0.69)	(0.72)
1970s	0.015	0.031	0.036	0.011	0.013	0.019
	(2.53)**	(3.86)***	(2.62)**	(1.75)*	(2.09)**	(2.18)**
1980s	0.034	0.035	0.042	0.026	0.015	0.022
	(5.02)***	(4.84)***	(3.07)***	(2.61)**	(2.37)**	(2.20)**
1990s	-0.036	-0.062	-0.072	-0.036	-0.036	-0.037
	(0.64)	(1.73)*	(1.66)	(0.71)	(1.41)	(1.21)
Constant	0.195			0.206		
	(5.70)***			(5.98)***		
Observations	78	78	78	78	78	78
R-squared	0.80			0.84		
test for AR(2) in first differences (p-value)		0.309	0.881		0.219	0.269
Hansen test of overid. restrictions (p-value)		0.988	0.548		0.999	0.973

Note: Heteroskedasticity-robust t-statistics are in parentheses. FE indicates the fixed effects estimator. IV regressions are using the Blundell and Bond (1998) system GMM estimator. For results reported under "IV2" the number of instruments is reduced by restricting the number of lags to 1. The omitted decade is always 1961-1971. ***, **, * indicates significance at 1%, 5%, 10%

Table 17: The role of education in the pre- and post- reform period

6 Conclusion

Education frequently takes center stage in discussions about economic development. Indeed, at the micro level, the positive effects of education for human and social development, including effects on health and wages, have been widely documented. However, at the macro level, the empirical evidence on the relation between education growth and economic growth is mixed. This paper investigates this puzzle, which is of significant relevance to policy makers and academics: While micro-evidence points to substantial returns to education at the individual level, cross-country analyses frequently cannot find evidence for a positive contribution of educational expansion to economic growth. While almost all of the literature on the contribution of education to economic growth uses cross-country regressions, in this paper, we employ instead the variation across states in India during the period 1961 to 2001 to investigate how educational expansion could have failed to promote economic growth in an economy with a substantial wage premium for education.

In the macroeconometric part of our study, we conduct first a standard analysis in which we regress our state-level measure of economic growth on measures of education growth to show that indeed the typical cross-country finding also applies to India: increases in the stock of educated workers are not positively associated with economic growth in standard specifications. Because of relatively clean and comparable data across time and Indian states that we derive from the census, we are confident that data quality issues are of minor importance and cannot explain this finding.

We hypothesize, instead, that in India part of the explanation of this phenomenon can be found in the relationship between the large public sector and the rest of India's economy: the public sector employed the majority of educated workers at high wages, but this allocation of India's human capital failed to promote growth because of the limited productivity of educated workers thus employed. Using micro data we provide substantial empirical support for this hypothesis regarding the mechanism underlying our macro findings.

The suggestion that India's bureaucracy has had limited success in promoting economic growth in the time period that we study is neither unique nor particularly controversial. Especially the role of its complicated set of regulations is studied extensively in the literature (e.g. Aghion et al. 2005, Besley and Burgess 2004, Sivadasan 2003). In addition, there is ample evidence to support our claim that India's public sector paid above-market wages and that the state employed a disproportionately large share of educated individuals. The bureaucracy that hired these educated workers created and managed a vast regulatory structure that limited the ability of firms to expand, hire or fire workers, create new products, and enter new markets. The effect of these regulations was to reduce significantly the efficiency of the Indian economy, creating a situation in which India's educated workers were paid well to engage in activities with low social returns.

Our theory generates a testable hypothesis, and we present evidence that is consistent with this hypothesis: the data indicates that the effect of government sector size on education's effectiveness in promoting growth was economically large, negative, and statistically significant. This suggests that government absorbed human capital during the time period that we study in low productivity activities. Once we control for this effect of government sector size on educational effectiveness the results indicate that the effect of education in India was positive and significant for states with low levels of government. At the smallest government sector size in the sample, using the IV results, the results imply that moving from the 25th percentile of the education growth distribution to the 75th percentile implies an increase in per capita SDP growth of between 0.43 (in the log specification) and 0.9 (in the linear specification) percentage points.

Can we say something more positive about the contribution of education to growth in India after the significant reforms that India underwent in the 1980s and early 1990s? First, note that in light of the dramatic improvement of economic performance in the years after 1980, one might suspect educational expansion to have begun to have a more positive effect on economic growth. Indeed, we find a larger, albeit not statistically significantly different, effect of education growth on economic growth in the post-reform period (i.e. the 1990s). However, there is no clear direction of change for the interaction between education growth and government sector. This may well be due to the fact that we have only one post-reform time period which limits the informativeness of our data for this question. However, we speculate that, while the negative effects of India's bureaucracy may have been ameliorated to some extent, the incentives for educated workers to join the private sector have not improved. Our micro-evidence on public-private wage differentials shows that large positive wage differentials between the public and private sectors existed in 1993 and persisted through the 1990s. The analysis of household-level data (based on NSS) and firm-level data (from ASI) suggests that the public sector wage premium actually increased for workers during the 1990s. The premium over this time period was substantial, namely up to 140%. There has been only limited evidence of a shrinking Indian state, even as reforms limit its competencies. Thus, on average, it seems that outside opportunities for educated workers were not attractive, but would have had large social returns in terms of economic growth.

When private and social returns to education are vastly different, decentralized decision making is inefficient. Our results suggest that the effects of the misallocation of human capital in India were significant. However, in India it was the state (i.e. the central decision maker) who was responsible for this misallocation of human capital in the first place, and it seems that changes in such a situation can only be expected when further reforms take place. Despite many issues that may be unique to India's situation, the analysis may provide a lesson for many different contexts, because for many developing nations, the public sector constitutes a particularly large fraction of the formal economy. This may, in the end, help reconcile economists' and policy makers' priors on the central role of education in the development process and empirical evidence.

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Appendix

A Government sector size, regulation and economic outcomes: additional evidence

Regulatory bureaucracy damaged the economy not only directly but also through its impact on India's culture. One particularly destructive aspect of this arrangement was the elite-fostered culture of corruption that then filtered down into the general culture of the public sector. Bardhan explains, "irresponsibilities at the managerial, technical, and worker levels thus [fed] on each other, creating a general atmosphere of demoralization and parasitism on the state" (Bardhan, 1984, p. 74). Further, the cultural effects of India's bureaucratic socialism extended beyond the public sector and not only reduced incentives to find productive employment but also further legitimated bureaucratic rule. Basu notes that the general cultural bias against business had "been woven into songs and into the remonstrations of parents to children who refuse to study hard that they will end up having to do business when they grow up" (Basu, 2004, p. 11-12). The connection here with the educational and labor market issues is explicit; the cultural expectation was that education's purpose was to allow workers to acquire a public sector job. This created further incentives for educated labor to enter the public sector and served to legitimate the regulatory powers of the bureaucracy.

The positive effects of removing regulatory competencies over the economy from the state in the last twenty years also verify the destructiveness of India's bureaucracy on the economy. Indira Gandhi, following Congress' first election loss in 1977, worked to restore her majority by appealing to the business groups in the Hindu heartland that had defected to the Janata Party in 1977 (Kohli, 1989). The reforms Indira Gandhi advanced tended to be pro-business. Rodrik and Subramanian (2004) note that business groups then supported not general market liberalization – which might threaten established positions – but rather hoped for relaxation of licensing controls and other reforms that would allow for them to expand already-existing businesses. Reforms during this period, then, were incremental; Rodrik and Subramanian (2004) further note that the policy changes were small enough that it is better to describe 1980 to 1984 as a time of "attitudinal" rather than policy change. Those attitudinal changes, however, had significant results. In 1981, the bureaucracy approved four times as many applications for business expansion or new projects as they approved in any of the previous five years (Kohli, 1989). In addition, a few direct policy reforms were introduced: the state relinquished control over steel and cement prices, and "automatic licensing" was introduced in some areas (Kohli, 1989).

These incremental reforms produced dramatic positive effects on India's economic performance. Rodrik and Subramanian (2004) note that, contrary to histories of India's economic performance that emphasize the importance of 1991, all of the chief measurements of economic growth – real GDP per worker, real GDP per capita, and total factor productivity – took a sharp upward shift in growth around 1980 after two decades of low growth: India's per capita economic growth rates more than doubled around 1980, moving from 1.7 percent between 1950 and 1980 to 3.8 percent between 1980 and 2000. In the view of Rodrik and Subramanian (2004) the reforms of 1991 seem to have merely preserved these positive trends rather than creating or dramatically improving them. The history of the reforms to the Indian economy beginning in 1980 provides evidence for the negative influence of the bureaucracy by comparison. Even the gradual decrease in its influence that began in 1980 led to dramatic increases in India's economic performance.

B Data construction

This section describes the sources of data for sector of employment, education levels, and state domestic product.

Data on government sector employees (that include central government employees, state government employees, quasi-government employees, local body government employees) as well as on total employment come from series of books published by India's Central Statistical Organization. The data from 1961 come from Statistical Abstract of the Indian Union 1962. Data from 1971 were unavailable, so data from 1972 were substituted; they come from Statistical Abstract 1972. Data for 1981 come from the Statistical Abstract 1982. Data for 1991 were also unavailable, and the closest available data were from 1988; these come from Statistical Abstract 1992. Government population share was computed by dividing the total number of government employees by the total population. In table 18 we presents summary statistics of this variable.

Data on levels of education in each state and year come from the various censuses of India for 1961, 1971, 1981, 1991, and 2001. These data were used to construct the estimates for average years of education as well as average primary years of education, average secondary years of education, and average higher years of education, from which the human capital growth numbers were computed. To compute average years of education, it was assumed that primary education corresponded to five years of education, middle education corresponded to eight years of education, and secondary education corresponded to ten years of education. A degree corresponded to thirteen years of education, a professional degree corresponded to fourteen years of education, a medical degree corresponded to fourteen and a half years of education, and vocational education corresponded to eleven and a half years of education. These estimates come from the web documents "Secondary Education," "Higher Education in India," and "Technical Education" published by India's Department of Education. To compute average years of education, total years of education were computed by summing the total number of persons with primary education times the years of primary education and the total number of person with secondary education times the number of years of secondary education, etc., for each year and state. Total years of education were then divided by total population, also from census data, to compute average years of education. Table 19 presents summary statistics for average years of education. For the average years of primary education data, a total number of persons with primary education (including those with more than primary education) was computed, and this was multiplied by the number of years for a primary education and then divided by the total population. Average years of secondary and higher education were computed likewise.

Time period	Observations	Mean	Standard deviation
1961-1991	97	.030	.021
1961	20	.019	.015
1971	24	.030	.025
1981	26	.033	.019
1991	27	.035	.022

Table 18: Government population share by decade

Time period	Observations	Mean	Standard deviation
All	158	2.182	1.332
1961	28	0.571	0.414
1971	31	1.533	0.811
1981	31	2.033	0.908
1991	32	2.909	0.976
2001	36	3.475	0.961

Table 19: Average years of education by decade

Time period	Observations	Mean	Standard deviation
1961-2001	18	.022	.008
1961-1971	19	.011	.014
1971-1981	22	.018	.011
1981-1991	26	.022	.015
1991-2001	27	.044	.025

Table 20: Annual real per capita SDP growth by decade

SDP per capita data come from the following sources: For 1961 and 1971 SDP data come from Özler et al. (1996). The data for 1981, 1991, and 2001 come from the website of India's Ministry of Statistics and Programme Implementation. The data on the public administration's contribution to SDP for the years 1961 and 1971 come from Economic and Political Weekly Research Foundation (2003). SDP data were corrected for inflation using the CPIIW (G) deflator with base year 1973, which is provided by Özler et al. (1996) for years up to 1991. The deflator for data from 2001 was calculated using data from the website of India's Labor Bureau (Labor Bureau, Government of India, no year). The electricity variable used in the analysis ($log(E)$) is electricity sold to ultimate consumers (measured as the logarithm of million kilo Watt hours per capita). The data is from various issues of the Statistical Abstracts.

C Summary statistics

Variable	Observations	Mean	Standard deviation
Δlog(SDP)	78	.027	.022
log(SDP_{t-1}) (Rs.)	78	2.42	.392
Δlog(S)	78	.040	.033
ΔS	78	.071	.036
gov_{t-1} (=government employees/population)	78	.029	.019
government employees/population aged 15-64)	78	.053	.032
ΔE	78	.065	.043
I{decade=1960s}	78	.182	
I{decade=1970s}	78	.217	
I{decade=1980s}	78	.294	
I{decade=1990s}	78	.307	

Table 21: Summary statistics

D The public-private wage differential in the manufacturing sector: estimated from enterprise-level data

In the main text we used NSS data to estimate the public-private wage differential. The NSS data allows us to provide evidence on the public-private wage differential for only two years (1993 and 1999/2000). Data from the Annual Survey of Industries (ASI) allows us to give additional evidence, from one specific sector of the economy, that goes back further in time and is consistent over the years. The ASI is a comprehensive survey of manufacturing enterprises. It is a census of all large firms and covers a subsample of the universe of small firms. This survey only covers registered businesses. The ASI distinguishes between privately and publicly owned enterprises (and jointly held enterprises, but here we focus on enterprises that are either wholly publicly owned or wholly privately owned). Using ASI data we can therefore provide some additional evidence about the wage differences between the private and public sector. We use data for the years 1981, 1986, 1991 1995 and 2000 (with initial sample sizes of between 25,901 and 58,503).[32]

First, we use the simple ratio of average earnings in public enterprises divided by average earnings in private enterprises.[33] Secondly, this micro data set also allows us to control for other firm-level characteristics when estimating the public sector premium in average wages paid at the enterprise level. For the purpose of this analysis, we create a dummy variable which is equal to one if a business is fully government owned (here we do not distinguish between central, state or local government) and zero if the business is fully privately owned, and disregard jointly owned businesses. We then regress the logarithm of the average wage paid at the enterprise level on this public ownership dummy variable, which we call *public*, and a vector of industry dummies at the two-digit level, i.e. we estimate the parameters of

$$\log(mean\ wage)_{is} = \beta\ public_{is} + industry_s + \varepsilon_{is}$$

where i indexes firms, s indexes industrial sectors, and $industry_s$ is a vector of industry dummy variables. Our measure of the public sector premium is then equal to $e^{\widehat{\beta}} - 1$ where $\widehat{\beta}$ is the estimate of the coefficient in that regression on the *public* dummy variable (we depict $e^{\widehat{\beta}}$, not $e^{\widehat{\beta}} - 1$ in the following picture).

Figure 1 illustrates the public-private wage differences for all of India. The data series labelled as "wages per worker (ratio)" shows the simple ratios and demonstrates that the average wage paid in public enterprises was about 50% higher than the average wage paid in private enterprises in 1981 and rose over the following years, to reach a maximum public sector premium of more than 120% in 2000. Although we cannot distinguish between average wages of employees with high and low education, the data allows us to distinguish between wages of workers and earnings of employees that are non-workers, which are individuals working in positions that require higher levels of education and/or experience, such as supervisory or managerial positions or those engaged in administrative office.[34] Using this distinction we find that the public sector premium is even higher in most of the years for high-level employees (see the data labelled as "emoluments per non-worker (ratio)") than for workers. The public sector premium falls for non-workers in 2000.

[32] All values are deflated to 1973 Rupees.

[33] Throughout, we use the terms state-owned, government-owned and publicly-owned interchangeably.

[34] More precisely, according to Economic and Political Weekly Research Foundation.(2002), Supplementary Item S. 3 (concepts and definitions) "[w]orkers are defined to include all persons employed directly or through any agency whether for wages or not, and engaged in any manufacturing process or in cleaning any part of the machinery or premises used for manufacturing process or in any other kind of work incidental to or connected with the manufacturing process or subject of the manufacturing process."

On the other hand, "[e]mployees include all workers defined above and persons receiving wages and holding clerical or supervisory or managerial positions or engaged in administrative office, store keeping section and

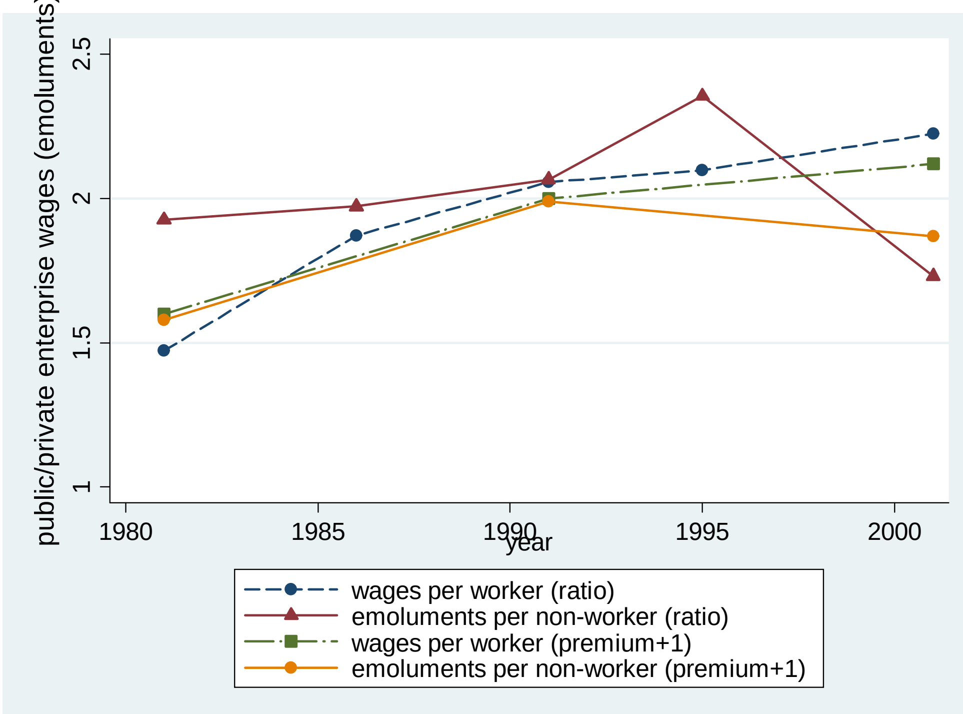

Figure 1: Public/private wage ratio in the industrial sector

The estimates of the public sector premium after controlling for differences across industries in a regression framework show similar trends (see the data series "wages per worker (premium+1)" and "emoluments per non-worker (premium+1)" in figure 1).[35]

Using the micro data, we also estimate the public sector premium separately for each state. Table 22 shows the results by state. Some of the regression results are imprecise in states with small numbers of public enterprises or few employees in the industrial sector. Estimates for states with less than 10 public enterprises are therefore reported in brackets. We find that a statistically as well as economically significant premium is paid on average wages in public-sector enterprises in almost all states. The only estimates with a negative public-private differential come from Andaman and Nicobar Islands.[36]

The correlation analysis, which is restricted to states with 10 or more public enterprises in our sample in order to only work with relatively precisely estimated differentials, shows a negative correlation between estimated differential and size of the government sector for

welfare section, sales department as also those engaged in purchase of raw materials etc. or production of fixed assets for the factory and watch and ward staff."

[35]Note that we add 1 to the estimated premium for the purpose of plotting this figure, to have ratios and estimated premiums at about the same magnitude.

[36]In 2000, we can separately identify "supervisors" in the data. The public sector premium for that group is somewhere between the premium for the two other groups. We find some significant variation across states, but no state has a public sector "penalty", i.e. all estimated premia are larger than 0 in that category.

high-level employees in all years, and a significantly negative correlation in 1991. The finding of a negative correlation for the manufacturing sector is in line with our previous findings for the overall economy, based on NSS data from 1999.

State	workers 1981	high-level employees 1981	workers 1991	high-level employees 1991	workers 2000	high-level employees 2000	supervisor 2000
India	0.60	0.58	1.00	0.99	1.12	0.87	1.04
Andaman and Nicobar Is.	0.08	-0.14	-0.10	-0.17			
Andhra Pradesh	1.17	1.18	1.53	1.56	1.62	1.59	1.77
Assam	0.27	0.09	0.51	0.43	1.07	1.10	0.68
Bihar	1.00	0.76	1.59	1.49	2.57	2.15	1.92
Chandigarh	0.51	0.26	0.55	0.49	0.55	0.32	
Daman and Diu	0.84	0.49					
Delhi	0.64	0.68	0.72	0.52	(3.92)	(2.60)	(4.05)
Goa			0.89	0.66	(1.32)	(1.14)	(1.20)
Gujarat	0.47	0.48	0.91	0.85	0.59	1.00	1.15
Haryana	0.23	0.16	0.62	0.68	1.09	0.96	0.99
Himachal Pradesh	0.44	0.22	0.75	0.53	(0.52)	(0.13)	(0.35)
Jammu and Kashmir	0.44	0.65	0.55	0.49	1.23	0.98	0.80
Karnataka	0.80	0.77	0.95	0.88	1.18	0.82	0.81
Kerala	0.64	0.65	1.09	1.12	1.07	0.61	1.10
Madhya Pradesh	0.41	0.35	1.05	0.92	0.86	0.84	0.74
Maharashtra	0.38	0.36	0.81	0.85	0.77	0.65	0.65
Manipur	(0.09)	(-0.09)	(0.61)	(7.49)	(0.33)	(1.39)	
Meghalaya	0.66	0.51	0.64	0.51			
Nagaland			(0.28)	(0.44)	(2.16)	(3.08)	
Orissa	0.54	0.38	0.95	1.00	0.82	0.71	0.85
Pondicherry	1.57	1.13	1.67	1.46	(2.25)	(1.14)	(1.63)
Punjab	0.21	0.36	0.68	0.89	1.18	1.26	1.42
Rajasthan	0.35	0.44	0.90	0.87	0.90	0.98	0.84
Tamil Nadu	0.69	0.69	1.32	1.31	1.59	1.01	1.68
Tripura	0.64	1.03	0.88	2.28	(2.06)	(2.73)	
Uttar Pradesh	0.70	0.70	1.09	1.13	1.17	0.85	1.19
West Bengal	0.74	0.73	0.99	1.10	1.16	0.96	0.98
correlation with current period government sector size (*gov*)	0.004	-0.171	-0.578	-0.567	-0.206	-0.288	0.352
p-value	0.984	0.460	0.005	0.006	0.383	0.218	0.166

Note: all results based on ASI firm-level data; shown is exp(b(stateowned))-1, where b(stateowned) is the coefficient on the *stateowned* dummy variable in a regression of log(wage) on the dummy variable and industry dummies (at the two-digit level); values larger than 0 therefore indicate a public-sector wage premium; brackets around a number in the table indicate that in that state/year there were less than 10 public enterprises in the ASI sample, making the estimated wage differential unreliable; the correlation analysis is restricted to states with 10 or more public enterprises in the ASI sample

Table 22: Public-private wage premium in the industrial sector

E The economic magnitude of the role of education growth and government size

state	year	annual SDP growth (decade average)	contribution of education growth	counterfactual contribution of education growth with government size at 25th percentile	counterfactual contribution of education growth with government size at 75th percentile
Andaman and Nicobar Is.	2001	8.1%	-0.9%	0.7%	0.2%
Andhra Pradesh	1971	1.4%	2.7%	2.7%	2.3%
Andhra Pradesh	1981	1.2%	1.0%	1.0%	0.6%
Andhra Pradesh	1991	3.0%	0.6%	0.6%	0.4%
Andhra Pradesh	2001	4.8%	1.1%	1.1%	0.2%
Assam	1971	-0.5%	3.6%	3.6%	3.1%
Assam	2001	1.4%	0.4%	0.4%	0.1%
Bihar	1971	0.2%	3.9%	3.7%	3.2%
Bihar	1981	0.7%	1.2%	1.2%	0.7%
Bihar	1991	1.4%	1.1%	1.0%	0.7%
Bihar	2001	-1.7%	0.2%	0.2%	0.0%
Delhi	1971	-0.1%	-1.1%	1.8%	1.6%
Delhi	1981	3.7%	-0.6%	0.5%	0.3%
Delhi	1991	2.7%	-0.4%	0.4%	0.3%
Delhi	2001	4.3%	0.0%	0.2%	0.0%
Goa	1991	2.8%	0.4%	1.1%	0.7%
Goa	2001	8.4%	0.0%	0.3%	0.1%
Gujarat	1971	0.6%	0.3%	0.3%	0.3%
Gujarat	1981	2.0%	1.2%	1.3%	0.7%
Gujarat	1991	0.9%	1.3%	1.3%	0.9%
Gujarat	2001	4.2%	0.4%	0.4%	0.1%
Himachal Pradesh	1981	1.9%	0.0%	1.4%	0.8%
Himachal Pradesh	1991	0.5%	0.1%	1.2%	0.8%
Himachal Pradesh	2001	7.6%	0.2%	1.0%	0.2%
Haryana	1981	1.6%	1.1%	1.1%	0.7%
Haryana	1991	3.2%	0.9%	1.0%	0.7%
Haryana	2001	3.2%	0.8%	0.9%	0.2%
Karnataka	1991	3.7%	0.7%	0.7%	0.5%
Karnataka	2001	4.0%	0.7%	0.7%	0.1%
Kerala	1971	1.6%	3.8%	3.7%	3.2%
Kerala	1981	1.2%	0.9%	0.9%	0.5%
Kerala	1991	3.1%	0.9%	0.9%	0.6%
Kerala	2001	6.5%	0.1%	0.1%	0.0%
Maharashtra	1971	0.6%	2.0%	2.5%	2.2%
Maharashtra	1981	3.4%	0.6%	0.9%	0.5%
Maharashtra	1991	2.5%	0.6%	0.8%	0.5%
Maharashtra	2001	3.5%	0.4%	0.5%	0.1%

Table 23: The economic magnitude of the estimated education growth - SDP growth relationship

state	year	annual SDP growth (decade average)	contribution of education growth	counterfactual contribution of education growth with government size at 25th percentile	counterfactual contribution of education growth with government size at 75th percentile
Meghalaya	1991	3.0%	0.1%	0.1%	0.1%
Meghalaya	2001	4.5%	0.4%	0.6%	0.1%
Manipur	1981	4.4%	1.4%	1.5%	0.9%
Manipur	1991	1.5%	1.0%	1.1%	0.8%
Manipur	2001	2.8%	0.7%	0.8%	0.2%
Madhya Pradesh	1971	1.1%	3.4%	3.5%	3.1%
Madhya Pradesh	1981	1.3%	0.8%	0.9%	0.5%
Madhya Pradesh	1991	1.9%	1.1%	1.1%	0.8%
Madhya Pradesh	2001	3.5%	1.1%	1.1%	0.2%
Mizoram	1991	5.8%	1.3%	1.7%	1.2%
Mizoram	2001	4.7%	0.2%	0.3%	0.1%
Nagaland	1991	3.4%	0.2%	1.5%	1.0%
Nagaland	2001	4.9%	0.0%	0.6%	0.1%
Orissa	1971	1.2%	6.5%	6.2%	5.4%
Orissa	1981	2.6%	0.2%	0.2%	0.1%
Orissa	1991	1.2%	1.1%	1.0%	0.7%
Orissa	2001	2.1%	1.0%	1.0%	0.2%
Punjab	1971	4.6%	3.1%	3.4%	2.9%
Punjab	1981	1.7%	0.9%	1.0%	0.6%
Punjab	1991	2.8%	0.7%	0.8%	0.6%
Punjab	2001	2.3%	0.6%	0.8%	0.2%
Pondicherry	1991	-0.2%	0.2%	0.9%	0.6%
Pondicherry	2001	9.5%	0.2%	0.7%	0.2%
Rajasthan	1971	0.2%	4.1%	4.5%	3.9%
Rajasthan	1981	0.1%	1.3%	1.4%	0.8%
Rajasthan	1991	3.0%	1.1%	1.1%	0.7%
Rajasthan	2001	3.8%	0.9%	0.9%	0.2%
Tamil Nadu	1971	0.5%	2.9%	3.3%	2.8%
Tamil Nadu	1981	1.5%	0.9%	1.1%	0.6%
Tamil Nadu	1991	3.1%	0.7%	0.8%	0.5%
Tamil Nadu	2001	5.3%	0.4%	0.6%	0.1%
Tripura	1981	1.2%	-0.4%	-0.4%	-0.3%
Tripura	1991	0.3%	0.6%	0.8%	0.5%
Tripura	2001	8.3%	0.8%	1.0%	0.2%
Uttar Pradesh	1971	0.4%	3.4%	3.3%	2.9%
Uttar Pradesh	1981	1.3%	0.9%	0.8%	0.5%
Uttar Pradesh	1991	2.4%	1.2%	1.0%	0.7%
West Bengal	1971	0.7%	2.2%	2.6%	2.2%
West Bengal	1981	0.5%	0.6%	0.7%	0.4%
West Bengal	1991	1.4%	0.5%	0.6%	0.4%
West Bengal	2001	4.7%	0.3%	0.3%	0.1%
simple mean (all states, all decades)		2.7%	1.0%	1.2%	0.8%

Table 24: The economic magnitude of the estimated education growth - SDP growth relationship (table continued)