Schooling Externalities and Public Labor Markets: Empirical Evidence from Urban India

by
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The empirical literature which examines the case for human capital spillovers has generally found little support for their existence, thereby undermining models of economic growth in which human capital spillovers play a central role. With labor market imperfections and a consequent reduction in inter-sectoral labor mobility, it is, however, the sectoral availability of skilled labor that matters. While market imperfections need not necessarily imply low aggregate spillovers, I argue that they are likely to do so in economies where the skilled are primarily employed in the public sector. Here, political considerations may cause government employment to increase with investments in higher schooling, as also with political factors such as the extent of local political competition. I provide empirical support for these hypotheses, using household data from urban India to establish the existence of significant local but low aggregate spillovers from higher schooling investments on the wages of the poor.

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1 Introduction

A common premise of models of economic growth is that aggregate levels of schooling in the economy generate spillovers increasing the productivity of all workers. Empirical research, however, finds little evidence of such spillovers. This could, however, be the consequence of labor market imperfections which maintain wages at above-market-clearing levels in some sectors. Under these conditions, schooling spillovers, should they exist, are likely to be local or sectoral, with the sectoral distribution of labor mediating the effect of aggregate levels of schooling on wages. Because the nature of labor market imperfections – the determinants of employment in regulated sectors – influences the sectoral distribution of labor, it will correspondingly influence the magnitude of both aggregate and local spillovers.

This paper provides empirical support for these hypotheses, using data from urban India to examine spillovers from investments in higher schooling to the wages of the poor or unskilled. In India, as in many other developing economies, labor market imperfections commonly emanate in the public sector which sets wages exogenously at relatively high levels. Because employment in the public sector is concentrated in the production of community and social services such as schooling and health, it is amongst the most skill-intensive sectors of the economy, employing very few of the unskilled. In a competitive economy, the sectoral distribution of labor has no implications for wages; they are determined by the economy's aggregate stock of skilled and unskilled labor. However, with sectorally-determined wages, the wages of the unskilled, the majority of who are employed in the unregulated private sector, will reflect the stock of skilled labor in this sector. Correspondingly, factors which draw skilled labor away from this sector will reduce the effect of aggregate schooling investments on the poor.

The existence of a regulated sector in which wages are maintained at above-market-clearing levels need not necessarily imply that the supply of skilled labor to unregulated sectors will be low, even if the regulated sector is skill-intensive as is the public sector. The sectoral distribution of labor will depend not just on technological factors, such as relative skill-intensity, but also on the determinants of employment in the regulated sector. If, for example, employment in regulated sectors is determined by productivity considerations alone, it may be unresponsive to a ceteris-paribus increase in the nation-wide stock of skilled labor. In this case, this increase will generate a commensurate increase in the stock of skilled labor in the unregulated sector, thereby providing the potential for significant local and aggregate spillovers from skilled labor to unskilled wages.

The public sector differs from others in that employment is generally not determined by productivity considerations alone; it also reflects the political and redistributive goals of governments. Regional variation in the size of the public sector, and hence in the proportion of skilled labor available to the private sector, may reflect political factors such as the extent of local political competition. And, investments in higher schooling which increase the stock of skilled labor may place pressure on governments to increase employment of the skilled, thereby swelling the size of the public sector. Public sector employment rules may therefore significantly reduce aggregate schooling spillovers, contributing to low wages in the unregulated economy.

The contribution of this paper is primarily empirical. I use household data from urban India to implement a non-linear instrumental variable methodology which establishes significant sectoral spillovers between the stock of skilled labor in the private sector and unskilled wages. I construct an instrument for private skilled labor using a structural model of schooling attainment and occupational choice between the public and private sector. This methodology enables

estimates of the marginal effect of aggregate schooling investments on unskilled wages, and reveals how they are affected by the political and other factors which influence government employment. The results of this paper show how low aggregate spillovers may be consistent with significant sectoral spillovers, and help reconcile empirical research which finds little evidence of aggregate schooling spillovers with studies which document the importance of schooling for entrepreneurial activity.

The primary empirical challenge in the literature on schooling spillovers is to establish causality. Aggregate measures of schooling in the economy may very well proxy for individual schooling or may be correlated with unobserved economic aggregates which directly influence wages. The scope for identifying *sectoral* schooling spillovers is greater; the supply of skilled labor to any given sector will reflect not just determinants of schooling attainment, but also factors which determine occupational choice. For example, the stock of skilled labor in the private sector will reflect the combined effect of government investments in higher schooling and determinants of entry into government employment. Because a negligible number of the unskilled or poor are employed in the public sector, these determinants of occupational choice for the skilled are unlikely to affect the participation or sectoral choice decisions of the unskilled.

However, many of the variables which determine government employment, such as current government revenues, may directly affect the wages of the unskilled, if they also affect investments in physical capital or infrastructure. Rather than rely on these variables, the primary source of identification of sectoral schooling spillovers in this paper are the age eligibility criterion which govern entry into public sector employment in India. As detailed in the body of this paper, entry into government employment is subject to minimum and maximum age restrictions. These criteria imply that variables which determine the size of new entrants into

government employment, such as current wages and government revenues, will apply primarily to individuals who satisfy eligibility criterion. Therefore, their effect on the probability of government employment will vary discontinuously with age, with the discontinuity defined by the minimum and maximum age for employment in entry-level public sector jobs. Because these age restrictions apply only to employment, the interactions between the size of the age-eligible pool for government employment and current wages and revenues are unlikely to be correlated with investments in physical capital, infrastructure or other determinants of unskilled wages. Nor are they likely to be correlated with an individual's own educational attainment.

This paper combines two literatures. The first is the empirical literature on human capital spillovers. Following a theoretical literature which suggests the importance of schooling externalities for economic growth, a number of studies have tested the empirical significance of human capital spillovers, generally by regressing wages on aggregate stocks of skilled labor or on the average levels of schooling in the economy. Though these studies do not primarily focus on the spillover from higher schooling to the wages of the unskilled, the empirical support for schooling externalities appears to be weak (Acemoglu and Angrist 2000, Rudd 2000). This result is at odds with an empirical literature which finds that education is an important determinant of entrepreneurship and the probability of opening a business (Paulson and Townsend 2004, 2003). Few studies attempt to explain this conflicting evidence, as does this paper.

The focus of this paper on the effect of government employment policies also relates this research to a literature which examines the effect of government on growth and income distribution. Alesina, Ardagna, Perotti and Schiantarelli (2002) document a negative effect of public spending and revenues on private sector profits in OECD economies, providing evidence that government affects the private sector through the labor market. More closely related to the

theme of this paper is the literature which examines the distributive consequences of public sector employment. Focusing on developed economies, Alesina, Danninger and Rostagno (1999), Alesina, Baqir and Easterly (1998), and others, argue that wage-fixing policies which generate a positive public-private wage differential redistribute income in *favor* of the poor.[1]

The distributional consequences of the public sector in developing economies may be very different. Because the public sector is a skill-intensive sector, employment is generally subject to minimum educational qualifications. Even when these are set at relatively low levels, such as eight years of schooling, the low level of schooling attainment in most developing economies implies that public sector employment is concentrated amongst those from the top quartiles of the schooling, and hence wealth, distribution. Here, an increase in public employment is likely to alter the income distribution in favor of the *wealthy.* The direct effect of public sector employment on the incomes of the poor may be marginal. Indirect effects, specifically, the effect of government employment on the supply of skilled labor to the private sector, and through that, on unskilled wages, may be far more important.

The rest of this paper is organized as follows. Section 2 describes the data used for the empirical analysis of this paper. Section 3 provides simple evidence on local and aggregate spillovers from higher schooling on the wages of the poor. Section 4 describes India's public sector and the rules which determine entry into this sector. The empirical work of this paper builds on earlier theoretical work (Kochar 2003) which is briefly described in Section 5. I describe the empirical model and identification strategy in Section 6. Section 7 provides results,

[1] This is because public sector wages display little regional variation, so that the public-private wage gap is larger in less-developed regions where private sector wages are lower. Consequently, the public sector is far more important in these regions. Alesina et al (1999) document this for Italy, where 12% of the employed in the developed Northern region work for the public sector, while 21% of those in the South do.

and estimates of how public sector employment conditions affect the spillover from aggregate schooling investments to the wages of the poor. The last section concludes.

2 Data

The principal data source is the urban sample of the 50th (1993) and 55th (1999-2000) rounds of the Government of India's National Sample Survey Organization (NSSO) survey on Employment and Unemployment. These surveys provide data on wages, occupations and schooling levels for a large sample of urban (and rural) individuals, as do earlier surveys. The 50th and 55th rounds also provide information on whether the individual was employed in the public or private sector, thereby providing the necessary data for this analysis.[2] The availability of two years of survey data makes it possible to control for time-invariant determinants of wages (and schooling) at the state level, thereby eliminating an important source of bias.

Each state is divided into a number of homogenous regions, and the empirical analysis of the paper takes the region as the relevant labor market. Thus, I calculate schooling aggregates by aggregating the survey data at the level of the region. Similarly, measures of aggregate age composition are regional variables, calculated from the household survey using provided multipliers. I restrict the analysis to the 17 major states that, together, comprise 62 regions.

The basic survey data is matched with data from secondary sources on government schooling expenditures, government revenues and on outcomes of state level assembly elections.[3] These data are at the level of individual states. Government revenues are measured as

[2] The 50th round provides this breakdown only for those in "salaried" jobs (status group 31). I define public sector employment in the 1999-2000 survey correspondingly. The 1999-2000 survey reveals that only 2.8% of "casual" wage earners are in the public sector: public sector employees almost exclusively earn regular salaries.

[3] Data on state-level revenue receipts come from various issues of the Reserve Bank of India's *Report on Currency and Finance.* Data on educational investments are from the Government of India, Ministry of Education. Data are

revenues from state taxes. Public sector wages are average state-level entry-level wages for government employees, calculated on the basis of survey data for males ages 20-30.

3 Initial Evidence on Local and Aggregate Spillovers from Higher Schooling on the Poor

The Government of India has historically placed a relatively high priority on investments in higher schooling. Even now, investments in elementary schooling account for only 49% of total schooling expenditure by the central and state governments (1998-99).[4] Because parental income remains a primary determinant of schooling attainment, it is not surprising that the body of students who complete at least 12 years of schooling (henceforth referred to as "higher schooling") is primarily drawn from wealthy households. NSS data for 1999 (table 1) reveal that 45% of males between the ages of 25 to 60 from the highest per capita expenditure quartile are schooled to this level, in comparison to 8% from the lowest per capita expenditure quartile. The direct effects of government investment in higher schooling on the schooling attainment of the poor would therefore appear to be low.

Nevertheless, the poor may still benefit from higher schooling investments, if they generate pecuniary externalities, increasing either the prices of products produced by the unskilled or unskilled wages. Price effects, if any, are likely to be small; the urban poor are

deflated using state-wide CPI indexes from the *Report on Currency and Finance.* Election data are from the Election Commission of India (http://eci.gov.in).

[4] These data reflect expenditures by central and state governments on elementary schooling , and are from the Government of India, Ministry of Science and Technology (2000-01). To put these data in international perspective, the *Human Development Report 2002* reveals that public expenditure on primary schooling in India as a percentage of total schooling expenditure (40% in 1995-97) is less than the corresponding percentage in countries at a similar level of GDP (Nicaragua 69%, Vietnam 43%), and lower, too, than the percentage in many countries at far higher levels of GDP (Mexico 50%, Philippines 56%, Malaysia 63%). India's per-student expenditure at higher levels (Rs. 9,125.6 per student in 1998-99) far exceeds expenditure per student in elementary (Rs. 1,617.5) and secondary (Rs. 5,436.1) levels.

primarily employed in manufacture in the informal sector, whereas the educated wealthy are far more likely to spend their income on products produced by the formal sector.[5]

Wage effects are far more likely. Even if skilled and unskilled labor are not complementary inputs[6], one would expect that more skilled labor would generate positive spillovers to unskilled labor through their effect on technology, on managerial capacity, and on access to imperfectly marketable inputs such as information and physical capital. Indeed, data from the NSSO's survey of informal ("non-directory") manufacturing establishments provides some evidence of such positive spillovers. The 1989-1990 survey (45th round) records whether owners have completed a secondary school education and provides information on wage payments to hired labor. Simple regressions of the share of wages in firm revenues on owner's schooling generate a positive and statistically significant effect.[7] Additionally, an increase in the supply of skilled labor should generate demand for unskilled labor through its positive effect on the number of firms (Paulson and Townsend 2004, 2003).

Given these positive correlations, one would expect a positive correlation between unskilled wages and aggregate levels of higher schooling in the economy. However, survey data from the 55th round of the National Sample Survey reveal very little correlation between these two variables (r^2 = 0.08). Turning directly to the effect of government higher schooling investments, OLS regressions, reported later in this paper, find no significant effect of these investments on the wages of the poor.[8]

[5] Murphy, Shleifer and Vishny (1989) emphasize this point, in their consideration of the effect of income distribution on industrialization.
[6] Hamermesh's (1993) survey finds little evidence of complementarity between workers classified by level of education, but the studies surveyed are based on data from developed economies, with workers of higher levels of schooling than in the urban Indian economy.
[7] Coefficient of 0.07 (standard error = 0.01). Estimates from this regression are available from the author on request.
[8] As subsequently detailed, government investments area the lagged investments in higher schooling undertaken when individuals are within the ages of 10-19. The OLS regression of wages on government schooling investments, amongst other regressors (table 2) reveals a coefficient of -0.03, with a standard error or 0.03.

Because such a significant proportion of the skilled labor force is employed in the public sector, it seems natural to seek an explanation for the lack of correlation between aggregate schooling investments and the wages of the unskilled in the nature of public sector employment. The next section therefore turns to a discussion of India's public sector.

4 Public Sector Employment in Urban India

As in many developing economies, India's public sector represents an important source of employment in the formal economy. Indeed, ILO data on public employment as a proportion of total (formal) employment reveals that India's public sector accounts for as much as 70% of total formal employment (1995). The very high percentage is, of course, a reflection of the small size of India's formal sector. However, NSS data on the occupational distribution of the population reveal that public sector employment is significant, even for the economy as a whole (table 1). In 1993, of urban males between the ages of 25 and 60, as many as 27% were employed in the public sector.[9] The data also confirm the very large role of the government sector in wage employment (casual and salaried): It accounts for 48% of total wage employment and 60% of employment amongst those who earn regular salaries.

In 1999-2000, just over half of public sector employment (51%) was in community, social and personal services. The second largest sector was transport, storage and communication (16%). Manufacturing accounted for just 8% of public sector employment, while the financial, insurance and real estate sectors accounted for 7%.[10] In contrast, employment in the (organized) private sector is concentrated in the manufacturing sector, which, in 2000, employed 59% of the

[9] Restricting attention to the economically active population raises this percentage marginally to 28%.
[10] All data are from the Ministry of Labor (DGE&T).

private workforce. 19% of private sector employment was in the community, social and personal services sector, while the financial, insurance and real estate sectors employed 4% of the total.

The concentration of public sector employment in the community, social and personal services sector, a skill intensive sector, results in the government employing a disproportionate number of the highly educated. Disaggregating the data by three broad levels of schooling (primary or less, middle and secondary, and higher secondary or more) reveals that, in 1993, fully 45% of the urban "skilled" population, those with at least a higher secondary education (12 years of schooling), was employed in the public sector (table 1). Of the skilled in "salaried" jobs, 73% were government employees. Looking across the public sector, in contrast to the 30% of the population schooled to the level of higher secondary school or beyond, 50% of government employees fall in this category. And, only 16% of public sector employees have less than 6 years of schooling, even though this percentage is 37% for the male urban population as a whole.

The skill requirements of public sector employment also imply that it is concentrated amongst the relatively wealthy. By quartile of the per capita expenditure distribution, 42% of those in public sector employment in 1993 came from the highest expenditure quartile, and only 13% from the poorest. As a proportion of the population in each of these wealth categories, 39% of households at the top of this distribution were employed in the government sector, while only 11% of the poorest households were.

As in other economies, average wage earnings in the public sector exceed those in the (organized) private sector.[11] Central Government wages are determined exogenously, in that they are decided on by a "Pay Commission", appointed by the Central Government every five years. The Pay Commission's recommendations are not binding on the Government, and the final

[11] Gregory and Borland (1999) document this for the OECD economies. For India, data from the Annual Survey of Industries, 1996-97, reveal that the difference between the public and private sector daily wage for the country as a whole was Rs. 65 per day. It was as high as Rs. 220 in Madhya Pradesh, and Rs. 180 in Kerala.

decision regarding wage scales reflects a process of collective bargaining with government unions. In this process, many believe that the strength of public sector unions dominates.[12] And, though the Pay commission recommends wages for Central Government employees only, pressure by state level unions has generally resulted in commensurate changes in the wages of state government employees.

A perusal of the deliberations of the Pay Commissions suggests that pay scales are set by factors other than the relative size of the government sector or the productivity of government employees. For example, the deliberations of the Fifth Pay Commission were guided by the disparity between the salaries paid to top-level government employees and CEOs in the private sector. On its recommendations, implemented in 1997-98, the salary bill of the Central Government escalated by 34% in this year along, so that salaries and pensions now absorb more than one-fifth of the total revenue receipts of the government.

Exogenously determined wages set at relatively high levels suggest that public sector employment will be demand determined. Available data support this conjecture. Under the Employment Exchange Act (1959), public sector agencies (and private agencies with employment of 25 or more) are required to notify employment exchanges of all vacancies and to provide data on employment. These exchanges also register those looking for employment. Data from the employment exchanges for 1999 reveal the total number of vacancies listed (public and private sectors) was 328.9 thousand. In contrast, the number of job-seekers on the "live" register numbered 40,371 thousand. Separate data on the number of fresh registrations during the year 1999 alone reveal the number of educated (10^{th} standard and above) and uneducated registrants at 4,498 thousand and 1,467 thousand respectively.

[12] Union Finance Minister, Yashwant Sinha, was candid enough to state that the United Front government buckled under the pressure of government unions in awarding employees wage increases which, in some instances, exceeded the recommendations of the Pay Commission (Financial Express, 14 April, 1999).

The vast majority of skilled recruitment into the government sector occurs at the entry or initial-job level, through a series of competitive examinations organized by different boards. In addition to academic qualifications, entry into public sector employment is subject to both minimum and maximum age restrictions.[13] The minimum age is generally 21, while the maximum age is 30. These same restrictions do not apply to the minority of government employees who are unskilled, most of whom are employed as menial or casual workers.

5 Theoretical Framework

The empirical analysis of this paper examines the effect of the availability of skilled labor in the private sector on the wages of the poor (unskilled), identifying this effect primarily through determinants of the occupational choice between the public and private sectors. A by-product of the analysis is evidence on how public sector employment rules affect the relationship between government investments in higher schooling and unskilled wages. The theoretical framework underlying this analysis, developed in Kochar (2003), combines existing models of the public sector with a standard two-sector analysis of wage determination. I merely sketch the main features of the model here, since the results are intuitive.

[13] These eligibility criterion are clearly stated in the application forms available for the different boards. For example, the Union Public Service Commission oversees recruitment into all Central Government jobs. While educational qualifications vary by job, eligibility is restricted to the 21-30 age group for most jobs (including all entry into the administrative services, which includes not just the Foreign and Indian Administrative Service, but also entry into the Indian Postal Service, the Indian Railway Service, and many other services). The upper age limit is relaxed by five years for members of scheduled castes, tribes and other backward castes. Similarly, entry into the public financial sectors is coordinated by the Banking Service Recruitment Boards, and is similarly subject to an age restriction of 21-30 years, with a relaxation of the upper age limit by five years for members of the scheduled castes and tribes. Under the Government's reservation policy, the age at entry is relaxed by five years for members of scheduled castes and tribes. However, there is no reservation at the highest grades (reservation is only up to the lowest level of Grade "A" employees of the Central Government), and members of these castes are generally recruited at lower grades. As of 1999, of grade A employees of the Central Government, 11% were members of the scheduled caste, while the respective figures for grades B, C, and D were 12.7%, 15.8% and 20.0% (Government of India, Department of Personnel and Training).

For simplicity, I assume that government investments in higher schooling affect the efficiency of skilled labor, but not their number or the number of the unskilled. More generally, investments in higher schooling may reduce the number of the unskilled, generating a *ceteris paribus* increase in unskilled wages. The primary goal of the theoretical model, however, is to compare the wage effects which arise because of public sector employment rules to those which arise when employment in the regulated sector is determined by productivity considerations alone. Since this comparison is unaffected by changes in aggregate labor supply caused by government schooling investments, the simplification comes at no loss of generality.

Let $\bar{L}^s$ and $\bar{L}^u$ represent the economy-wide number of skilled and unskilled labor respectively. For simplicity, assume that that the regulated sector (sector f) employs only skilled labor, and production in this sector is a function of efficiency units (H). The efficiency of a skilled worker is a function of the investments made by the government in higher levels of schooling, at the time that he was enrolled in (high) school. The economy-wide stock of skilled labor in efficiency units is given by H = H($\bar{L}^s$, X) where X represents a function of lagged government investments in higher schooling and other variables which increase efficiency.[14]

Wages in the regulated sector are exogenously set at an above-market-clearing level through, for example, collective wage agreements with unions. As a result, employment of efficiency units of skilled labor is demand determined at $H_f^*(w_f)$, $H_f'(w_f) < 0$. Surplus skilled labor, $H(\bar{L}^s, X) - H_f^*(w_f)$ is employed in the competitive unregulated sector which also employs all unskilled labor.

[14] More specifically, X will represent an average of government investments in higher schooling made while different cohorts of current adults were enrolled in high school, weighted by the distribution of the population across cohorts. The empirical analysis uses this definition.

Production in the unregulated sector (sector i) is given by the production function $F(L_i^u, H_i, Z_i)$ where Z represents other productive inputs. Assuming positive schooling spillovers, the productivity of unskilled workers, $\partial F / \partial L_i^u$, is increasing in the stock of skilled labor employed in the unregulated sector.

In addition to the usual first order conditions, equilibrium wages for unskilled (w_i^u) and skilled (w_i^s) labor must satisfy the following full employment conditions:

$$(1) \qquad L_i^u(w_i^u, .) = \bar{L}^u$$

$$(2) \qquad H_i(w_i^s, .) = H(\bar{L}^s, X) - H_f^*(w_f)$$

Through these conditions in conjunction with positive schooling spillovers, unskilled wages will increase with the supply of skilled labor to the informal sector, $H(\bar{L}^s, X) - H_f^*(w_f)$. Under these conditions, an increase in government investments in higher schooling, because it increases the supply of skilled labor to the unregulated sector, will increase unskilled wages.

This result may not, however, hold if the regulated sector represents a public sector in which employment also reflects the government's objective of increasing incomes. Kochar (2003) builds on theoretical work by Bardhan and Mookherjee (1998), positing that the party in power chooses public sector employment to maximize a weighted function of the sub-group utilities of skilled and unskilled voters. Voter's utilities derive from incomes and from public goods produced by the government. Utility weights reflect the relative proportion of the different sub-groups, but also political factors such as the level of local political competition. Because government employment directly affects incomes, public sector employment will not be determined purely on efficiency grounds, as would occur if the government were solely a

producer of public goods; levels of employment will reflect the government's "distributive" objective of increasing sub-group incomes.

In this case, government investments in higher schooling and the concomitant increase in skilled labor, because it reduces skilled wages in the unregulated economy, may cause the government to increase public sector employment.[15] If so, the demand for skilled labor in the regulated sector is no longer given by $H_f(w_f)$, but may also respond to schooling investments (X), so that $H_f = H_f(w_f,X)$, with H_f increasing in its second argument. In contrast to the earlier case, public sector employment rules may cause government employment to increase with investments in higher schooling, thereby reducing the supply of skilled labor to the unregulated sector. Comparing the two models, the presence of a public sector will unambiguosly lower the "spillover" from higher schooling investments to unskilled wages.

Because the weights placed by the government on the utility of voters also reflect political factors, so, too, will government employment. For example, an increase in the extent of local political competition may cause the government to increase the weight placed on the utility of voters, particularly educated voters who are more likely to vote. This will cause government employment, particularly of the skilled, to be higher in regions where political competition is greater. Consequently, the spillover from higher schooling investments to the wages of the unskilled will also vary with political factors.

If government employment reflected productivity considerations alone, then demand-determined employment induced by relatively high wages would imply a negative effect of public sector wages on government employment. Concern for the utility of voters may, however, change this result: the effect of government wages on employment could also reflect the direct

[15] Whether this happens depends on the relative weight placed by the government on the utilities of the skilled and the unskilled, amongst other factors.

effect of wages on voter utility, as well as on the relative weights placed on the utility of skilled and unskilled voters. If greater weight is placed on the welfare of the skilled, then any union-bargained increase in government wages will increase public sector employment.

6 Empirical Methodology

For the purposes of this paper, the "skilled" refer to individuals with 12 or more years of schooling. The "poor" or "unskilled" are defined as individuals whose household per capita expenditure places them in the bottom quartile of the regional per capita expenditure distribution. Defining the poor by this "relative" definition, rather than by level of schooling, removes the possibility of a definitional relationship between increases in higher schooling and the wages of the unskilled, as an increase in the proportion of the population with higher levels of schooling automatically implies a decrease in the population with lower levels of schooling and hence a supply-induced increase in their wages.[16] The vast majority of the poor, so defined, are employed in the private sector (89%).

While the private sector comprises both a regulated (formal) and an unregulated (informal) sector, India's formal sector employs only 6% of the urban male population and 9% of those with higher education (NSS 55th Round). For this reason, I do not further distinguish between the private regulated and unregulated sectors.

6.1 The empirical wage equation

The wage equation I estimate takes the following form:

[16] Defining the poor or unskilled by level of schooling would also make it difficult to control for sample selection bias, since selection into the sample would reflect the individual's schooling, which is, of course, a direct determinant of wages.

$$(3) \qquad \ln(w_i^u) = \delta_o + \delta_1 \ln[\Pr(skilled \mid prviate)] + W_i' \delta_2 + \varepsilon_i$$

The dependent variable in the regression is the (log) real wage of the poor.[17] I measure the stock of skilled labor as the proportion of the private sector male labor force with higher levels of schooling. The vector $\mathbf{W}_i$ represents other determinants of wages, detailed subsequently. It does not, however, include the individual's schooling. Schooling is endogenous, and while measures of state-level schooling expenditures provide identification of schooling aggregates, they represent very weak instruments for individual schooling. In turn, weak identification of individual schooling may generate biases in all other regression coefficients.

Because individual schooling is not included in the set of determinants, there is always the concern that the estimated effect of schooling aggregates merely reflects that of individual schooling. Schooling aggregates may also reflect unobserved variables which determine the returns to schooling in the regional economy. For example, regions with a relatively high proportion of skilled labor in the private sector may reflect characteristics of the regional economy which lower the returns to unskilled labor. If so, an OLS regression of unskilled wages on the stock of private skilled labor in the region will generate estimates which will be biased downward. I therefore use an instrumental variable (IV) strategy for identifying the effect of higher schooling spillovers at the sectoral level.

6.2 Econometric model

The proportion of the private sector labor force with higher schooling reflects the joint distribution of higher schooling investments and public sector employment. This in turn implies a non-linear relationship between the determinants of the two equations and the private skilled

[17] Calculated by deflating nominal wages by state-specific CPI for industrial labor.

labor force. Consequently, a linear IV regression which uses determinants of each of the underlying marginal distribution as instruments will, in general, yield inconsistent estimates. Instead of the linear IV approach, I implement a non-linear IV strategy. Specifically, I estimate the joint distribution of higher schooling investments and public sector employment, and use the predicted value of the proportion of the private labor force with higher schooling as an instrument in the second-stage wage regression.

The estimation of the bivariate model allows us to see how occupational choices mediate the spillover from government investments in higher schooling to the poor, and how significant spillovers at the sectoral level may be consistent with low spillovers at a more aggregate level. It also shows how public sector employment reflects not just economic factors, but also political considerations, and how these in turn affect the correlation between government investments in higher schooling and unskilled wages.

I start by outlining the empirical framework. I then discuss the determinants of each of the underlying marginal distributions, explicitly discussing the sources of identification in the model.

Let the net value of higher schooling to individual i be given by the following equation:

(4) $$S_i = X_i' \alpha + \upsilon_i$$

While S_i is not observed, its sign determines the value of the (observed) indicator variable, I_{1i}, I_{1i}=1 if S_i>0, 0 otherwise.

Entry into the public sector is possible for both the skilled and the unskilled. While the regulated nature of the public sector (and available data on vacancies and employment discussed in section 4 of this paper) suggests that entry is demand determined, I do not attempt to derive a

demand function, but, instead, estimate a reduced form equation. I assume that the determinants of entry into the public sector are the same for different skill groups, but I allow their coefficients to vary. Entry reflects the value of the latent variable y_{1i} (for skilled labor) and y_{2i} (for unskilled), specified below:

$$(5) \qquad y_{1i} = Z_i' \beta_1 + u_{1i}$$
$$y_{2i} = Z_i' \beta_2 + u_{2i}$$

These two latent variables determine an associated set of indicator variables I_{2i} and I_{31} which take the value 1 if the individual (skilled or unskilled as the case may be) obtains government employment.

Assuming that the residuals ν_i, u_{1i} and u_{2i} are jointly normally distributed, with mean vector zero and covariance matrix:

$$(6) \qquad \begin{bmatrix} 1 & \rho_1 & \rho_2 \\ . & 1 & \rho_{12} \\ . & . & 1 \end{bmatrix}$$

There are thus four mutually exclusive schooling-occupational categories (d_j, j=1 to 4), with associated choice probabilities:

$$(7) \qquad \begin{aligned} \Pr(d_{1i}=1) &= \Pr(I_{1i}=1, I_{2i}=1) = \Phi(\mathbf{X\alpha, Z\beta_1, \rho_1}) \\ \Pr(d_{2i}=1) &= \Pr(I_{1i}=1, I_{2i}=0) = \Phi(\mathbf{X\alpha, -Z\beta_1, -\rho_1}) \\ \Pr(d_{3i}=1) &= \Pr(I_{1i}=0, I_{3i}=1) = \Phi(\mathbf{-X\alpha, Z\beta_2, -\rho_2}) \\ \Pr(d_{1i}=1) &= \Pr(I_{1i}=0, I_{3i}=0) = \Phi(\mathbf{-X\alpha, -Z\beta_2, \rho_2}) \end{aligned}$$

The likelihood function is therefore:

(8) $$\boldsymbol{L}= \prod [\Phi(X\alpha, Z\beta_1, \rho_1)]^{d_{1i}} [\Phi(X\alpha, -Z\beta_1, -\rho_1)]^{d_{2i}} [\Phi(-X\alpha, Z\beta_2, -\rho_2)]^{d_{3i}} [\Phi(-X\alpha, -Z\beta_2, \rho_2)]^{d_{4i}}$$

Estimates of the joint probability distributions generate the relevant conditional distributions. Specifically, the proportion of those in the informal sector with higher schooling, Pr(higher|informal), is the sample counterpart of:

(9) $$\frac{\Phi(X\alpha, -Z\beta_1, -\rho_1)}{\Phi(X\alpha, -Z\beta_1, -\rho_1) + \Phi(-X\alpha, -Z\beta_2, \rho_2)}$$

The above expression clearly reveals how the determinants of schooling investments and those of occupational choice combine to generate the private skilled labor force. Because schooling is completed prior to the choice of occupations, I estimate the model sequentially, but allow for a correlation between schooling and occupational outcomes. Correlation coefficients between the probability of government employment and schooling status are separately calculated for the skilled and the unskilled.

6.3 Determinants of higher schooling investments

The (completed) schooling of the adult population reflects past realizations of the relevant set of variables. In general, this makes the identification of the effect of adult schooling more difficult than that of occupational choice. Cross-sectional household surveys generally offer few variables that can predict the schooling of the adult population, schooling which was completed prior to the survey period. Conventional "demand side" determinants, such as parental schooling, are usually only available for individuals who reside with their (still living) parents.

I rely, instead, on state-level investments in higher schooling, matching the cross-sectional household data with a time series of data on real per capita state level expenditure on secondary schooling between the years 1953 and 1993 (Government of India 2002).[18] For each 5-year age cohort, I take the relevant measure of government schooling investments (*gov_sch)* to be the average state-level per capita expenditure on secondary schooling for the period when they were between the ages of 10 and 19. I allow the effect of government investment on schooling to vary across households distinguished by wealth by interacting government schooling investments with indicator variables for which quartile of the regional per capita expenditure distribution the household falls in.[19] In addition, the regression includes a set of cohort dummy variables, dummy variables for the household's position in the per capita expenditure distribution, and an indicator variable for whether the household is a member of the scheduled caste or tribe.

Identification of the effect of private skilled labor on wages for the unskilled cannot come from (lagged) government investments in higher schooling; these investments could very well be correlated with investments in lower levels of schooling and hence with the schooling of the relatively unskilled. Instead, it is public sector employment rules, which govern the division of the skilled labor force between the private and public sector (and their non-linear relationship with government schooling investments) which drive identification. The determinants of public sector employment are described below.

6.4 Determinants of public versus private sector employment and identification of sectoral schooling spillovers

[18] The data are deflated using the state-specific CPI for industrial labor.
[19] Data on household income at the time of schooling are not available. However, given low income mobility in the country, an individual's position in the expenditure distribution is likely to have remained stable.

The identification of "local" spillovers from the private skilled labor force to unskilled wages is enabled by the dependence of the sectoral distribution of skilled labor on public sector employment rules, in addition to the determinants of the economy-wide stock of skilled labor. Because only 11% of the poor are employed in the public sector, determinants of public sector employment are unlikely to directly affect their occupational choices or labor market participation decisions.

The primary source of identification is the age-eligibility rules which govern entry into the public sector. Because of this eligibility criterion, fresh entrants into government employment, in any given year, are drawn primarily from the 20-30 year age group. This in turn implies that the variables which determine the availability of new jobs in the public sector, such as state-level tax revenues and government wages, will disproportionately apply to this "young" age group.

The set of regressors therefore include a dummy variable *(young)* which takes the value 1 if the individual is in the 20-30 age group in the survey year, 0 otherwise. To ensure that this variable does not merely reflect a non-linear effect of age on the probability of employment, the set of regressors also include a quadratic in the individual's age, as well as a full set of cohort dummies. Identification is enabled by the significant variation in the relative importance of this age group, even within a state. To substantiate this, figure 1 graphs the variation in the proportion of the adult skilled male population between the ages of 20 and 30 for a few states (Madhya Pradesh, Maharashtra and Uttar Pradesh).

There remains the concern that a non-linear effect in age provides a weak basis for identification, even though the non-linearity comes directly from government employment rules. Stronger identification comes because, as noted above, the effects of variables which normally

determine public sector employment will apply disproportionately to this age group. In addition to the dummy variable *young*, the set of regressors therefore also include state-level per capita tax revenues *(gov_rev)*[20] and government wages, and their interaction with *young (gov_rev*young, gov_wage*young).* While these variables could directly influence wages through, for example, their effect on infrastructure and other determinants of production, there is little reason to expect any direct effect on unskilled wages to vary with the particular age grouping suggested by government employment rules.

Political economy theory opines that governments' responsiveness to citizen welfare varies with the likelihood of election. To test the relevance of political factors in government employment decisions, I include a measure of local political competition (*pol_comp).* This variable measures the number of candidates per constituency in the state assembly elections held *prior* to the survey year in question, calculated from results from state assembly elections.[21]

Political competition could also cause governments to increase investments in roads and other public goods, which could directly affect wages, invalidating the use of *pol_comp* as an instrument. As before, identification comes from the age-eligibility criteria which govern entry into the public sector. If political outcomes cause governments to increase employment, we would expect them to have their greatest effect on the age group which is eligible for government employment. The set of regressors therefore includes the interaction of the number of candidates per constituency with the proportion of the regional population which is eligible for government employment.

In addition, I allow *gov_sch,* (lagged) government higher schooling investments undertaken while the individual was between the ages of 10 and 19, to directly affect the

[20] Sources for the tax revenue data are listed in footnote 3.
[21] Available from http://www.eci.gov.in

conditional probability of government employment, even after conditioning on the individual's higher schooling status. This accommodates the hypothesis, discussed in the theoretical framework, that increased investments in higher schooling could cause governments to increase jobs, if the increase in the numbers of skilled labor reduces private sector skilled wages.

Looking across states, variation in the proportion of the skilled labor force in the private sector depends on state-level variation in economic and political conditions in the public sector (per capita state revenues and the extent of local political competition) and in the proportion of males who are age-eligible for government employment. Within a state, variation in the size of the private skilled force comes from variation over time in the same political and economic conditions, but also in regional differences in the pool of eligible applicants. It is variation in ages across a *specific* age group, one determined by public sector employment rules, that matters.

To ensure this, the regression separately includes a set of variables which capture the age distribution of the region in question (the proportion of the regional population in six age groups). It also includes other regional factors, such as the average per capita expenditure of the region and its share of the state population. Finally, the regressors include a dummy variable which takes the value 1 if the individual is a member of a scheduled caste or tribe.

A valid concern is whether state-level variables are the appropriate determinants of public sector employment, and whether high levels of migration invalidate the use of the regional age distribution as a source of identification. The next sub-section addresses these concerns.

6.5 Central versus state governments and migration concerns

State-level measures of public sector wages and government revenues would have little effect on public sector employment, if employment in this sector is primarily determined by the Central Government. The reverse is true in India: the Central Government accounts for only 34%

of total public sector employment (Government of India, 2002). This implies that the state-level variables will have significant explanatory power in explaining public sector employment.

Even so, will the size of the regional public sector reflect the age distribution of the region in question? Suppose the state government determines employment based on a state-wide pool of applicants, and then assigns them to regions based on, for example, the regional demand for public goods or other welfare criterion. Then, the regional age distribution will not explain the size of the local public sector.

The concentration of government employment in community, social and personal services reduces this concern. Teachers, social workers, health personnel and other employees who fall in this category are recruited at "local" levels, generally through district level boards.[22] Employment as a public school teacher, for example, is to a district level cadre, with an individual's district being defined as the district in which he or she has studied for at least 7 years. Relatively few posts are available for "non-locals."[23]

Another factor which relates public sector employment to the age distribution of the individual's region is that a significant percentage of public sector employment is generated by "local bodies" – government institutions which function at the sub-state level (12% in 2000).

Data on migration in the 55th round of the NSS (1999-00) enable a check on the extent of inter-state and intra-state migration amongst public sector employees. The survey asks respondents if their present residence differs from their last "place of usual residence." If so, it gives broad details of the location of the last place of residence including whether it was in a different state or in another district of the same state.

[22] The region is a broader geographical unit, which encompasses several districts.
[23] The restrictive effect of this rule on job-related migration was very visible in a recent field trip by the author to some of India's southern states, where only 15% of teaching posts within any district are reserved for "non-locals."

The data reveal that only 9.6% of public sector employees in the major states have re-located from other states or from outside the country, validating the use of state-level aggregates of per capita revenues and public sector wages as instruments.[24] Moreover, 68% of public sector employees have either not changed their place of last residence or have re-located only within the district. While 23% have re-located from other districts within the state, many of these are likely to have moved within the region, given the relatively few regions within a state.[25]

If we restrict attention to those in the eligible age group, the data reveal that the young are even less likely to have migrated, again supporting the use of the proportion of the young in the region as a predictor of regional government employment. Of the young, only 7.5% have relocated from outside the state of current residence. And, 70.4% have either not moved, or have only moved within the district. 22% have re-located from other districts of the state.

6.6 Sample selection in the wage equation

The wage equation (3) is run only on the sample of the poor who report wages. As previously noted, very few of the poor (9%) are employed in the public sector. The poor, however, do choose between self-employment and wage employment; 36% are in wage employment. I make no attempt to control for selection into wage employment.[26] Consequently, the estimates of the wage equation do not recover the parameters of a demand equation, but instead combine the effects of demand parameters with the determinants of the decision to participate in wage labor markets. The coefficient on schooling aggregates, in particular, cannot be interpreted as the effect of aggregate schooling on the demand for unskilled labor.

[24] This percentage increases marginally to 11.4% if one includes the union territories and minor states, primarily because of the inclusion of government centres such as Delhi and Chandigarh.
[25] Most states are divided into 3 to 4 regions. Madhya Pradesh, with 45 districts, has the most regions (7).
[26] Earlier drafts of this paper did include a sample selection correction term, using the demographic composition of poor households to identify the choice between self and wage employment. Results with and without controls for sample selection bias, so estimated, did not significantly differ.

It does, however, tell us how much an in-sample increase in the stock of skilled labor in the private sector will increase market wages. As such, it does provide evidence of the existence of local spillovers at the sectoral level from higher schooling investments to the poor. Since one would expect any positive effect of skilled labor on demand to increase market participation, estimates from the wage equation (3) will generally underestimate the effect of skilled labor on demand. If we define spillovers narrowly as the effect of schooling on wages through the production function, the estimates of this paper can be viewed as a lower bound on their magnitude.

7 Results

7.1 OLS wage regressions

I start the empirical analysis of this paper with a series of OLS regressions (table 2) which examine the correlation between skilled labor availability and the wages of the poor. As discussed earlier, the regression sample in all cases is restricted to adult male wage earners in the bottom quartile of the regional per capita expenditure distribution. Other than the measures of aggregate skilled labor, the regression includes standard determinants of wages: a quadratic in the individual's age, a dummy variable for whether the individual is a member of the scheduled castes, a set of cohort dummies which indicate membership in 5 year age cohorts, family size, the proportion of the regional population in 5 age groups (the proportion of the regional population between the ages 0-5 is omitted), average per capita expenditure in the region, and the ratio of the region's population to the state population. The regressions also include a full set of state dummy variables, as well as a dummy variable which takes the value 1 for observations in 1999-00.

The first regression (regression 1, table 2) examines the correlation between wages and state-level (lagged) government investments in higher schooling, undertaken while the individual was between the years of 11 and 19. There is no significant effect of schooling investments on wages, suggesting an absence of aggregate spillovers from skilled labor to unskilled wages.

The second regression considers the OLS case for sectoral spillovers, replacing aggregate state-level schooling investments with the proportion of the regional private labor force with higher schooling *(skilled_pvt)*. OLS estimates provide no support for human capital spillovers from the skilled to the poor, even at a sectoral level.

It could well be the case that higher schooling investments, though they increase the stock of skilled labor, are negatively correlated with the elementary schooling investments which matter more for the poor. Regression 3 therefore includes both *skilled_pvt* and government higher schooling investments. The effect of state-government investments in higher schooling, undertaken while the individual was between the ages of 11 and 19, *do* reduce wages, though the estimates are not statistically significant at conventional levels (p value=0.17). And, the coefficient on the stock of skilled labor remains essentially unchanged.

Finally, I report results from a regression which includes determinants of government employment (*gov_rev, gov_wage, pol_comp)* as well as the dummy variable *young* (=1 if the individual is between the ages of 20 and 30) amongst the regressors. Of these variables, the extent of local political competition has a statistically significant positive effect on unskilled wages, suggesting that political factors may cause governments to undertake infrastructural and other investments which directly increase wages. The inclusion of these determinants of government employment also increases the (negative) coefficient on government schooling

investments (*gov_sch)*, and, correspondingly, its statistical significance (p=0.12). However, while the coefficient on skilled labor increases slightly, it remains statistically insignificant.

7.2 Results from the bivariate model of schooling and occupational choice

As previously noted, the joint model of schooling and occupational choice is estimated sequentially: I first estimate the individual probabilities of higher schooling and then the likelihood function (8), which allows differences in the probability of public sector employment amongst the skilled and the unskilled. Table 3 presents estimates of the schooling equation, while table 4 reports determinants of public sector employment for the skilled and unskilled.

Table 3 reveals that cohort-specific investments by government in higher schooling *do* increase the probability that an individual completes at least 12 years of schooling. Confirming results from other studies (Kochar 2002), the regression reveals that government investments are more important for the poor than the wealthy, possibly because the wealthy have available a number of alternatives to public schooling. The estimated elasticity of the probability of completing at least 12 years of schooling with respect to government expenditures on higher schooling is 0.2 for individuals in the bottom half of the per capita expenditure distribution, but only 0.1 for those in the upper half. The probability of completing at least 12 years of schooling does, however, increase significantly with wealth.

The estimates in table 4 of the probability of government employment confirm the skill intensity of the public sector; the probability of public sector employment conditional on completing 12 years of schooling is 0.33 (std. error = 0.18), whereas it is 0.16 (std. error=0.11) for those with less schooling.

Turning to the determinants of government employment, the results reveal the significant effect of age eligibility criterion on the probability of government employment for the skilled and

the unskilled: Males between the ages of 20 and 30 are significantly more likely to be employed in the public sector, even after controlling for non-linear age effects through a quadratic in the individual's age.

The regression results also confirm the hypothesis that government employment is not determined by productivity considerations alone: it is also sensitive to political factors, such as the extent of local political competition. Supporting theoretical models which argue that governments are differentially sensitive to the welfare of the educated, who are more likely to be "informed voters," the estimates of the probability of government employment reveal that higher levels of political competition increase the probability of employment for the skilled, but not for the unskilled. Further, the effect is largest for skilled workers between the ages of 20 and 30, confirming the hypothesis that variables which affect the probability of government employment would differentially affect those who satisfy the age eligibility criterion.

This is also seen from the effect of government tax revenues on the probability of government employment: An increase in state-level revenues increases the employment prospects of skilled workers who are age-eligible for government employment, though it has an insignificant effect on the employment of other workers. However, an increase in public-sector wages has no significant effect on the probability of government employment for the skilled, suggesting that employment decisions are not determined purely on productivity grounds.

Lagged state government expenditures on higher schooling affect the probability of government employment, not just through their effect on schooling status (as revealed in table 3), but also directly, for both the skilled and the unskilled. This finding is consistent with the hypothesis that an increase in the stock of skilled labor generates pressure on governments to increase skilled employment. However, this reduced form regression also lends itself to

alternative interpretations; lagged government schooling investments could merely be picking up the effect of omitted individual schooling attainment.

Of other variables of interest, it is worth noting the significant decline in public sector employment in 1999-00 relative to 1993, for both the skilled and the unskilled. This decline is widely believed to be a consequence of the massive increase in government wages awarded by the Fifth Pay Commission, as discussed in Section 4 of this paper.

7.3 Instrumental variable wage regressions

Table 5 reports results from the instrumental variable estimation of the (log) wage regression, with the same sample and set of additional regressors as in the OLS estimation of table 2. The proportion of the regional private labor force with higher schooling is instrumented by the estimates derived from the joint model of schooling and occupational choice, calculated according to equation (9).

I report results from several different specifications, which differ in their inclusion of the determinants of public sector employment. The first regression omits government investments in higher schooling, government tax revenues and wages, political determinants of employment *(pol_comp)* and the dummy variable *young*, under the assumption that these have no direct linear effect on unskilled wages. However, as previously argued, government schooling investments and government revenues may very well affect the unskilled through any affects on individual schooling and on other public goods including local infrastructure. The remaining equations include these variables, thereby ensuring that identification of the effect of higher schooling spillovers does not rely on the linear effect of these variables alone, but on their interaction with the age eligibility criterion which govern employment. However, it is worth bearing in mind that

these auxiliary regressions cannot be interpreted as standard over-identification tests of the instruments, because of the non-linear instrumental variable strategy.

The regressions reveal a statistically significant effect of private skilled labor on unskilled wages. The significant IV estimates stand in contrast to the insignificant effect revealed in OLS regressions (table 2). The results suggest a large *sectoral* spillover from investments in higher schooling: a 1% increases in the proportion of skilled labor in the private sector increases wages of the unskilled by approximately the same percentage. The results suggest that the low proportion of skilled labor in this sector (25% of the private workforce is skilled, as compared to 51% of workers in the public sector) is a significant constraint on its productivity and growth.

Regressions 2 through 4 reveal that government higher schooling investments *do* directly affect unskilled wages, but that this effect is *negative*. This could be a consequence of a negative correlation between government higher schooling investments and investments in elementary schooling, which matter more for the schooling of the unskilled. Regression 4 also reveals that the extent of local political competition significantly increases the wages of the poor. However, unskilled wages are unaffected directly by the age-eligibility of the individual for government employment (*young)*, by government revenues and by public sector wages.

As previously noted, labor market imperfections imply that schooling spillovers will exist primarily at the sectoral level; it is the supply of skilled labor to the private sector which matters for the wages of the unskilled who are primarily employed in this sector. However, the *nature* of market imperfections will determine the sectoral distribution of the (skilled) labor force and hence the magnitude of both sectoral spillovers as well as aggregate spillovers defined, here, as the marginal effect of government higher schooling investments on unskilled wages. It is quite possible that wage-setting policies which apply primarily to the skilled labor force could reduce

their employment in regulated sectors, increasing the supply of labor to unregulated sectors and, simultaneously, the level of aggregate spillovers.

The low proportion of the skilled who are employed in India's private sector suggest that this is not the case in the Indian economy. In this economy, market imperfections operate to segregate the skilled and the unskilled in different sectors. Correspondingly, we should expect the aggregate spillover from government higher schooling investments to unskilled wages to be low. The next section provides estimates of aggregate spillover effects, and of their determinants.

7.4 Spillovers from government investment in higher schooling

A significant advantage of the estimation of the structural model of schooling and occupational choice is that it generates estimates of aggregate schooling spillovers, defined as the marginal effect of government higher schooling investments on the wages of the poor, estimates which can be calculated at the level of each region. From the structural model, this is given by:

$$(10)\quad \frac{\partial \ln(wages)}{\partial \ln(gov\_sch)} = \frac{\delta_1^*}{[\Pr(pvt)]^2} \bullet$$

$$\left\{ [\Pr(pvt) - \Phi(X\alpha, -Z\beta_1, -\rho_1)] \left[\Phi\left(\frac{-Z\beta_1 + \rho_1 X\alpha}{\sqrt{(1-\rho_1^2)}} \right) \phi(X\alpha)\alpha_g - \Phi\left(\frac{X\alpha - \rho_1 Z\beta_1}{\sqrt{(1-\rho_1^2)}} \right) \phi(Z\beta_1)\beta_{1g} \right] \right.$$

$$\left. + \quad \Phi(X\alpha, -X\beta_1, -\rho_1) \left[\Phi\left(\frac{-Z\beta_2 + \rho_2 X\alpha}{\sqrt{(1-\rho_2^2)}} \right) \phi(X\alpha)\alpha_g + \Phi\left(\frac{-X\alpha + \rho_2 Z\beta_2}{\sqrt{(1-\rho_2^2)}} \right) \phi(Z\beta_2)\beta_{2g} \right] \right\}$$

where $\delta_1^* = \delta_1/(skilled\_pvt)$, δ_1 is the coefficient on the (log) proportion of skilled employees in the private work force from the wage equation, α_g is the marginal effect of government schooling expenditures on the probability of completing at least 12 years of schooling, and β_{jg},

j=1,2, is the coefficient on government schooling expenditures on the probability of government employment for skilled and unskilled workers respectively Pr(pvt) is estimated from the joint distribution of schooling and occupational choice:

$$\Pr(pvt) = \Phi(X\alpha, -Z\beta_1, -\rho_1) + \Phi(-X\alpha, -Z\beta_2, \rho_2) \tag{11}$$

Calculated at the mean level of the relevant probabilities for the sample, the elasticity of wages with respect to government schooling expenditures is 0.05; a 10% increase in government expenditures on higher schooling will increase wages of the poor by only 0.5%.

The focus of this paper on spillovers between skilled labor and unskilled wages differentiates it from the literature which examines the relationship between aggregate measures of schooling in the economy and aggregate wages. Nevertheless, this research confirms the empirical evidence that the effect of aggregate measures of schooling on wages is low. However, the evidence it provides of significant sectoral spillovers suggests that low aggregate spillovers are primarily the consequence of labor market imperfections.

Because this analysis generates estimates of the determinants of employment in the government sector, it is possible to use the results to assess how these determinants affect the magnitude of aggregate spillovers. This can be done analytically, by using (10) to calculate the effects of any given variable on the marginal effect of government higher schooling investments on wages. However, a more revealing and intuitive approach is to estimate a linear approximation of (10), by running an OLS regression of aggregate spillovers, estimated from (10) at the regional level separately for each of the two survey years, on the set of determinants of public sector employment. Table 6 reports the results from this exercise, taking estimates of (10) at the region-year level as the dependent variable, and regressing these on region-year

averages of the various determinants. Because the regression is run on region-year averaged data, I report GLS estimates, with each observation weighted by the regional population.

This exercise confirms that increases in government revenue and in local political competition reduce the aggregate spillover from state-level higher schooling investments on unskilled wages. The negative correlation between these determinants of government employment and the magnitude of aggregate schooling spillovers revealed in this regression is graphed in figures 2 and 3.[27]

8 Conclusion

The question of why some economies achieve a pattern of growth whereby investments in capital generate broad-based improvements in living standards for the economy as a whole, while in others the benefits of income growth percolate only very slowly to the poor, is of paramount interest to policy makers and researchers. Since improvements in income, particularly in urban economies, are highly correlated with schooling, the question can be rephrased: are there economic policies or institutions which can enhance the spillovers from investments in higher schooling?

This paper argues that labor market imperfections determine the nature and magnitude of schooling spillovers. These imperfections forge a dependence of wages on the sectoral distribution of skilled labor, so that schooling spillovers, should they exist, are likely to do so at the sectoral level; investments by state-level governments in higher schooling will affect the wages of the unskilled primarily through their effect on the sectoral distribution of skilled labor. However, with labor market imperfections, this distribution will reflect not just technological

[27] These are "added variable" regressions, which graph the incremental explanatory effect of the variable.

factors, such as technologically driven differences in sectoral skill intensities, but also the factors which govern employment in regulated sectors.

Using data from urban India, the empirical analysis of this paper establishes the existence of significant local spillovers; unskilled wages in the private sector increase with the proportion of the private labor force with higher schooling. Unlike the case in a competitive economy, factors which draw skilled labor away from the private sector to the public sector will therefore reduce unskilled wages. The empirical analysis provides estimates of such effects, documenting the negative correlation between government revenues and increases in local political competition on the benefits which the unskilled receive from government investments in higher schooling.

The results of this paper also reveal that the aggregate effect on unskilled wages of higher schooling investments undertaken by state governments is low, despite relatively high local or sectoral spillovers. The results therefore provide one explanation for why previous empirical research finds little evidence of aggregate spillovers, even though micro-empirical research suggests that the availability of managerial skills can significantly enhance productivity.

This analysis cannot be taken to imply that completely eliminating the government sector will generate substantial improvements in the incomes of the poor. This is, of course, not true. Government employment does have productive value, particularly for poor households, as attested by the positive effect of government investments on their schooling. The conclusion one *can* draw from this research is that labor market imperfections, such as wage setting policies, are costly, and that they are particularly costly for the poor. They forge a dependence of informal wages on the stock of labor in the private sector, so that increases in the size of government come at the expense of income increases for the poor.

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Table 1: Occupational Distribution, Males ages 25-60, Urban India

	Full sample	Self-employed	Casual wage	Salaried job		Formal private
				Public	Private	
By schooling level and year						
1993						
Full sample	100.00 (100.0)	38.3	11.5	26.8	17.7	--
Primary or less	100.00 (37.1)	42.7	24.0	11.7	16.8	--
Middle/ second	100.00 (33.8)	40.6	7.0	27.4	19.7	--
Higher	100.00 (29.8)	30.1	0.8	45.0	16.7	--
1999						
Full sample	100.00 (100.0)	39.7	12.3	18.4	22.9	5.9
Primary or less	100.00 (32.5)	42.6	26.0	7.4	18.4	3.1
Middle/ second	100.00 (35.1)	41.7	9.5	17.9	25.2	5.7
Higher	100.00 (32.4)	34.6	1.5	29.9	25.1	9.0

	Prop. w/ higher schooling	Self-employed	Casual wage	Salaried job		Formal private
				Public	Private	
By expenditure quartile and year						
1993						
Lowest	7.70	42.40	27.02	13.18	17.41	--
Second	15.60	44.20	15.00	21.13	19.67	--
Third	29.29	42.30	8.29	30.26	19.15	--
Fourth	47.41	36.95	2.86	41.81	18.39	--
1999						
Lowest	7.94	43.61	29.53	6.71	17.17	2.98
Second	17.23	48.09	15.39	13.17	18.70	4.66
Third	29.41	46.93	7.38	21.74	17.97	5.99
Fourth	45.41	41.98	2.15	32.80	13.98	9.09

Note: Self-employed includes household helpers (NSS status categories 11, 12, and 21); casual wage includes work in public works (NSS status categories 41 and 51). For 1999, data for "private" include private formal.

Table 2: OLS wage regressions

Regressor	Regression 1	Regression 2	Regression 3	Regression 4
ln *skilled_pvt*	--	-0.006	0.06	0.07
		(0.03	(0.05)	(0.05)
Gov_ sch	-0.03	--	-0.07	-0.08
	(0.03)		(0.05)	(0.05)
Young	--	--	--	0.03
				(0.03)
Gov_rev				0.03
				(0.07)
Gov_wage				0.001
				(0.002)
Pol_comp				0.01*
				(0.003)
Age	0.06*	0.06*	0.07*	0.07*
	(0.01)	(0.01)	(0.01)	(0.01)
Age squared	-0.001*	-0.001*	-0.001*	-0.001*
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Scheduled caste	-0.08*	-0.09*	-0.02	-0.002
/tribe	(0.01)	(0.04	(0.06)	(0.06)
Regional prop.	-1.07	-1.05	-1.07	-1.00
aged 5-12	(1.10)	(1.10	(1.10)	(1.11)
Regional prop.	-0.03	-0.05	0.10	0.54
Aged 13-18	(0.88)	(0.88)	(0.89)	(0.90)
Regional prop.	-2.06*	-2.05*	-2.10*	-1.59
aged 19-25	(1.03)	(1.03)	(1.03)	(1.04)
Regional prop.	0.46	0.47	0.39	0.41
Aged 26-60	(0.70)	(0.73)	(0.73)	(0.73)
Regional prop.	-3.70*	-3.69*	-3.60*	-3.64*
aged 60+	(1.15)	(1.14)	(1.15)	(1.15)
Ln(reg. p. c	0.67*	0.66*	0.69*	0.69*
Expenditure	(0.07)	(0.07)	(0.08)	(0.08)
Ratio regional to	-0.11*	-0.11*	-0.11*	-0.11*
state pop.	(0.02)	(0.02)	(0.02)	(0.02)
Dummy, year	0.18*	0.18*	0.18*	0.15*
1999-00	(0.03)	(0.03)	(0.03)	(0.04)
Regression F	66.31	66.35	64.63	59.20
	(p=0.00)	(p=0.00)	(p=0.00)	(p=0.00)
Sample size	9293	9293	9293	9293

Note: The sample for all regressions is the proportion of adult male wage earners, ages 20-60, in the lowest quartile of the regional per capita expenditure distribution. The dependent variable is the log of the individual's real wage. All regressions include a set of dummy cohort variables, as well as a set of state-level dummy variables.

* significant at a 5% level + significant at a 10% level

Table 3: Estimates of the probability of higher schooling, urban males, ages 25-60

	Coefficient	Standard error
Gov_sch		
* exp quartile 1	0.13*	(0.02)
* exp quartile 2	0.12*	(0.01)
* exp quartile 3	0.04*	(0.01)
* exp quartile 4	0.03*	(0.01)
exp quartile 2	0.47*	(0.03)
exp quartile 3	1.14*	(0.03)
exp quartile 4	1.85*	(0.03)
scheduled caste/tribe	-0.46*	(0.02)
age cohort 1	-0.05*	(0.02)
age cohort 2	-0.07*	(0.02)
age cohort 3	-0.08*	(0.03)
age cohort 4	-0.12*	(0.03)
age cohort 5	-0.24*	(0.04)
age cohort 6	-0.42*	(0.04)
Mean log likelihood	-0.50	
Sample size	84,161	

Note: * Significant at the 5% level.
The regression also includes a full set of dummy variables for state of residence. Per capita government expenditure on higher schooling is a state- and cohort-specific variable, measured as the mean government expenditure in the state on higher schooling for the years when members of the cohort were between the ages of 11 and 20.

Table 4: Estimates of the probability of public sector employment by skill group

	Skilled (higher schooling)		Unskilled (secondary or less)	
Young	1.33*	(0.48)	0.81*	(0.40)
Gov_rev	-0.06	(0.04	-0.002	(0.03)
*Gov_rev*young*	0.58*	(0.20)	0.08	(0.16)
Pol_comp	0.06+	(0.03)	0.01	(0.02)
*Pol_comp*young*	0.07*	(0.03)	0.02	(0.02)
Gov_wage	-0.04	(0.03)	-0.02	(0.02)
*Gov_wage*young*	-0.06	(0.04)	-0.24*	(0.06)
Gov_ sch	0.11*	(0.03)	0.07*	(0.02)
Age	3.02*	(0.22)	2.27*	(0.15)
Age squared	-2.78*	(0.21)	-2.09*	(0.13)
Scheduled caste/tribe	0.38*	(0.07)	0.31*	(0.03)
Regional prop. age 6-12	0.12*	(0.04)	0.20*	(0.03)
Regional prop. age 13-18	0.10*	(0.02)	0.11*	(0.01)
Regional prop. age 19-25	0.03	(0.02)	0.03*	(0.01)
Regional prop. age 26-60	0.02	(0.04)	0.23*	(0.03)
Regional prop. age 60+	0.11*	(0.03)	0.04*	(0.02)
Regional avge. p.c. exp.	0.10*	(0.02)	0.01	(0.01)
Ratio regional to state pop	-0.05*	(0.01)	-0.02*	(0.01)
Dummy year=1999-00	-0.34*	(0.07)	-0.27*	(0.05)
Dummy, exp quartile 2	0.40*	(0.06)	0.43*	(0.02)
Dummy, exp quartile 3	0.72*	(0.09)	0.80*	(0.04)
Dummy, exp quartile 4	1.07*	(0.13)	1.14*	(0.08)
Correlation with higher schooling equation	0.4*	(0.2)	-0.4*	(0.22)
Mean ln Likelihood	-0.28		-0.30	
Sample size	84,161		84,161	

Note: In addition to the above regressors, the regression includes a full set of dummy variables for age cohort and for state of residence. All regressions are probit regressions. All regressions are run on standardized data $((X_i - \overline{X})/\sigma_x$.

* Significant at the 5% level
+ Significant at the 10% level

Table 5: Instrumental variable wage regressions

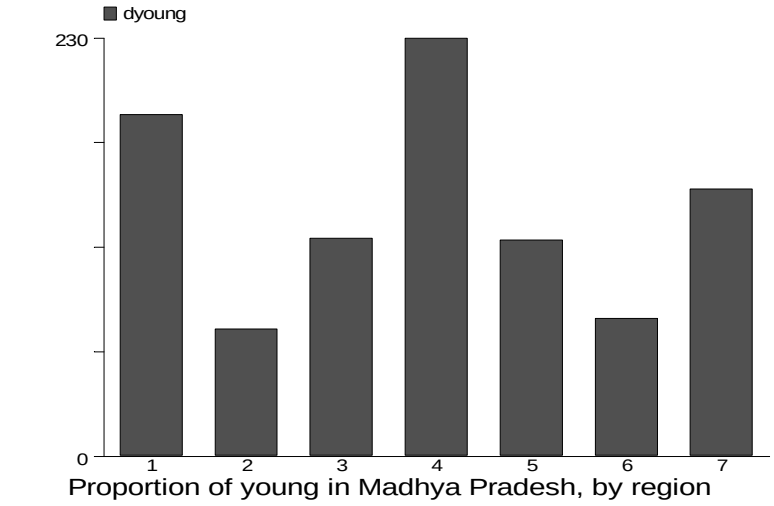
Regressor	Regression 1	Regression 2	Regression 3	Regression 4
Ln *skilled_pvt*	0.68^{+}	0.84^{+}	0.85^{+}	1.48*
	(0.38)	(0.46)	(0.46)	(0.66)
Gov_ sch	--	-0.64*	-0.64*	-1.11*
		(0.33)	(0.33)	(0.48)
Young	--	--	0.02	0.004
			(0.03)	(0.03)
Gov_rev	--	--	--	-0.05
				(0.08)
Pol_comp	--	--	--	0.02*
				(0.01)
Gov_wage				-0.003
				(0.003)
Age	0.16*	0.14*	0.14*	0.19*
	(0.05)	(0.04)	(0.04)	(0.06)
Age squared	-0.002*	-0.002*	-0.002*	-0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Scheduled caste	0.67	0.86*	0.86^{+}	1.56*
/tribe	(0.42)	(0.50)	(0.50)	(0.73)
Regional prop.	-0.53	-1.01	-1.01	-0.61*
aged 5-12	(1.18)	(1.11)	(1.11)	(1.17)
Regional prop.	1.50	2.10	2.11	4.45*
Aged 13-18	(1.27)	(1.49)	(1.49)	(2.09)
Regional prop.	-2.44*	-2.68*	-2.68*	-2.18*
aged 19-25	(1.08)	(1.10)	(1.10)	(1.13)
Regional prop.	-0.34	-0.63	-0.63	-1.28
Aged 26-60	(0.84)	(0.92)	(0.92)	(1.06)
Regional prop.	-2.04	-2.16	-2.16	-1.04
aged 60+	(1.49)	(1.44)	(1.43)	(1.72)
Ln(reg. p. c	0.90*	0.96*	0.96*	1.18*
Expenditure	(0.15)	(0.17)	(0.17)	(0.24)
Ratio regional to	-0.11*	-0.12*	-0.12*	-0.13*
state pop.	(0.02)	(0.03)	(0.02)	(0.03)
Dummy, year	-0.07	0.11*	0.11*	0.08
1999-00	(0.14)	(0.05)	(0.05)	(0.05)
Regression F	63.07	63.12	61.538	54.93
	(p=0.00)	(p=0.00)	(p=0.00)	(p=0.00)
Sample size	9293	9293	9293	9293

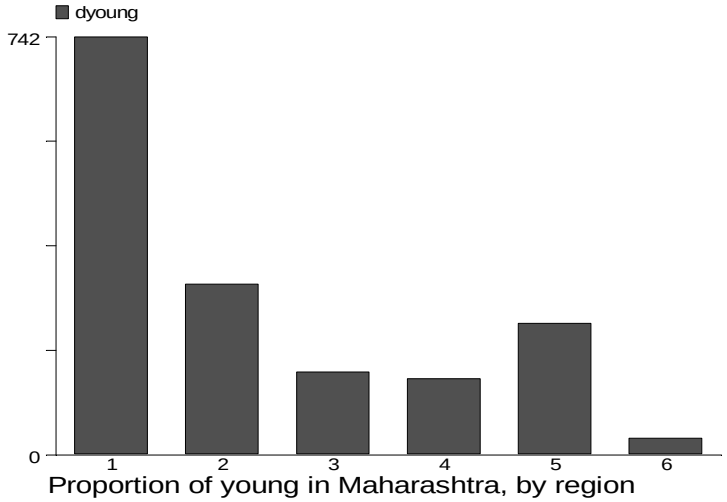
Note: The regression sample is the proportion of adult male wage earners, ages 20-60, in the lowest quartile of the regional p. c. expenditure distribution. The dependent variable is the log of the individual's real wage. Regressions include cohort and state-level dummy variables. The proportion of the regional private labor force with higher schooling is instrumented with its predicted value, calculated from the estimates of tables 3 and 4. * Significant at a 5% level $^{+}$ significant at a 10% level

Table 6: Determinants of Aggregate Schooling Spillovers

	Coefficient	Std. error
Gov_rev	-0.01*	(0.003)
Pol_comp	-0.0004*	(0.0002)
Gov_wage	0.0001	(0.0002)
Gov_sch	0.01*	(0.002)
Scheduled caste/tribe	-0.04*	(0.01)
Age	-0.002+	(0.001)
regional. prop. age 5-12	-0.12	(0.13)
regional prop. ages13-18	-0.10	(0.10)
regional prop. ages adults19-25	-0.20+	(0.11)
Regional. prop. ages 26-60	-0.02	(0.07)
regional. prop. ages 60+	-0.32*	(0.12)
Ln Regional p.c. expenditure	-0.02*	(0.01)
ratio regional to state pop	0.001	(0.001)
dummy – 1999-2000	0.01	(0.003)
Sample size	123	
Regression F statistic(15,107)	12.37	

Note: The dependent variable is the marginal effect of government schooling expenditures on wages calculated from the wage estimates and from the bivariate model of schooling and occupational choice. All data are aggregated to the level of the region, and observations are weighted by the regional population.





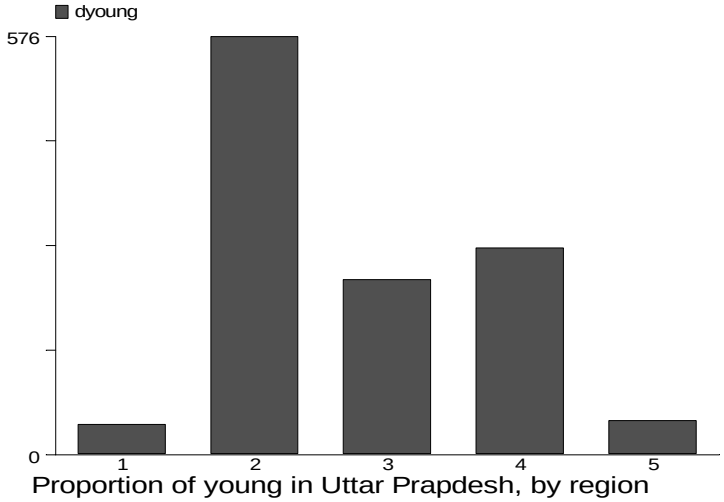


Figure 1: Proportion of Young (males ages 21-30), selected states, by region

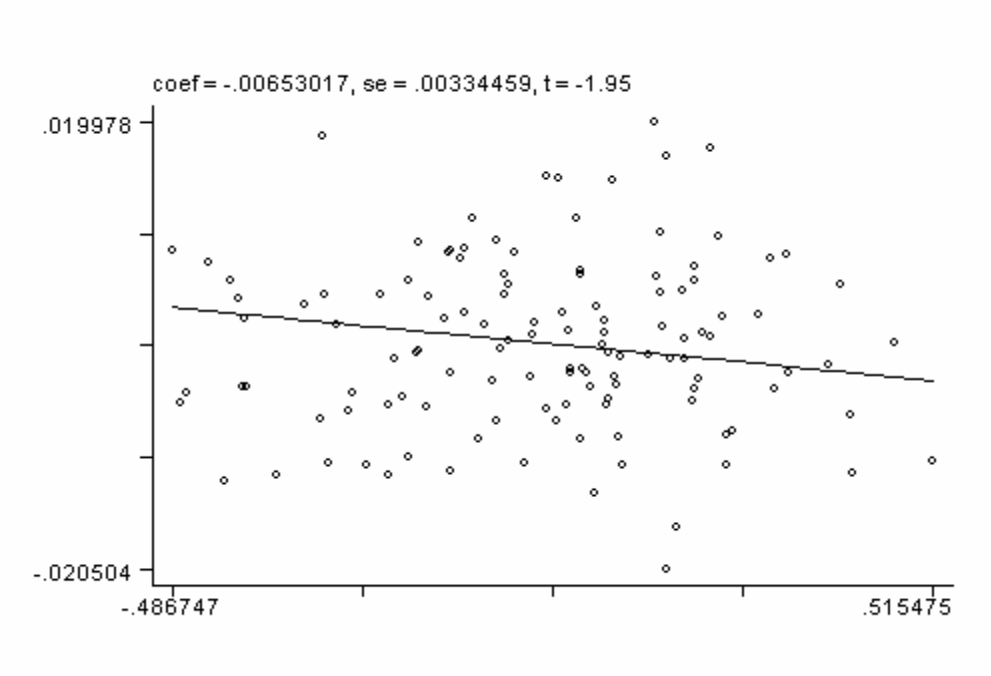


Figure 2: Effect of government revenues on aggregate schooling spillovers

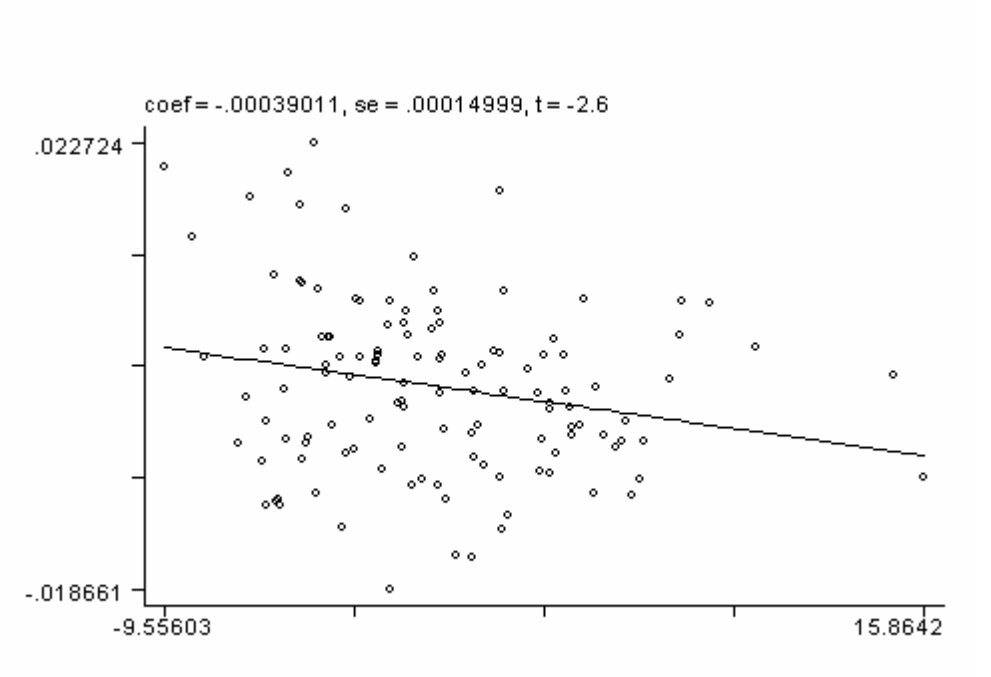


Figure 3: Effect of local political competition on aggregate schooling spillovers