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The Impact of Cutting Education Expenditures

The Case of Mexico in the 1980s

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LABOR AND POPULATION

The impact of Cutting Education Expenditures: The Case of Mexico in the 1980s

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Abstract

This paper studies the impact of expenditures on the returns to schooling within a context of dramatic reductions in public spending. I match data on expenditures and pupil-teacher ratios from Mexico in the 1980's with individual earnings in 2007/2008 and find that the returns to education among individuals that went to poorly funded schools are lower than among those that went to better funded ones. I determine that within-state changes in educational expenditures and pupil-teacher ratios predict changes in the returns to education.

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1 Introduction

This paper analyzes the impact of changes in education expenditures on the returns to schooling. I study the cohorts that entered primary school during the 1980s in Mexico, a period marked by economic crisis and severe contractions in the public budget. The empirical strategy pursued here consists in relating within-state changes in school resources to the within-state changes in the returns to schooling for the appropriate cohort.

The impact of the quality of education on labor market returns has been a topic of heated debate for decades. Despite the extensive research on the issue, few studies have focused on developing countries and none (to our knowledge) has focused on a period of economic crisis. There has been extensive research on the impact of economic crises on educational attainment but not on their effects on quality. Ferreira and Schady (2008), after reviewing the research on educational attainment during recessions, affirm that: "much less is known about the effects of aggregate income shocks on the quality of education and about how, if at all, any possible changes in quality affected the labor market performance of cohorts who received their education during crisis years".

This paper addresses two issues left unresolved in the two different strands of the literature: First, it answers whether the results found in the US on the topic of the impact of resources on returns would carry over to a developing country such as

Mexico. Second, this paper complements the literature on economic crises by studying the impact of the Mexican crisis of the nineteen-eighties on the returns to education.

I start by describing the macroeconomic and political context of the period studied, before getting to the econometric model, description of the data and empirical results.

2 Literature Review

The empirical study of the impact of quality of education on earnings has a long history. Akin and Garfinkel (1980) and Link, Ratlege and Lewis (1980) first estimated a log wage earning equation that included years and quality of schooling interactions. Those studies used expenditures at the state of residence in the decade when the individuals were more likely to have gone to school. They found no effect of expenditures on the income-schooling gradients.

Card and Krueger (1992) studied how pupil-teacher ratios and other school quality variables impacted the returns to education in the US. Their study is similar to ours in that both match state-level education quality variables with individual level data. They estimate returns to education for individuals born in each state and belonging to one of three cohorts (those born in the 20's, 30's and 40's). They then regress those returns to education on the quality variables (pupil-teacher ratios, teacher wages and term length) corresponding to those states and cohorts. In their preferred specification, they find that a reduction of five students per teacher increases the return to education by 0.4 percentage points, while the impact of a five percent increase in teacher wages was of 0.1 percentage points.

There is a long literature of studies on the impact of economic crises on educational attainment in developing countries, but none study their impact on returns to education. In fact, there are not many studies on the impact of quality of education on labor market outcomes. Case and Yogo (1999) study the impact of pupil-teacher ratios on the returns to schooling in South Africa. Using large cross-sectional differences on the pupil-teacher ratios between magisterial districts, they find that returns to education for men are 2% larger in districts where there are 10 less students per instructor. They use only cross-sectional information on school quality but at a very detailed geographical level (over 300 districts).

3 Background

3.1 Overview of the trends in educational variables

The high rates of economic growth experienced by Mexico during the nineteen-sixties and nineteen-seventies came to an abrupt end in 1981. The federal government had run large deficits which were not sustainable and had to be immediately cut if a default on debt was to be avoided. Large cuts in public education spending were implemented throughout the 1980s. Figure 1 shows real per student expenditures in education and pupil-teacher ratios in select years in the seventies and eighties. As can be seen, individuals who were born in the early eighties attended much less funded schools than those born a decade earlier.

The severe reductions in the education budget severely affected the educators' wages but not their employment. On the contrary, during the period studied, there was a small increase in the number of teachers. This was accompanied by a small dip in the number of enrolled primary students (resulting from a reduction in the number of older children joining the system).[1]

These two factors taken together mechanically resulted in an increase in pupil-teacher ratios. The growth of secondary school's student body (interrupted only in 1988-1989) was accompanied by an increase in the number of teachers at this level, resulting in a relatively constant pupil-teacher ratio at the secondary level. Total primary and secondary school enrollments are shown in Figure 2.

Taken together, the fall in the pupil-teacher ratios in primary schooling and the constant ratios in secondary school implied that individuals starting school in the late nineteen-eighties did so in smaller classes than their older counterparts, but their teachers were paid significantly less. The simultaneous fall in pupil-teacher ratios and in expenditures per pupil make it interesting to study the impact of these two factors in the returns to education. Previous work on this topic that relies on variation through time has found that the quality variables are strongly correlated and move together most of the time. The situation I will study differs importantly in this way.

Figure 3 shows the pupil-teacher ratios, expenditure levels and returns to education for individuals who started school in the year shown in the x-axis. The returns to

[1] The coverage of the primary school grew enormously to cover close to 98% in 1981-This number represents the limit attainable, since the other 2% is composed of children either with disabilities or living in unreachable places (Guevara Niebla, 1995).-. This number represents the limit attainable, since the other 2% is composed of children either with disabilities or living in unreachable places (Guevara Niebla, 1995)

education fell from 8% for those who started primary school in 1980 to 5% for those who started towards the end of the decade. Although some of that drop can be attributed to the interaction of experience and education (i.e. to a steeper schooling gradient for older individuals), doing a similar analysis for the same age groups in 1990 and 2000, I see that the comparable fall in returns to education is smaller than one percentage point (see Figure 4). With the analysis presented in the following sections, I will try to demonstrate that the large fall in the returns for the cohorts schooled in the eighties can be attributed to the decline in expenditures brought about by the crisis.

3.2 How was the level of education expenditures determined?

As detailed in the following section, our empirical strategy consists on relating within-state changes in educational inputs. It is therefore important to briefly discuss the marked differences across the states in the changes of those variables. Such differences were large: while the six most affected states saw their per pupil expenditures fall by more than 40%, for the six least affected this drop was smaller than 20%.

State budgets in education were, until very recently, determined centrally following no clear rule. The actual allocations resulted from a complicated negotiation process between government agencies and the Federal Union of Education Workers (SNTE), with the Presidency of the Republic having the final decision. It is important to note that the SNTE was not an independent trade union but an arm of the government itself.

Although education needs might have played a role in the determination of educational budgets, much of the variation responded to political issues among the parties involved in the negotiations[2].

The large cross-sectional differences in federal funds to the states has been analyzed by Esquivel (1999) and Jarque, Perez-Arce and Revilla (2008). They find that these differences do not respond to the variables that could rationalize them (such as GDP, poverty rates, % of rural population, etc.) but that there is a strong relationship with the size of the state (smaller states receive more funds per student). This fact highlights that the allocation of resources responded to motives different to educational needs.

The cuts in expenditures responded strongly to political motives. Much of the between-state differences in cuts responded to the emergence of an independent organization of teachers (the CNTE) that threatened to supplant the official SNTE. Although organizations emerged throughout the country, it was in only a few states where it grew and became the new representation of the teachers. Through strikes and protests for higher wages and union independence between 1979 and 1981, the CNTE branches of the states of Oaxaca, Chiapas, Hidalgo, Morelos, Guerrero and the State of Mexico[3] emerged as independent organizations that rivaled the official SNTE. These six states were among the eight states that suffered the smallest decrease in

[2] As McGin and Street (1982) put it: "I believe that the major rationale behind planning and resource allocation in education in Mexico is consideration of the position of factions or groups within the ruling elite and others (notably teachers) that compete for power within the bureaucracy of the educational system" (p.7).

[3] Cook (1996), Foweracker (1993), Perez Arce Ibarra (1988) and Muñoz Armenta (2005)

expenditures during the nineteen-eighties. Organized teachers protested for higher wages and independence. Cook (1996) and Foweracker (1993) document how specific protests achieved pay raises for the teachers of the state where those protests originated. Of course, this raises the question of why the `movement' erupted in that time and those places. In her 1996 book, Cook argues that "the timing of the emergence of the teachers' movement can best be understood by the presence of conflict between major actors in the movement's immediate environment- namely, the state and union leadership". Wages of educators, in states that were at risk of experiencing similar movements, might have also increased (or decreased less than the rest) in an attempt by the authorities to retain control of the teachers. Education expenditures dropped more in states that had higher per student expenditures in 1980.

For our purposes, it would be troubling if those dissidence eruptions predicted future improvements in the quality of education for reasons different to affecting the public resources appropriated by the states. I believe this was not the case. The existence of political conflict within the teachers' union is not likely to be a predictor of other outcomes such as public expenditures in non-education areas since dissidence in the education sector was not part of a broader movement that could have affected expenditures in other sectors. However, the existence of conflict itself (or the base level of teacher wages) is correlated with the level of development at the starting point, i.e. most of the states that experienced lower decreases in expenditures were at the lowest end. One might therefore worry that these states experienced higher growth and development (as predicted by the classical models of economic growth) therefore biasing upwards our estimates. This does not compromise our estimation strategy

because such "catch-up" did not exist during our period of study. Further reassurance comes from estimating models which additionally control for within-state changes in variables that can proxy for development. As I detail in the Results section, our conclusions of the impact of the quality variables do not change when I control for variables such as GDP per capita or child mortality rates.

4 Method

Our aim is to quantify the impact of the pupil teacher ratios and expenditures per capita on the rate of return to education. The graphs on the Background Section suggest that returns to education were lower for individuals who would have started school towards the latter part of the nineteen-eighties (when expenditures were lower). However, many things change simultaneously, so it would be difficult to attribute the decline in returns to the contraction of expenditures by simply looking at the time series. I therefore pursue a method which consists in relating the level of expenditures and pupil-teacher ratios that correspond to a given state and cohort with the returns to education for the individuals born in that state and in that cohort. I first estimate Equation 1, and progressively add controls to deal with potential problems in the identification.

Equation 1

$$y_{ijkc} = \delta_{jc} + \mu_{kc} + x_{ijkc}\beta + S_{ijkc}(\alpha + QUAL_{jc}\eta) + \varepsilon_{ijc}$$

The log income of individual i, born in state j in year c is regressed on unrestricted state-of-birth-by-cohort fixed effects δ_{jc}, state of residence-by-cohort fixed effects μ_{kc}, marital status x_{ijkc}, years of education S_{ijkc}, years of education interacted with the corresponding quality variables (S_{ijkc}*$QUAL_{jc}$) and a stochastic error term ε_{ijkc}. Vector η measures the impact of the interaction between the quality variables and education on the logarithm of income; that is, it measures how much the quality variables affect the slope of the education-income relationship. I therefore interpret them as the impact of the quality variables on the rate of return to education.

In a first set of specifications, $QUAL_{jc}$ is solely the level of expenditures per student in state j and cohort c. In these cases, I hypothesize that η is positive, meaning that expenditures increase the income-schooling gradient. In a second set of specifications, $QUAL_{jc}$ is composed of pupil teacher ratios and expenditures per teacher. Although "expenditures per teacher" includes other expenses, I believe it is a good proxy for the wages of school personnel. In each year of our period of study, non-personnel related expenditures constituted less than 7% of the overall education budget. The hypothesis here is that the coefficient on the interaction of education with pupil-teacher ratios is negative, and the one on the interaction of education with `wages' is positive; meaning that smaller groups and higher teacher wages increase the income-schooling gradient. In a third set of specifications, $QUAL_{jc}$ is solely the pupil-teacher ratio.

I assume individuals were educated in their state of birth and that they started school at age six. The latter assumption would be problematic if there was large variation in the

age at which individuals enter primary school. As described in the background section, it seems that primary schooling regularity had been fully achieved in Mexico by the mid nineteen-eighties. However, an additional source of error remains since I do not know the month of birth of the individual, so I cannot be sure whether I am assigning the individual to the correct cohort. It is important to note, though, that this source of error biases downwards our coefficients.

It is not entirely clear which pupil-teacher ratio and expenditures datum I should assign to each cohort. I start by doing the following: for the pupil-teacher ratios, I take the six-year average of the primary pupil-teacher ratios corresponding to the years when the individual was six to twelve, and the three-year average of the secondary pupil-teacher ratios corresponding to the years when the individual was thirteen to fifteen and take the weighted mean of those two averages. I would like to do the same with expenditures data but, unfortunately, I don't have expenditures by school-level data. Therefore, I have to assume state-level changes in expenditures are equally distributed between the primary and secondary levels. In the robustness checks section, I show the results with different ways to assign this data.

Following the literature, I use only observations for males, which helps us deal with different labor force participation rates by education level since the vast majority of men are in the labor market.

Equation 1 estimates the parameters of interest out of within and inter-state differences. This generates a series of problems, the most important of which is that most individuals live in the same state they were born. If regional labor markets are characterized by different returns to education, and these differences are correlated

with characteristics of their school systems, our estimates of γ and η will be biased. In Equation 2 I address this issue by including state of residence by cohort fixed effects interacted with years of education ($S_{ijkc}*\rho_{kc}$). The inclusion of these interactions assures that η is identified by individuals who do not reside in their state of birth, thereby eliminating that potential source of bias.[4]

Equation 2

$$y_{ijkc} = \delta_{jc} + \mu_{kc} + x_{ijkc}\beta + S_{ijkc}(\alpha + QUAL_{jc}\eta + \rho_{\mathrm{kc}}) + \varepsilon_{ijkc}$$

[4] To clarify the potential sources of bias, consider these examples:
Suppose that cohorts that are born in states where there are higher expenditures on education will tend to live on states where education is rewarded more. This could happen for two reason: The first one, and the one I am aiming to prove, is that the education on those states is on average better and therefore more rewarded. The second reason is that those are the states that happen to be the hosts of industries that pay a higher premium for education, regardless the quality. Suppose state X hosts high-technology firms and therefore generates more revenue, whereas state Y is mainly a self-subsistence, undeveloped economy where productivity does not depend on education. The technology sector is willing to pay a large premium for educated individuals whereas agriculture is not. Limited mobility could stop higher educated individuals to move from state Y to state X, stopping the returns to education from being fully equalized. Since state X obtains more revenue, it can also spend more in education, causing us to detect a correlation between expenditures and return to education that is not caused by an effect of expenditures on quality. Including state of residence dummies interacted with education takes care of such a bias.
Consider the following cause of concern. Suppose that the return to education increases as people get older (at least while the workers are relatively young, as they all are in my sample), and that there is a general trend in the level of expenditures. This would cause a spurious correlation between expenditures and the returns to education. Controlling for the cohort of birth would deal with this issue. I can do better than this: I add state of residence by cohort dummies interacted with education. This effectively accounts for both of the issues discussed above. Additionally it captures any factor that affects labor demand and changes at the state level. When controls are included, the impact of expenditures and pupil-teacher ratios are identified out of the individuals who move from their state of birth.

The inclusion of residence dummies deals with confounding factors that arise from the labor market side. However, there could be other unobserved factors that impact the formation of human capital. If such factors are correlated with our quality measures, the results I obtain would be biased. States could differ on things such as health systems, income per capita, education levels, etc. Consider the parental income and education example which have been shown to have an impact on the learning of their children. If the average income and education of parents are higher in one state, the learning that goes on in its schools might be higher which could imply that the returns to education for people born there are also higher. These factors could also be correlated with our quality measures, biasing upwards our estimate of their impact. The same issue arises with trends in time: for example, if the average education of parents is increasing and there is a trend in our measures of the quality of education, our coefficients will be biased[5]. To address this, Equation 3 includes interactions of

[5] This note addresses other examples of this type of bias:
A bias could arise if states that spend more on education also spend more on other services that by themselves raise the return to education (expenditures in child health care, for example). If it is the case that states that spend more on education also spend more on child health and these raise the return to education (healthier kids might learn more at school), then our coefficient on education expenditures is biased upwards. This problem can be dealt with by including dummies for the interaction of state of birth with education. Similar concurrences on the time dimension can be dealt with the inclusion of time trends or year of birth dummies (always interacted with education). For example, the reduction of the public budget in Mexico in the 1980's might have caused a reduction not only on educational spending but also on other forms of social expenditures.
Also, state level expenditures on education could be correlated with other conditions that facilitate learning in schools. For example, wealthier states can spend more on public education and also have families that spend more on food, culture, etc. and this type of family expenditures can have an impact on the return to education. Similar issues arise with variation in time. In economically good years, families could be spending more both on food and on taxes (which are used to spend more on education).

years of education with state and cohort dummies. The inclusion of s_j*S_{ijkc} and c_c*S_{ijkc} (the interaction of state and cohort dummies with years of schooling) effectively controls for differences in omitted variables that exist across states and/or nationally across time. The only remaining threat to our identification is the existence of unobserved determinants of the return to education that move within states in a manner that is correlated with our quality variables.

Equation 3

$$y_{ijkc} = \delta_{jc} + \mu_{kc} + x_{ijkc}\beta + S_{ijkc}(\alpha + s_j + c_c + QUAL_{jc}\eta + \rho_{kc}) + \varepsilon_{ijkc}$$

5 Data

I collected all available information on the number of teachers and students in the two levels of basic education (primary and secondary schools) as well as information on public expenditures. I aim to estimate the impact of those variables on the return to education using individual level schooling and income variable from the ENOE surveys of 2006 and 2007.

I obtained official data for the number of teachers, groups, schools and students from 1981 onwards in Mexico. This comes from the federal government (compiled by the Secretary of Education- SEP, INEGI-2003). This data is disaggregated by state (32 states) and by level (primary - years 1-6) and secondary (years 7-9). There are two variables that can be used to study class size: the ratio of students to school personnel

and the ratio of groups to students. Throughout the main body of the paper I use the former; I use the latter in the robustness checks section.

As part of the national accounts, the federal government used to compile total expenditures in education by federal entity. These numbers were published as a statistical appendix of the presidential' report of affairs (Presidencia de la República, 1993 and INEGI). Besides the information from 1980 onwards, this document reports the expenditures for the years 1970 and 1975. I am only using the information from 1980 onwards.

This data is matched to the ENOE of 2006 and 2007, a household survey representative at the state level that has information on, among other things: place of birth, education, and earnings. The ENOE is a quarterly rotating panel of households which are interviewed on five consecutive occasions. To avoid having more than one observation for each household, I use the last quarter of 2007 (which was the latest available at the moment this paper was being written) and one preceding by five quarters (the third quarter of 2006). From the ENOE I will use the variables: age, state of birth, state of residence, marriage status, years of completed education and income.

Table 1 presents an overview of our data. It consists of men ages 25 to 33. The average education level in our sample is 10 years, and the mean monthly income is 5,389 Mexican pesos. There is wide variation in terms of both educational attainment and income levels. Since the ENOE was built to be representative at the state level, the number of observations for each state does not vary greatly.

6 Results

I start by estimating the impact of expenditures per students. Table 2 shows the results of estimating the equations discussed in the Method section. In all specifications I cluster the standard errors simultaneously at the state of birth level and at the state of residence level, using the method proposed by Cameron, Gelbach and Miller (2006). In the Appendix I present results where I additionally cluster at the cohort level, but this makes little difference.

Estimating Equation 1, I find that expenditures in schooling have a positive impact on the return to education (first column of Table 2). Since it could happen that states that have a higher return to schooling also spend more on education for external reasons (i.e. because they spend more on health), I need to control for state of residence and its interaction with education, which I do in Equation 2. The results are presented in the second column of Table 2. Expenditures retain the positive impact I detected in Equation 1. There doesn't seem to be a bias created by leaving out state of residence controls.

As discussed in the previous section, the inclusion of residence dummies and its interaction does not alleviate the biases that arise if our quality variables are correlated with unobserved factors that impact the learning of school-age children. I can, however, include indicators for state-of-birth interacted with education, to account for the possibility of geographical biases. Including those variables, however, will eliminate much of the variation I rely on, making our estimates imprecise. The results

are presented in the third column of Table 2. Including these new variables reduces the precision of the estimates but does not importantly change the point estimate of the impact of expenditures per pupil.

Including state-of-birth dummies interacted with years of education gives more credibility to our estimates but eliminates much of the variation in the right hand side variables, resulting in imprecise estimates. I want a way of dealing with the omitted factors issues but without losing so much precision.

An alternative is not to include the full set of state-of-birth dummies, but instead grouping them into regions. Following standard practices for Mexico, I group states into seven regions. These region dummies capture much of the heterogeneity in the development of the states (and therefore eliminate much of the potential of bias that would arise if the level of development rather than the specific level of expenditures was the factor affecting the returns to education). Column 4 presents the results of running regressions like the previously discussed but including interaction of years of education with region-of-birth dummies instead of state-of-birth dummies. The results are more precisely estimated although they leave more room for bias. The point estimates are of roughly the same magnitude. Expenditures per capita are significantly related to returns to education.

In Panel B of the table, I present the results obtained from estimating the same model but where expenditures are interacted only with the first nine years of education. Since the variation in expenditures comes from basic education, I might expect to see the impact deriving from the returns to education of those years (although not necessarily: for a discussion, see Heckman et al. 1996 and Card and Krueger, 1998).

The results are similar. In all specifications where the interactions of state of residence and education years are controlled for (columns 2-4), the impact is estimated to be large and at least marginally significant.

The implied effects of expenditures on the returns to education are large. For example, the coefficient on the third column of Panel A implies that a 10% fall in expenditures would cause a reduction on the return to education of 1.61 percentage points.

Columns 1 to 3 of Table 3 show the result of estimating the models when I divide the expenditures into pupil-teacher ratios [6] and expenditures per teacher. In these models $QUAL_{jc}$ is composed of the pupil-teacher ratios and expenditures per teacher (to which I loosely refer to as teacher wages). I find less robust evidence as to which of the two factors is more important. In columns one and three, the impact of pupil-teacher ratio is significant, while that of wages is insignificant. However, when I replace the state-of-birth times education with region-of-birth times education interactions, teacher wages become significant and pupil-teacher ratios insignificant. Although including state-of-birth interactions is better than including region-of-residence interactions (in terms of identification) and I am therefore tempted to claim that more teachers is more effective than better paid ones, it is puzzling that when I use the variation that comes out of the difference between regions I find a different result than when use the variation between the states of a given region. Therefore, I do not force a conclusion to this question. What does seem robust, though, is that increasing expenditures had an impact although I do not know through which of the

[6] The variable included in the models is (students/teachers)/100

two channels. Columns four to six show the results of including only pupil teacher ratios; having smaller classes retain their positive impact. The coefficient in the fifth column implies that a reduction of five students per class would increase the rate of return to education by one percentage point. Excluding teacher wages from the equation allows us to do the following exercise: allow for different impact of schooling of different levels, and interact the pupil-teacher ratios with the relevant schooling variables. I divide schooling into primary, secondary and higher education, and I interact the primary pupil-teacher ratios with the number of primary years, and the secondary pupil-teacher ratios with the number of secondary years. The results are shown in columns seven to nine. The coefficients for both the primary and secondary pupil-teacher ratios are of the expected sign, although only the former are significant.

I have also estimated these models using an alternative measure for class size. The question of whether to use school personnel/students or groups/students to capture class size is more important for the secondary level than for the primary level. In primary school, the numbers for school personnel are similar to those for groups. In secondary school, however, teachers are subject-specific which means that each group has many teachers. Although educators can teach the same subject in many groups, some have part-time jobs. This means there is a larger number of teachers than there is of groups[7]. Even though it is unclear which represents class size better, using the

[7] This is not always the case. There is a system called "telesecundaria", where a single teacher is responsible for all the subjects (and in many cases for several grades). The teacher is aided by television programs (hence the name). This is popular in scarcely populated rural areas.

alternative definition did not change qualitatively none of our results (results are available upon request).

6.1 Additional Controls

One of the two difficulties in isolating the impact of the quality of education variables is that these might be correlated with other variables that also affect the learning of the students, creating a bias in the estimated impact of the expenditure and pupil-teacher variables. I partially addressed this by including state-of-birth and year-of-birth dummies interacted with years of education. This solves the problem if the correlation with the omitted variables exists across states, through a national trend or both. However, if the state-specific trends in education expenditures are correlated with such omitted variables, our results will be biased. I propose two approaches to deal with this issue. The first one consists in trying to determine which variables are missing and include them in the regressions. For an omitted variable to cause us trouble, it has to affect school age children's abilities (assuming I have dealt with the possible confounding factors from the demand side). Within this approach, I include child mortality rates at the state level for each cohort interacted with years of education. The idea for doing this is the following: suppose increases in educational expenditures are actually correlated with health expenditures. The latter, in turn, have an impact on children' health which increases learning at school and therefore the return to education for those specific cohorts. In that case, what I am claiming to be an effect of educational expenditures is actually an effect of health expenditures.

Including a health variable like child mortality should help us differentiate between the effects of educational and health expenditures.[8] Similarly, I can include the GDP_{pc} for the state for each year as an alternative measure of the overall situation of the economy at the time the individuals were in school[9]. Including GDP_{pc} can help alleviate the concern that the impact of the quality variables is just proxying for the impact of the overall state of the economy, which could have an effect through increased family expenditures (on food, books, etc.) that can improve academic outcomes. It is unclear which the appropriate GDPpc variable that I should use is. In the results presented in Table 4, I used the GDPpc corresponding to the year when the individual was three years old, but changing this rule made no significant difference[10].

I use child mortality data for 1975, 1980 and 1985 from Gomez de Leon and Bush (1993). They estimated the probability of death for a child 5 years old or younger for all the federal entities of Mexico. They use responses from mothers in the census of 1980 and 1990 about children born and living children, to estimate the probability of a child dying in the five year period. Their estimates for the in-between years (1976-1979 and 1981-1984) are linear combinations of the closest quinquennial estimates. I associate each individual with the number corresponding to the year when he was three years old (the midpoint of the age range covered by the datum). Including this in

[8] Mortality by itself could have a positive effect by eliminating the worse-off children from getting an education with a presumably low return. I assume this effect to be miniscule and use this variable solely as an indicator of the health of that cohort.
[9] GDP information comes from Banco de Informacion Economica, INEGI. Population by state was taken from calculations made by the Comision Nacional de Educacion para la Vida y el Trabajo who based on the Censuses IX-XII
[10] If GDP_{pc} was unavailable for a particular year, I used a linear combination of the closest preceding and following years, weighting by the distance to these two dates

the regression does not significantly alter the results. As can be seen from columns 1 to 4 of Table 4, the coefficients for both the pupil-teacher ratios and expenditures level do not change much from those shown in Table 2, and the expenditures coefficient is still significant. Higher child mortality rates are associated with lower returns to education. How much credence this exercise gives to our result depends partly on how much error there is in this measure.

The second approach is to control for variables that would be affected if there was a general state-level trend that impacted school children. If the conditions of a given state were generally improving at a time that a given cohort was in school, I could expect to observe a more rapid migration to that state for that cohort. Within this strategy, I run the same specifications as above but include population size. Including the size of that state in our full specification does not change the magnitude of the coefficients on the quality variables (columns 5 to 8 of Table 4). This result gives us confidence that I am actually estimating the impact of the quality of education variables.

7 Reduced Form Evidence of the Impact of Quality on Attainment and Earnings

So far, I have concentrated on the effect of expenditures on the schooling-income relationship. I can ask the broader question of how much changes in expenditures have impacted the average income of the population of the state. The results presented so far can not answer the question for two reasons: 1) educational attainment might have

been affected and 2) the change in the income/schooling gradient can be due to an increase in the income of the more highly educated but also from a reduction among the less educated. I then proceed to show the results of estimating an equation where the dependent variable is, in turn, educational attainment and the logarithm of the income. The right hand side consists of cohort dummies, state-of-birth dummies and the quality variables. Identification relies on the assumption that the changes in the quality variables within states are uncorrelated with changes in the other variables that might affect educational attainment or average income.

Equation 4

$$S_{ijc} = s_j + c_c + QUAL_{jc}\lambda + \varepsilon_{ijc}$$

Equation 5

$$y_{ijc} = s_j + c_c + QUAL_{jc}\lambda + \varepsilon_{ijc}$$

The results are presented in Table 5. The coefficient on the effect of expenditures on enrollments is statistically undistinguishable from cero. Increases in expenditures, however, caused higher significantly higher average incomes. The coefficient for income implies that a 10% increase in expenditures per student would generate a 1% increase in the income of the cohort affected.

8 Conclusions

I have studied the impact of education quality in a peculiar setting in which teacher wages fell dramatically but class size decreased at the same time. I find that lower wages implied lower returns to education and that smaller class sizes counteracted this effect. The effect of expenditures per pupil is found to be robust and large. Using the coefficients from our preferred specification (columns 2 to 4 of Table 2), I estimate that a 10% increase in education expenditures causes the return of education to go up by about 1.6 percentage points. Our preferred specifications also show that smaller sizes imply larger returns to education. Public expenditures were markedly cut during crises such as the one studied here. These cuts translated into lower returns for the education acquired by the children who were students at the time.

Appendix 1. **Accounting for Non-Linearities in the Returns to Education**

Non-linearities in the returns to education would cause a problem to our identification strategy if better measures of educational quality were correlated with higher levels of educational attainment. Suppose that the increase in the quality of education variable causes individuals to move up in educational attainment levels, and that the returns are larger the higher the educational level. Although improvements in the quality of education are related to increased attainment, returns to education seem to be very close to linear (see Figure 5). To be certain, I ran regressions similar to the ones discussed in the body of the text, but where education is allowed to have a different impact at different stages. The results are presented in Table 6. Our coefficients do not qualitatively change when I incorporate more flexibility in the returns to education.

Appendix 2. **Using ENOE 2006 and ENOE 2007 separately**

Running the regressions using the third quarter of 2006 and the fourth quarter of 2007 separately does not change the main interpretation of the results. Columns 1 to 4 of Table 8 show the outcomes of estimating Equation 2 and Equation 3 with the third quarter of 2006, and columns 5 to 8 show the corresponding to the fourth quarter of 2007. All coefficients for the expenditures per capita are of the right sign, although magnitudes vary widely.

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Table 1. Education Characteristics by State

	Educational Years			Income (monthly)			Exp. per student *	Teach Ratio*
	Mean	25 pct	75 pct	Mean	25 pct	75 pct		
Natl. Avg.	10.047	7	12	5,389	3,010	6,020	0.078	27.8
Ags.	9.3	6	12	4,927	3,354	5,590	0.076	27.7
B.C.S	10.4	9	13	6,954	4,214	8,600	0.101	26.8
Baja Cal.	10.7	9	13	7,393	3,849	7,000	0.086	25.2
Campeche	10.4	9	14	4,492	2,580	5,400	0.075	27.5
Coahuila	10.2	9	12	5,700	3,010	6,000	0.081	26.1
Colima	9.9	6	12	5,347	3,440	6,020	0.083	25.8
Chiapas	9.4	6	13	4,207	2,150	5,160	0.059	27.7
Chihuahua	9.9	6	12	5,691	3,440	6,450	0.077	26.6
D.F.	12.1	9	16	7,010	3,440	8,000	0.155	26.7
Durango	9.7	6	12	4,503	3,000	5,160	0.075	23.9
Guanajuat	9.0	6	12	5,371	3,600	6,450	0.062	30.6
Guerrero	9.4	6	12	4,700	3,000	5,590	0.066	26.2
Hidalgo	10.5	9	14	5,126	3,000	6,000	0.075	27.8
Jalisco	10.1	6	12	5,939	3,655	6,450	0.075	30.0
Edo Mex	9.9	9	12	5,041	3,010	5,590	0.060	30.4
Michoacan	9.2	6	12	4,968	3,010	6,000	0.063	27.3
Morelos	10.2	9	12	4,586	3,010	5,160	0.078	28.3
Nayarit	10.0	8	12	5,272	3,096	6,450	0.073	26.0
Nvo. Leon	10.3	9	12	6,721	3,870	7,310	0.124	25.4
Oaxaca	10.0	6	15	5,090	3,000	6,000	0.064	28.9
Puebla	9.9	6	12	4,786	2,580	5,590	0.071	31.0
Queretaro	9.5	6	12	6,588	3,440	6,000	0.071	30.0
Q. Roo	9.3	6	12	5,742	3,010	6,450	0.073	28.0
San Luis P	9.7	6	12	5,002	2,700	6,000	0.069	25.8
Sinaloa	10.3	7	14	6,492	3,600	7,513	0.073	28.0
Sonora	10.5	9	14	5,793	3,440	6,450	0.080	28.6
Tabasco	10.3	9	12	5,344	3,000	6,400	0.068	31.3
Tamps	10.6	9	14	5,420	3,010	6,450	0.087	26.8
Tlaxcala	10.1	9	12	3,835	2,200	4,300	0.065	28.7
Veracruz	9.9	6	12	5,518	3,000	6,450	0.063	28.1
Yucatan	9.5	6	12	4,717	2,580	5,590	0.072	26.4
Zacs	9.7	6	12	4,714	3,010	5,200	0.063	26.4

Note: All are the average for the observations in the sample. * 2000-pesos per student per year

Table 2. Impact of Expenditures on the Returns to Schooling

Panel A. Expenditures interacted with years of education

	(1)	(2)	(3)	(4)
Real Expenditures p/c	0.245***	0.274***	0.206	0.228***
	(0.063)	(0.037)	(0.160)	(0.037)
State-of-Residence by Cohort dummies interacted with education	No	Yes	Yes	Yes
State-of-Birth dummies interacted with years of education	No	No	Yes	No
Region-of-Birth dummies interacted with years of	No	No	No	Yes
No. of observations	36,381	36,381	36,381	36,381
R-squared	0.217	0.270	0.267	0.270

Note: significant at: * 10%, **5%, ***10%, s.e. in parentheses. All include: State-of-Birth by Cohort Dummies; State of Residence by Cohort Dummies, Marriage Status and period of interview dummy.Clustering is done at the state of birth AND at the state of residence level.

Panel B. Expenditures interacted with years of basic education

	(1)	(2)	(3)	(4)
Real Expenditures p/c	0.159	0.429***	0.315*	0.336**
	(0.189)	(0.086)	(0.173)	(0.136)
State-of-Residence by Cohort dummies interacted with basic-	No	Yes	Yes	Yes
State-of-Birth dummies interacted with years of basic-education	No	No	Yes	No
Region-of-Birth dummies interacted with years of basic-education	No	No	No	Yes
No. of observations	36,381	36,381	36,381	36,381
R-squared	0.270	0.270	0.274	0.273

Note: Like Panel A, except: State-of-Residence is Interacted with years of basic education instead of total years of education, ecuations include years of basic education and years of higher education. Expenditures are interacted with years of basic education only.

Table 3. Impact of Pupil-Teacher Ratios and Teacher Wages

	'upil Teacher Ratios and 'Wage:			Pupil -Teacher Ratios Only			Pupil-Teacher Ratio per Level		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Pupil-Teacher Ratio[1]	-0.259**	-0.062	-0.269***	-0.260**	-0.198	-0.276***			
	(0.111)	(0.224)	(0.085)	0.107	0.250	0.096			
Teacher Wages	3	1129***	25						
	246	441	223						
Pupil-Teacher Ratio (primary school)							-0.521**	-0.273***	-0.376***
							0.239	0.061	0.107
Pupil-Teacher Ratio (secondary school)							-0.026	-0.156	-0.068
							0.229	0.200	0.215
State-of-Res. by Cohort dummies X education	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-of-Birth dummies X	No	Yes	No	No	Yes	No	No	Yes	No
Region-of-Birth dummies X	No	No	Yes	No	No	Yes	No	No	Yes
No. of observations	36,381	36,381	36,381	36,381	36,381	36,381	36,381	36,381	36,381

Note: * significant at 10%, ** significant at 5%, ***significant at 10%, s.e. in parentheses. All include: State-of-Birth by Cohort Dummies; State of Residence by Cohort Dummies, Marriage Status and period of interview dummy. 9 cohorts, 32 states.

[1](Students/Teachers)/100

Table 4. Models with Additional Controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Real Expenditures p/c	0.259***	0.193*			0.238***	0.322		
	(0.075)	(0.158)			(0.081)	(0.205)		
Pupil-Teacher Ratio			-0.13*	-0.232			-0.174**	-0.293
			(0.079)	(0.003)			0.083	(0.271)
Child_Mortality[1]*educ	-0.042	-0.019	-0.072***	-0.055	-0.042	-0.044	-0.062	-0.041
	(0.037)	(0.070)	(0.028)	(0.075)	(0.036)	(0.071)	(0.033)	(0.083)
GDP pc (at school age)	-0.01**	0.007	-0.006	0.008	-0.10**	0.007*	-0.006	0.007
	(0.005)	-	(0.004)	.	(0.005)	(0.008)	(0.004)	.
Population Size *educ					0.0003	-0.009	0.001	0.003
					(0.001)		0.001	0.005
State-of-Birth & Cohort dummies interacted with years of education	No	Yes	No	Yes	No	Yes	No	Yes
R-squared	0.268	0.267	0.267	0.267	0.268	0.268	0.270	0.270
No. of observations	36,381	36,381	36,381	36,381	36,381	36,381	36,381	36,381

Note: * significant at 10%, ** significant at 5%, ***significant at 10%, s.e. in parentheses. All include: State-of-Birth by Cohort Dummies, Marriage Status, period of interview dummy State of Residence by Cohort Dummies, State of Residence by Cohort Dummies interacted with education 9 cohorts, 32 states 1 Prob of death of a child younger than 5.

Table 5. Reduced Form Results

	Dependent variable:	
	Years of Education	Log Income
	(1)	(2)
Real Expenditures p/c	2.853	1.302**
	(3.020)	(0.541)
R-squared		
No. of observations	46,847	36,400

Note: Standard errors in parentheses. All specifications include: state dummies, cohort dummies and period of interview dummies. Clustering is done at the state of birth in columns 1 to 4. Significance levels: * 10%, ** 5%, *** 1%

Table 6. Models with Place of Birth Controls

	(1)	(2)	(3)
Real Expenditures p/c	0.446***	0.367**	0.364***
	(0.087)	(0.168)	(0.125)
State-of-Birth dummies interacted with years of education	No	Yes	No
Region-of-Birth dummies interacted with years of education	No	No	Yes
No. of observations	36,381	36,381	36,381
R-squared	0.272	0.276	0.274

Note: * significant at 10%, ** significant at 5%, ***significant at 10%, s.e. in parentheses. All include: State-of-Birth by Cohort Dummies; State of Residence by Cohort Dummies, State-of-Residence Interacted with years of basic education, Marriage Status and period of interview. dummy 9 cohorts, 32 states. Ecuations include years of basic education and years of higher education. Expenditures are interacted with years of basic education only. Clustering at the state of birth AND state of residence levels.

Table 7. Models using 2007 and 2008 Data Separately

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Real Expenditures p/c	0.262***		0.040		0.270***		0.384	
	(0.055)		(0.229)		(0.072)		(0.267)	
Pupil-Teacher Ratio		-.070		-0.473		-.414***		0.077
		(0.131)		(0.596)		(0.147)		(0.238)
State-of-Birth & Cohort dummies interacted with years of education	No	No	Yes	Yes	No	No	Yes	Yes
N	17,680	17,680	17,680	17,680	18,701	18,701	18,701	18,701
R2	0.285	0.284	0.288	0.288	0.281	0.281	0.284	0.284
Data	2006	2006	2006	2006	2007	2007	2007	2007

Note: * significant at 10%, ** significant at 5%, ***significant at 10%, s.e. in parentheses. All include: State-of-Birth by Cohort Dummies, Marriage Status, period of interview dummy State of Residence by Cohort Dummies, State of Residence by Cohort Dummies interacted with education 9 cohorts, 32 states.

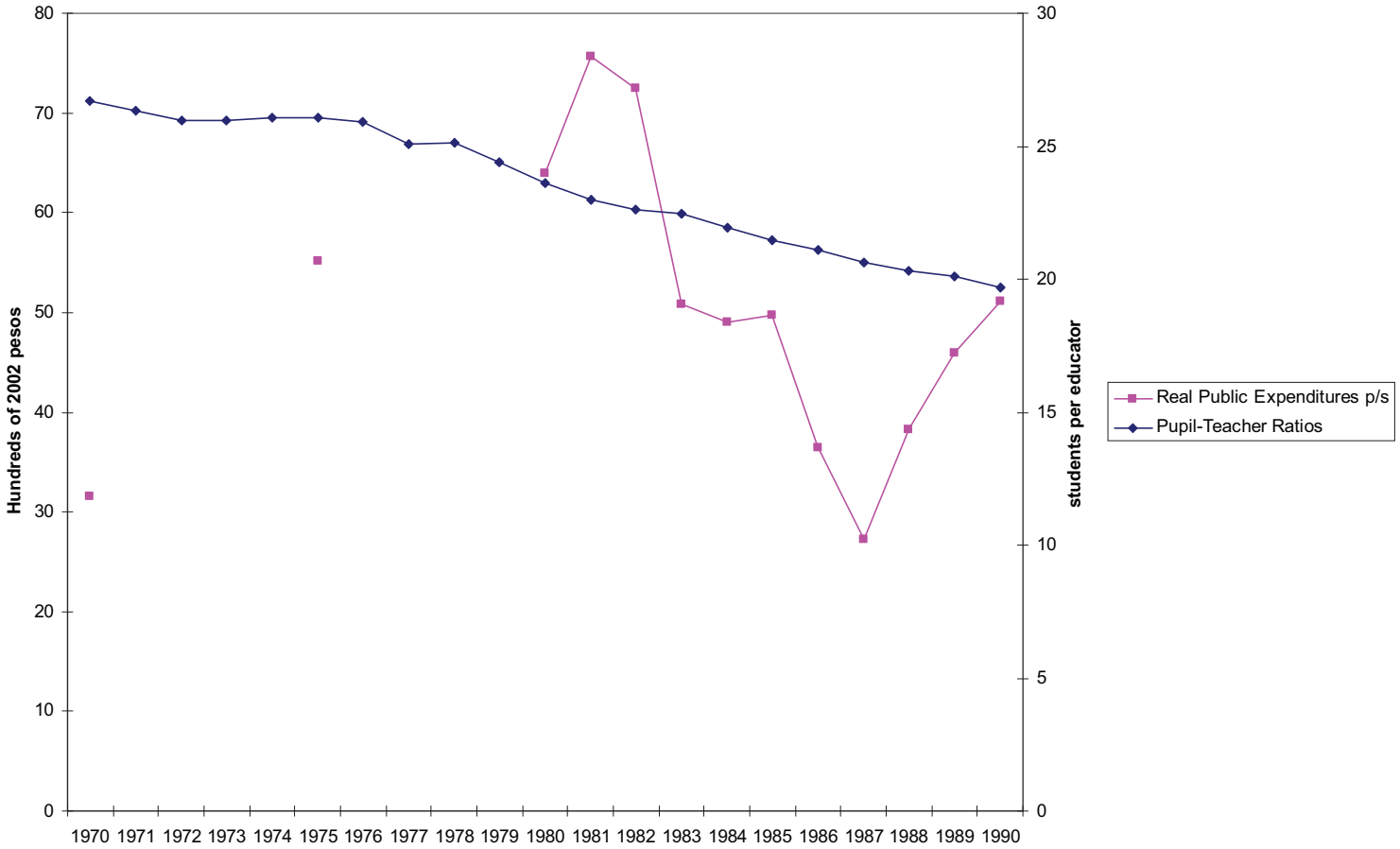
Table 8. Clustering at the State of Birth, State of Residence and Cohort Level.

	(1)	(2)	(3)	(4)	(5)	(6)
Real Expenditures p/c	0.274***		0.206		0.228***	
	(0.059)		(0.181)		(0.074)	
Pupil Teacher Ratios		-0.260**		-0.198		-0.276***
		(0.114)		(0.291)		(0.101)
State-of-Residence by Cohort dummies	Yes	Yes	Yes	Yes	Yes	Yes
State-of-Birth dummies interacted with years of education	No	No	Yes	Yes	No	No
Region-of-Birth dummies interacted with years of education	No	No	No	No	Yes	Yes
No. of observations	36,381	36,381	36,381	36,381	36,381	36,381
R-squared	0.270	0.270	0.267	0.267	0.270	0.270

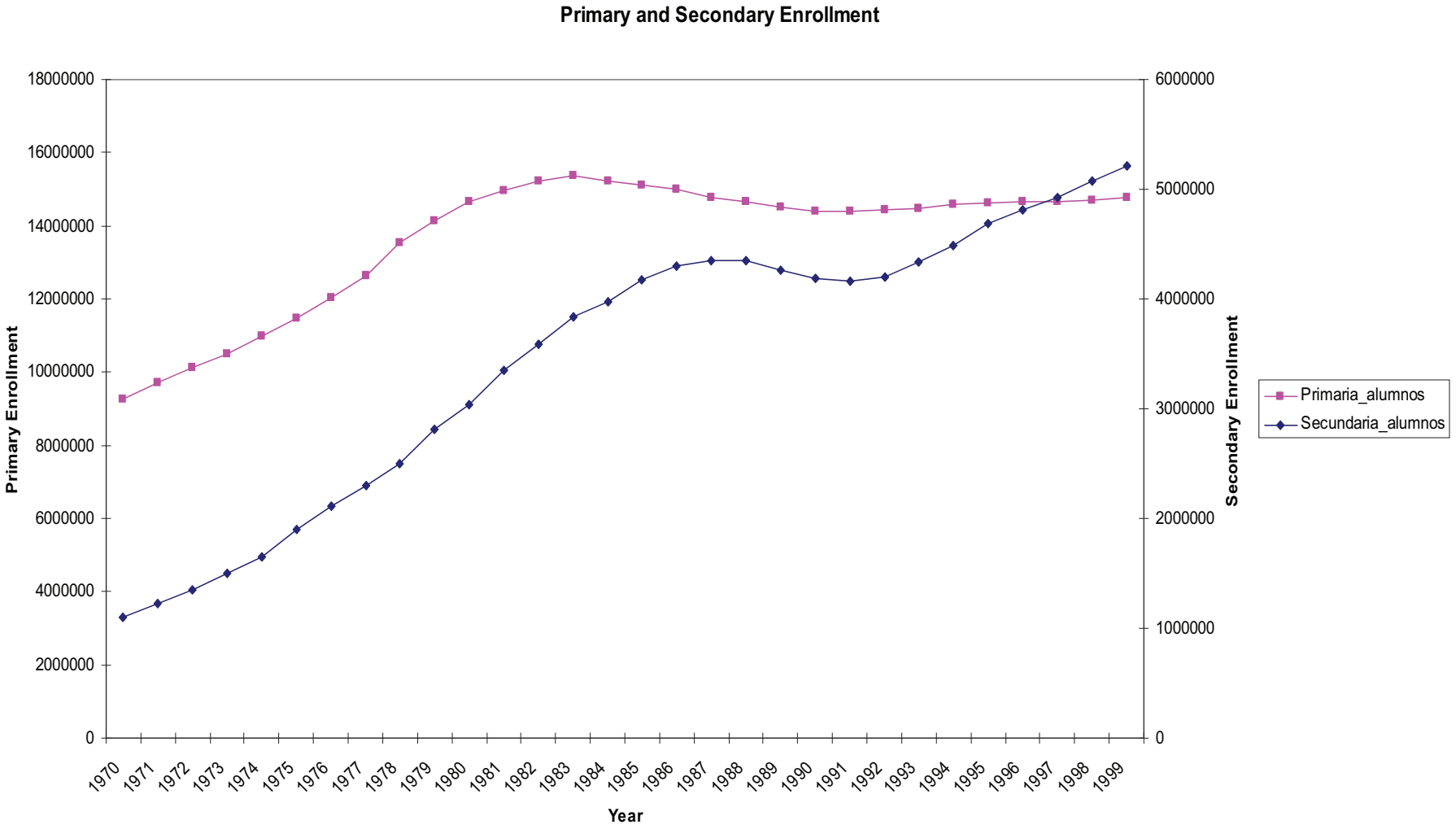
Note: * significant at 10%, ** significant at 5%, ***significant at 10%, s.e. in parentheses. All include: State-of-Birth by Cohort Dummies; State of Residence by Cohort Dummies, Marriage Status and period of interview dummy 9 cohorts, 32 states. Clustering is done at the state of birth, state of residence AND cohort level.

Figure
Click here to download Figure: article_graphs.pdf

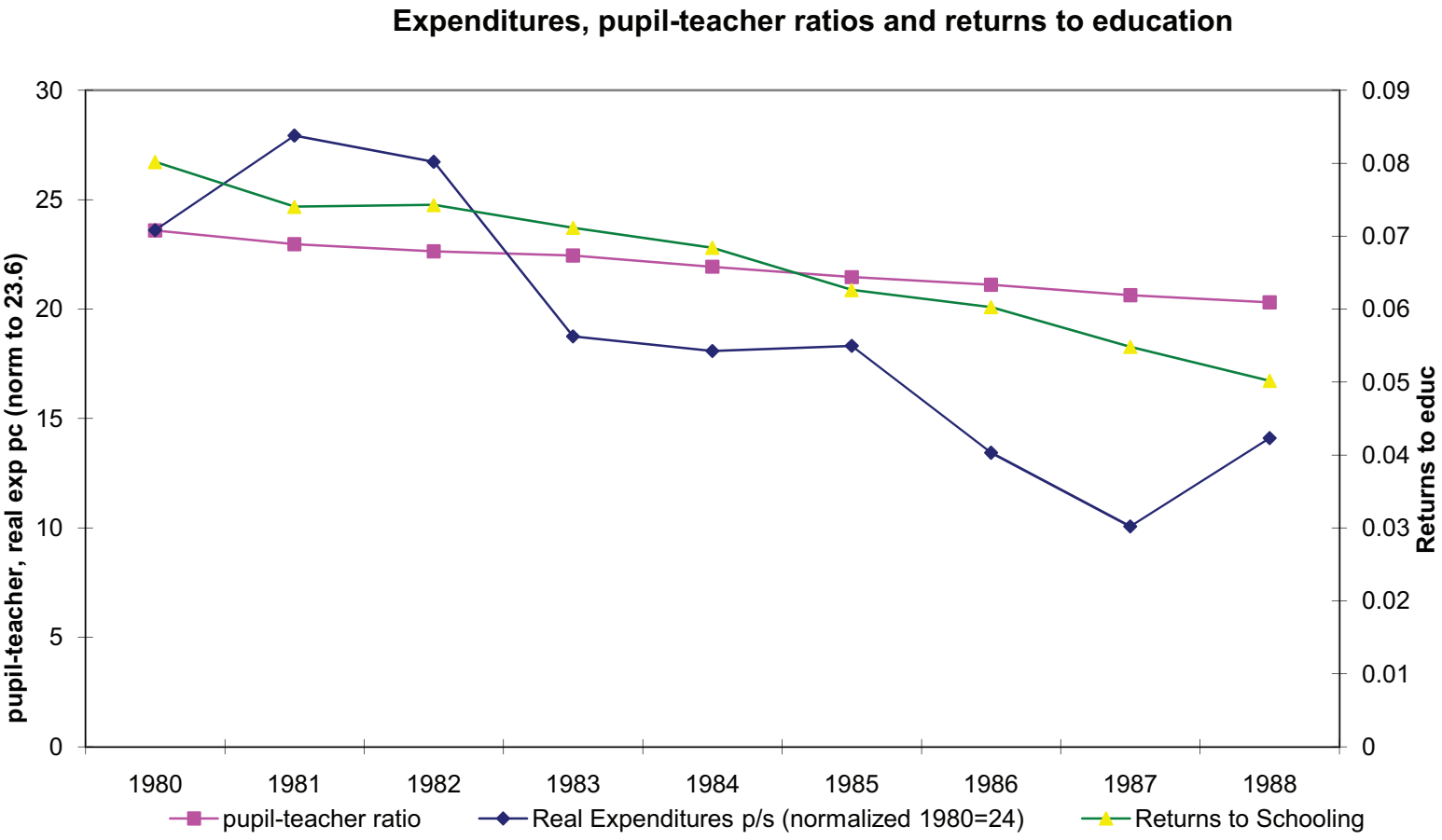
Graph 1: Public expenditures and pupil teacher ratios



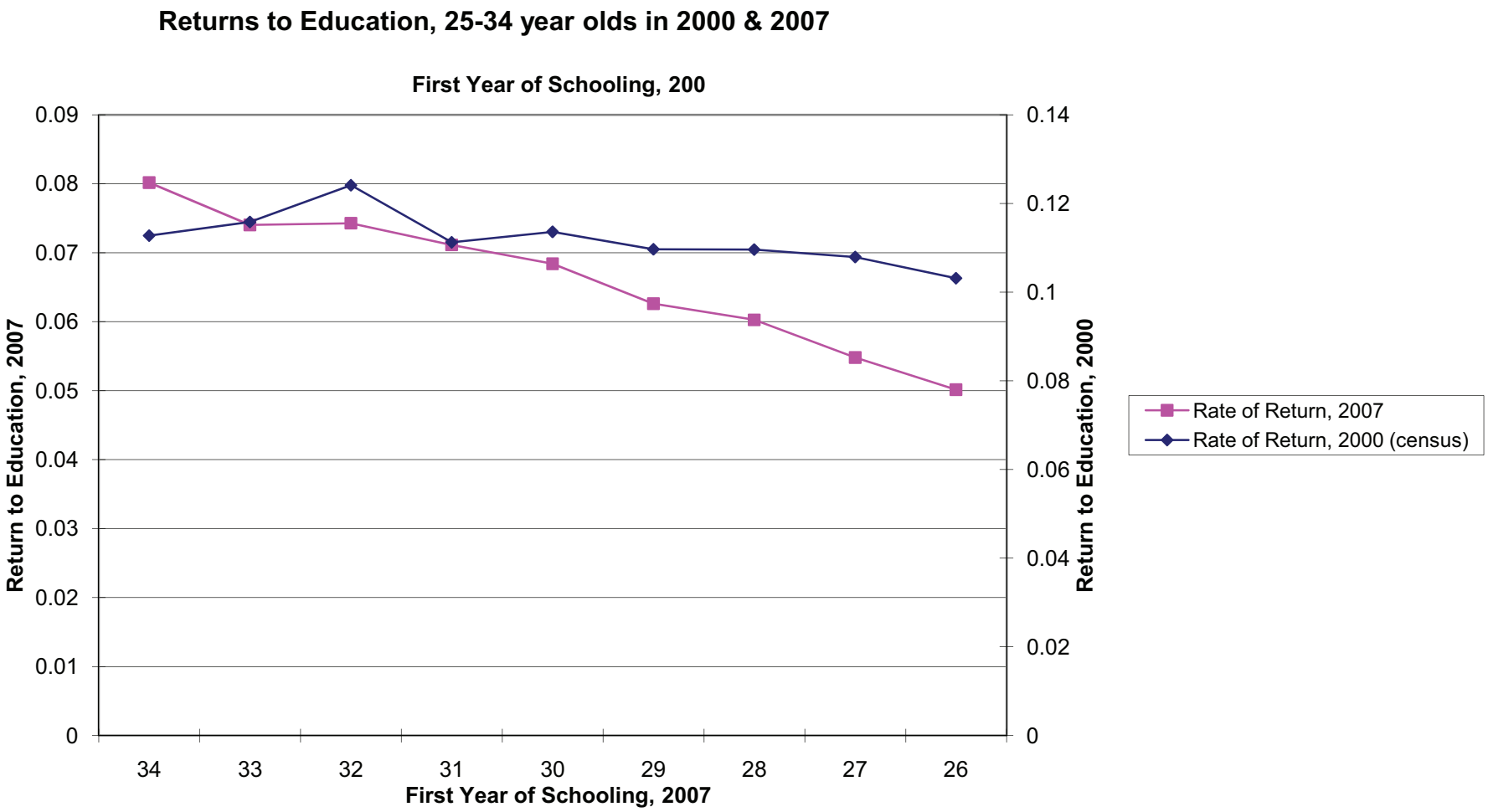
Graph 2


Primary and Secondary Enrollment
Primary Enrollment
Secondary Enrollment
Year
Primaria_alumnos
Secundaria_alumnos
18000000
16000000
14000000
12000000
10000000
8000000
6000000
4000000
2000000
0
6000000
5000000
4000000
3000000
2000000
1000000
0
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999

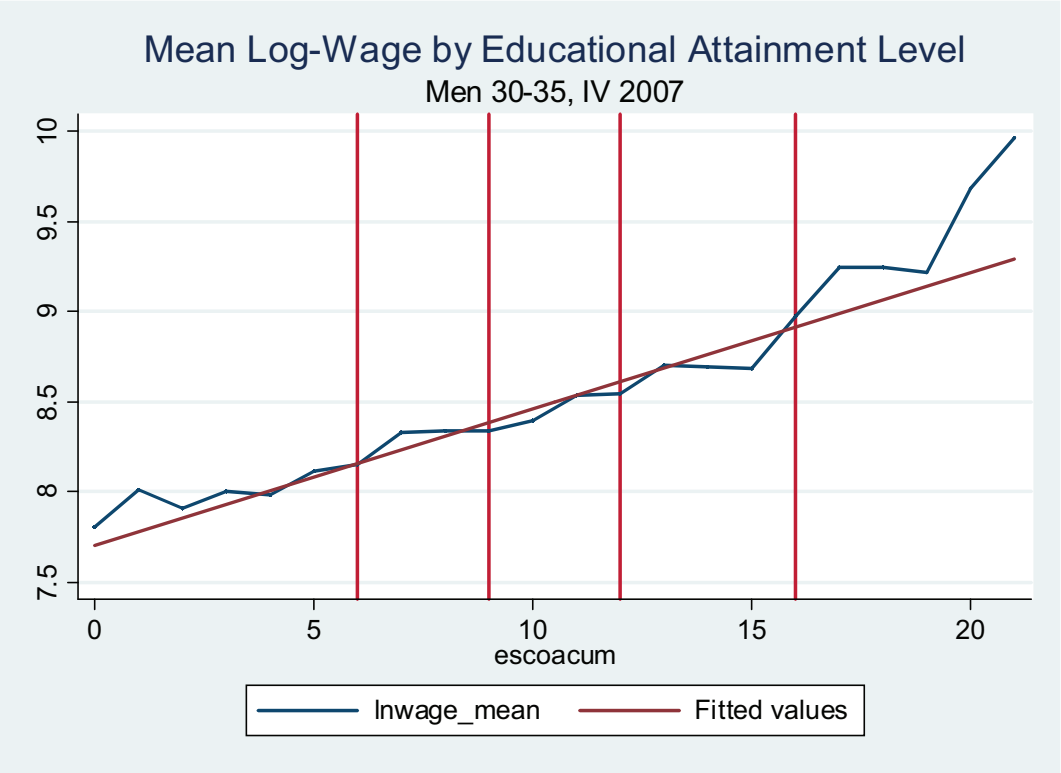
Graph 3


Expenditures, pupil-teacher ratios and returns to education
pupil-teacher, real exp pc (norm to 23.6)
Returns to educ
30
25
20
15
10
5
0
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1980
1981
1982
1983
1984
1985
1986
1987
1988
pupil-teacher ratio
Real Expenditures p/s (normalized 1980=24)
Returns to Schooling

Graph 4


Returns to Education, 25-34 year olds in 2000 & 2007
First Year of Schooling, 200
Return to Education, 2007
Return to Education, 2000
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
34
33
32
31
30
29
28
27
26
First Year of Schooling, 2007
Rate of Return, 2007
Rate of Return, 2000 (census)

Graph 5


Mean Log-Wage by Educational Attainment Level
Men 30-35, IV 2007
7.5
8
8.5
9
9.5
10
0
5
10
15
20
escoacum
lnwage_mean
Fitted values