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John Cullinan, National University of Ireland, Galway
Kevin Denny, University College Dublin
Darragh Flannery, University of Limerick

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A Distributional Analysis of Upper Secondary School Performance

John Cullinan[a], Kevin Denny[b] and Darragh Flannery[c*]

[a] JE Cairnes School of Business & Economics, National University of Ireland, Galway, Ireland. Email: john.cullinan@nuigalway.ie

[b] School of Economics & Geary Institute for Public Policy, University College Dublin, Ireland. Email: kevin.denny@ucd.ie

[c] Department of Economics, Kemmy Business School, University of Limerick, Ireland. Email: darragh.flannery@ul.ie

*** Corresponding Author Details**

Corresponding Author: Dr. Darragh Flannery

Postal Address: Department of Economics, Kemmy Business School, University of Limerick, Limerick, Ireland

Phone: +353 (0)61 202975

ABSTRACT

We examine the relationship between the distribution of upper secondary school performance and a range of individual and school level characteristics using unconditional quantile regression methods and data from Ireland. We find that determinants such as social class, maternal unemployment, extra private tuition, and working part-time have differential effects for low and high ability students and that important insights are lost by focusing on the conditional mean. The implication is that while certain factors can impact on whether or not a student is likely to proceed to higher education, other factors may affect where students go and what they study.

KEY WORDS

Secondary school performance; Distribution; Unconditional quantile regression; Ireland.

JEL CLASSIFICATION

I20, I21, J00, J01

1. INTRODUCTION

The financial and non-pecuniary returns to higher levels of education are well documented. Enhanced employment prospects and increased lifecycle earnings, as well as improved levels of self-reported health, job satisfaction and general happiness, are all associated with greater human capital accumulation (Flannery and O'Donoghue, 2017; Dolton and Sandi, 2017; Dickson and Harmon, 2011; Oreopoulos and Salvanes, 2011). These links help motivate studies that explore the determinants of participation and performance in higher education, as well as at other levels of education. In this context, this paper focuses on the performance of upper secondary students in Ireland in their terminal examination, since this performance is likely to have a significant impact on whether a young person transitions to third level education and may also influence where and what they study (Cullinan et al., 2013; Flannery and Cullinan, 2014). More specifically, we examine the relationship between the distribution of upper secondary school performance and a range of individual, socioeconomic and school level characteristics using unconditional quantile regression methods.

Numerous previous Irish and international studies have examined upper secondary performance and progression to tertiary education. Denny and Flannery (2017) provide a summary of this literature, showing the potential role that graduate earning premiums and socioeconomic factors play in determining participation in third level education. For example, studies specific to Ireland have highlighted persistent inequalities in the social class or socioeconomic composition of those in higher education (O'Connell et al., 2006; Smyth and Hannon, 2007; McCoy and Smyth, 2011; Flannery and O'Donoghue, 2009; Denny, 2014). Importantly, however, Flannery and Cullinan (2014) and Denny (2014) show that this socioeconomic gap tends to be strongly mediated by attainment in secondary school, a finding that is consistent with research from the UK (Chowdry et al., 2013). The implication is that one

of the main, if not the main, reasons that young people from lower socioeconomic backgrounds are less likely to progress to third level education is because they tend to do worse in upper secondary education. This has strong implications for policy, since it suggests a limited role for interventions at the point of entry to higher education, such as financial supports[1]. It also suggests that a more complete understanding of the determinants of academic performance in upper secondary education is required if we wish to address socioeconomic disparities in third level outcomes.

In this context, one of the weaknesses in much of the literature to date has been a focus on how potential determinants, such as socioeconomic status (SES), impact on the 'conditional mean' of secondary school performance. Using standard regression techniques, such as ordinary least squares (OLS), most previous studies have tended to ignore the possibility that some determinants of performance may have very different effects at different points of the performance distribution. In fact, analysing the entire distribution of academic performance, as opposed to just the conditional mean, is crucial. This is because significant information is likely to be concealed by a mean analysis if some factors have meaningfully different impacts at say low and high levels of achievement. Moreover from a policy perspective, where progression to college is rationed, the effects of a given variable on attainment at different quantiles can have very different implications. This is because attainment at lower quantiles may determine whether an individual progresses to college, while attainment at higher quantiles may determine which higher education institution (HEI) they chose to study at, or which course of study they pursue. Therefore, in this paper, we estimate whether a range of factors such as gender, social class and school type have differential effects on upper secondary attainment for lower and higher ability students. This analysis, which is unique in the Irish context and rare

[1] Heckman and Carneiro (2002) and Dearden et al. (2004) also argue, for the US and UK respectively, that credit constraints have a quite small impact on progression to third level education.

in the international literature, has important implications for policy.

The paper is structured as follows: Section 2 presents a review of the relevant literature, while Section 3 sets out the institutional context. Section 4 presents our data and methods and Section 5 the main empirical results. Finally, Section 6 summarises the implications of our results and findings and concludes.

2. LITERATURE

There is a large international literature that examines the determinants of academic performance in secondary school with a number of studies focussing on the role and importance of SES. For example, Blundell et al. (2000) estimated that having a father in a professional and/or managerial social class was associated with better A level attainment in the UK. Guimarães and Sampaio (2013) find a similar result for Brazil, showing that higher household income and parental education levels were associated with better performance in a university entrance exam. Fuchs and Weissman (2007) used Programme for International Student Assessment (PISA) data to show strong family background influences performance in standardised reading, mathematical and science exams for second level students across a range of countries. They also highlighted the positive role that factors such as the existence of formal exit exams and greater school autonomy may have on academic performance. Weissman (2016) focused on the mathematics score in PISA data from 2003 to estimate the relative impact of family background, school resources, and institutional level factors on performance. He found that resource inputs such as expenditure per student appear to have limited effects on student achievement but that socioeconomic factors, such as parental employment status and social class, had significant effects. Furthermore, using the number of books present in a home

as a proxy for the educational, social, and economic background of the students' families, it was found that this has a large and significant effect on student performance.

Other factors such as school and class size may also impact student performance but the evidence is mixed as to the direction of this impact. For example, Krassel and Heinesen (2014) find that larger class sizes are negatively associated with exam performance in secondary level education, while Denny and Oppedisano (2011) suggest that bigger classes lead to better results when analysing PISA data for the UK and USA. On school size, Bradley and Taylor (1998) present evidence from the UK that students in larger schools perform better, while Foreman-Peck and Foreman-Peck (2006) show the opposite using Welsh data. Jepsen (2015) provides a useful overview of the class size literature, while Leithwood and Jantzi (2009) and Humlum and Smith (2015) provide good summaries of the prominent empirical work that has explored the issue of school size.

School type may also be an influential factor, with Dearden et al. (2002), Sullivan and Heath (2003) and Sullivan et al. (2014) all showing that private (fee paying) schooling raises academic achievement and subsequent labour market outcomes[2]. Other notable studies have shown a positive impact of the conversion of disadvantaged schools to academies on end of school pupil performance (Eyles et al., 2016), that students in voucher based schools perform worse than those in municipal based schools (Hinnerich and Vlachos, 2017), and that teacher abilities have a negligible impact on average student achievement but the achievement of high-aptitude students improved when matched with teachers with high cognitive abilities and suffered when matched with teachers with high social abilities (Gronqvist and Vlachos, 2016).

[2] Since school type is to some extent a choice variable, controlling for endogeneity may be important. An analysis of performance in PISA tests for Ireland found that once selection was controlled for, the apparent benefit of fee paying schools disappeared (Pfefferman and Landesman, 2011)

In an Irish context, Denny (2010) and Denny and Flannery (2017) provide evidence that being female, higher paternal SES, and higher parental education levels may all positively influence a young person's performance in upper secondary education. Other studies to have specifically explored upper secondary exam performance in Ireland include Smyth (1999), who used data from 1994 to show a similar social gradient while controlling for a range of school level factors, such as school organisation and pupil involvement in extracurricular activities e.g. sport. More recently, Smyth (2009) explored the impact of extra paid tuition (outside of normal schooling) on student performance and found that private tuition yields no advantages in terms of upper secondary examination performance when other factors such as student aspirations and quantity of homework hours are accounted for. Furthermore, Lunn et al. (2013) used the 2007 wave of the School Leavers Survey to show evidence of the positive impact that participating in sport can have on upper secondary exam performance, while Smyth and McCoy (2013) provide a useful summary of studies that have focused on the potential influence that school and teacher characteristics may have on broader upper secondary outcomes.

While insightful, all of the aforementioned studies focused on the impact of one or more determinants on the conditional mean of an outcome variable, such as secondary school performance. In other words, they all ignored the possibility of differential effects of determinants across the distribution of performance outcomes. As noted, this may be problematic if certain factors (in)significantly influence performance depending on the point of the achievement distribution that an individual lies. Studies such as Gorry (2016), Lounkaew (2013), Haile and Nguyen (2008), and Eide and Showalter (1998) are some of the few previous studies that have considered this issue using quantile regression methods. For example, Gorry (2016) focused on the impact of sports participation on the grade point average (GPA) of American high school students and showed a greater impact for students in the lower end of the GPA distribution.

In other earlier studies, Lounkaew (2013) used PISA literacy test scores in Thailand to show significant variation in the impact of socioeconomic and school level factors across the achievement distribution, while Haile and Nguyen (2008) investigated determinants of high school students' academic attainment in mathematics, reading and science in the US, finding that Blacks and Hispanics tend to fare worse in their attainment at higher quantiles, particularly in science. They also showed that the effects of family background factors such as parental education and father's occupation varied across quantiles of the test score distribution. Eide and Showalter (1998) explored the impact of school characteristics on the change in math performance in US high school students from sophomore to senior year and found significant differences in the impact of variables such as school expenditures and school year length across the distribution in comparison to the average effects. For instance, they found that increased per pupil expenditures helped increase maths performance for those in the lower end of the achievement distribution but had no impact on those at the upper end, while the average effect was not found to be significant. Such findings illustrate the value of moving beyond the mean when considering student academic performance, something that is done in this paper.

Overall, while a small number of papers have considered the distribution of academic performance in secondary school, the vast majority of studies have employed a conditional (as opposed to unconditional) quantile regression approach, a notable exception being Lounkaew (2013). This is potentially problematic, since according to Borah and Basu (2013), conditional quantile regression can generate results that are hard to interpret in a policy or population context. Moreover, they may not be generalizable. Unconditional quantile regression, on the other hand, provides results that are more interpretable, since it marginalizes the effect over the distributions of the other covariates in the model (Borah and Basu, 2013). A further drawback of a number of previous studies is a focus on just one possible determinant of academic

performance. Our unique dataset provides a range of student, socioeconomic and school level characteristics that can be considered.

3. INSTITUTIONAL CONTEXT

HEIs in Ireland include universities, institutes of technology (IoTs), colleges of education (CoEs), as well as a small number of other public and private colleges, with a competitive entry system based mainly on grades achieved in their terminal upper secondary examination, otherwise known as the Leaving Certificate. These grades are converted into a points score generally referred to as Central Applications Office (CAO) points, with the number of points an individual receives helping to determine the type of course they can pursue. HEIs allocate places to students with the highest CAO points who wish to take that course, subject to constraints on course student numbers. As the number of students applying for places generally exceeds the supply, the system is typified by excess demand. Therefore, performing as well as possible in the terminal upper secondary examination is significant in an Irish context.

In addition, the type of course pursued is also heavily influenced by this Leaving Certificate performance, as there is considerable heterogeneity in the number of CAO points necessary to pursue different pathways and programmes of study. Universities and CoEs generally provide honours bachelor degree level courses with a focus on more traditional academic fields of study such as health, social sciences and humanities. This sector is generally seen as more 'prestigious' relative to the IoT sector, where both ordinary and honours bachelor degrees and a focus on engineering, construction and care courses are more common. These differences are reflected in the fact that entry to the university sector generally requires a higher number of CAO points compared to a course in an IoT – see McCoy and Smyth (2011), Denny (2014) and Flannery and Cullinan (2017) for more in depth considerations of these differences. As

McCoy and Smyth (2011) also note, participants in the different sectors face different employment prospects, with a higher probability of employment for those with a university education (Kelly et al., 2010). Therefore, if upper secondary school performance is influenced by an individual's SES or other factors, the extent of that influence may not necessarily prevent participation in higher education, but may affect the type of study and subsequent career path of that individual in the Irish education system.

Young people in Ireland typically spend 5 or 6 years in upper secondary education before taking their terminal exam. The length of time may vary depending on whether a student completes a transition year programme; this is an optional extra year of study between lower and upper secondary school and is free from formal examinations that may be offered within a school. Secondary schools in Ireland are largely State funded and of the 763 secondary schools in Ireland in 2016, only 52 (7%) were fee paying (Department of Education and Skills, 2017). All school types follow the same State prescribed curriculum and take the same State public examinations, including the Leaving Certificate examinations. From a policy perspective, second level schools that are deemed to be underprivileged may access supplementary resources such as extra learning support for teachers and a home-to-community liaison programme through the Delivery of Equality of Opportunity In Schools (DEIS) system (Department of Education and Science, 2005).

4. DATA AND METHODS

4.1 Data

The data used is from the 2007 wave of the School Leavers' Survey (SLS) from Ireland, with school leavers who exited the second-level system in the 2004/05 academic year providing the

reference cohort for the survey. The SLS is based on a stratified random sample of those leaving the second-level system, with a total sample size of 2,025 respondents[3]. It collects a wide range of individual, demographic, social, school, education and labour market related information. The SLS dataset also contains the Leaving Certificate examination grades of the student which is used to calculate the CAO points they achieved. Furthermore, information on whether or not an individual has undertaken any extra private tuition outside of regular school hours while in upper secondary education is available, as are data on whether a student participated in a transition year programme while in school and whether they worked in part-time employment or participated in formal sporting activities while in their final year of study.

Information on whether individuals applied to enter higher education is also available in the SLS, as are certain school-level variables such as whether the student attended a school that is fee paying or not, or if a school is designated as having DEIS status, and these are also included in our analysis. We also include a dummy variable for whether a student attended a large school, defined as one above the median enrolment size of schools within our sample (over 693 students). Our focus is on young people that completed upper secondary education and their Leaving Certificate examination. Of the 2,025 young people surveyed, 1,221 did so. Using only those with reliable examination result information from this group leaves us with an estimation sample of 1,032 individuals. Summary statistics for our sample and a more detailed description of these variables are presented in Table 1.

[Insert Table 1 about here]

To better explore heterogeneity around the mean of our school performance variable, we also present kernel density functions of CAO points across some of our key independent variables, namely parental social class and gender. Figure 1 illustrates the social gradient in performance

[3] See Byrne et al. (2008) for more details on this dataset.

with those from higher socioeconomic backgrounds (higher or lower professional) more heavily concentrated towards the upper end of the performance distribution relative to those from non-manual, skilled manual, semi-skilled or unskilled manual backgrounds. For gender we see little difference between males and females at the bottom of the performance distribution, while females outperform males at the upper end of the distribution – see Figure 2.

[Insert Figure 1 and Figure 2 about here]

4.2 Methods

In order to model the relationship between upper secondary school performance and the personal, socioeconomic, and school characteristics listed in Table 1, we use a number of estimation approaches. To begin, we first estimate a standard linear regression model, such that:

$$CAO_i = \beta_0 + \beta_1 \mathbf{X}_i + \varepsilon_i \qquad [1]$$

where CAO_i represents the CAO points of student i and $\mathbf{X}_i$ is a vector of student- and school-level characteristics such as gender, parental social class, parental employment status and school size. β_1 is a vector of parameters to be estimated and ε_i represents the error term.

As mentioned previously, one of the main contributions of this study is to go beyond a conditional mean analysis such as provided by an OLS estimation of Equation [1]. To this end, we also estimate the unconditional quantile regression (UQR) model proposed by Firpo et al. (2009)[4]. This technique is similar to that used in Lounkaew (2013) and has been applied in

[4] The quantile regressions of Koenker and Basset (1978) model conditional quantiles but the interpretation of these is less straightforward than the approach here since individuals can be, for example, at a high unconditional quantile but a low conditional one, or vice versa.

other fields of economics such as labour (Galego and Pereira, 2014), development (Agyire-Tettey et al., 2017), health (Borah and Basu, 2013) and hedonic house price models (Fortin et al., 2011). The UQR technique is based on the use of the re-centered influence function (RIF). To estimate the UQR model we initially calculate the RIF of the dependent variable (*CAO Points*), where the RIF for the τth quantile is given as:

$$RIF(Y;\hat{q}_\tau) = \hat{q}_\tau + \frac{\tau - D(Y \leq \hat{q}_\tau)}{\hat{f}_I(q_\tau)} \qquad [2]$$

where $\hat{f}_I(q_\tau)$ is the marginal density of Y at point q_τ estimated by kernel density methods, q_τ is the sample quantile and $D(Y \leq \hat{q}_\tau)$ is an indicator function determining whether the outcome variable is less than the τ quantile or otherwise.

As noted by Agyire-Tetty et al. (2017), a key feature of the RIF approach as developed by Firpo et al. (2009) is to replace the outcome variable with the estimated RIF and then regress this against a set of explanatory variables. Furthermore, Firpo et al. (2009) show that the RIF quantile regression model may be estimated using OLS with the expected value of the influence function equal to zero. Thus, this approach allows the estimation of partial effects for each covariate at various points across the distribution. For our study, this will translate as the marginal impact of our covariates on *CAO Points* at a given CAO percentile and for the purpose of our analysis we present results at the 20th, 40th, 60th and 80th percentiles.

5. EMPIRICAL RESULTS

In Table 2 we present a series of linear regression models with different covariates, estimated using OLS. Common to all the models is a set of dummy variables indicating age, gender, socioeconomic background, whether the person's mother is a homemaker, whether their father

is disabled and whether each parent is unemployed. We then consider the consequences of adding additional covariates including school characteristics. What is clear from the first specification is that parental background and labour market status have large effects. For example, a child from the lowest socioeconomic category (social class 3) will achieve, on average, almost 70 points fewer compared to one from the highest category. This is over one half of one standard deviation and given the highly competitive nature of entry (the so-called 'points race') this could translate to a significantly inferior outcome for a student. As an illustration of the potential importance of an additional 70 points, the minimum entry points to study Science in one Irish university in 2016 was 380, while the corresponding minimum to study Arts was 330. Previous research has shown significantly higher average earnings for Science graduates compared to Arts graduates in Ireland (Kelly et al., 2010). The advantage associated with being female is much smaller, around 23 points. Either parent, and particularly the mother, being unemployed has a much larger negative effect on attainment as does the father being disabled, which carries a significant penalty of just under 70 points[5].

[Insert Table 2 about here]

In the second column we add three activities which might enhance or detract from students' studies: whether the student worked part-time, whether s/he availed of private tuition, as well as whether the student was active in sport. Clearly these may be correlated with unobservable characteristics and therefore the estimated parameters may not be causal effects. We find all have a practically and statistically significant association with performance in this model, with working part-time leading to a reduction of 31 points on average and receiving extra private tuition resulting in 29 extra points. Intuitively, one might expect that students who are involved

[5] We have excluded the student's own disability status and their mother's since neither is statistically significant at the 5% level. Interestingly, if we interact paternal disability with the student's gender it is clear that it is essentially daughters who are affected by this and not sons.

in sport are both less academic by nature and/or are spending less time studying. However our finding that 'sporty' students do better is consistent with the bulk of the literature on the subject[6]. In terms of magnitude, the coefficient is comparable to that of gender. In this model the advantage associated with being female is about 50% larger than the first model.

In the third specification we add several variables associated with the school: whether the student took a transition year (a less academic school year between junior and senior cycles), if the school is fee paying, if it has DEIS status (a marker for being from a disadvantaged area), and if it is a relatively large school. While transition year is a characteristic of the student, in practice the variation in this is largely between schools. DEIS status will be negatively correlated with SES which explains the negative coefficient and also the smaller coefficients on social class compared to the previous models. By the same logic, one expects fee paying schools to do better, however the effect is not statistically significant. The simple difference in points between these types of schools in our sample is 78 (=413-335). Anecdotally, many parents seem to believe there is a causal effect on points from sending their children to fee paying schools. The results here suggest the correlation is spurious in the sense that once the model has sufficient controls the effect goes away[7].

The final specification adds a dummy variable for whether the individual applied to enter higher education. This could be interpreted as a marker for student ambition or an academic temperament. On the other hand, it could clearly be endogenous in that sense that the decision to apply could reflect their expected results. Nonetheless it is interesting to see that such students report significantly higher points levels here, by about 80 points.

[6] See Pfeifer and Cornelißen (2010) for a recent application. Bradley et al. (2013) analyse a single school in Ireland and find the same pattern as we do.

[7] This shows that selection on observables is sufficient to explain the apparent premium to fee paying schools. Pfefferman & Landesman (2011) compare fee paying status of schools using Irish PISA data. They find that allowing for selection on unobservables is sufficient to drive the estimated benefit of fee-paying schools to zero (or less).

The unconditional quantile regressions are presented in Table 3 using the same specification as the last model in Table 2, which is repeated in the first column to facilitate comparison. We estimate four models corresponding to the 20th, 40th, 60th and 80th percentiles of the dependent variable. If one considers the dummy variables for social class 2 and 3, it is noticeable that they are larger in magnitude for the higher percentiles and indeed are not statistically significant for the 20th percentile. So for weaker students, they are generally not helped nor hindered by their socioeconomic background. By contrast, at higher percentiles these effects very much come into play – see Figure 3(a). This is important as who gets high points determines access to the more prestigious university courses such as medicine, law and engineering. Policy discussions around access tend to focus simply on what proportion of particular demographic groups progress to university. These results suggest that attention should also be paid to which course they progress to, since this is where at least some of the socioeconomic gradient may be revealed. One could seriously underestimate the extent to which SES influences educational attainment if one only considers quantity and not quality also. A similar pattern holds with regard to the negative effect of students working part-time while preparing for their exams, with a relatively small effect at the 20th percentile and the effect doubling higher up the distribution – see Figure 3(b).

[Insert Table 3 and Figure 3 about here]

The opposite pattern exists with regard to the mother's unemployment status where the effect is much larger at the bottom of the distribution than elsewhere – see Figure 3(c). This is also true for the coefficient on private tuition which is small and not statistically significant other than for the 20th percentile (see Figure 3(d)). Interpreted causally, it suggests that private tuition may help avoid achieving very low points but are of little benefit otherwise. Variables such as this, where the effects are greatest in the left tail of the distribution of the dependent variable,

are likely to influence whether a student progresses to third level (or not) and if they do it will most likely be to less prestigious low-point degree courses. Overall what is clear from Table 3 and Figure 3 is that there is a great deal to be learned from going beyond the analysis of the effect of a variable on the mean as one does with OLS[8].

6. CONCLUSION

With evidence that socioeconomic gaps in higher education participation may be strongly mediated by attainment in secondary school, a more complete understanding of the determinants of academic performance in upper secondary education is warranted. However, the main focus of previous research has been on how potential determinants, such as SES, impact on the conditional mean of secondary school performance. Furthermore, most studies that have examined the distribution of academic performance have tended to employ a conditional quantile approach.

In this paper we present an unconditional quantile regression model of upper secondary academic performance to consider the importance of a range of factors such as gender, social class and school type, something that is distinctive in the Irish context and rare in the international literature. We find that variables such as social class, mother's employment status, working part-time and engaging in private tuition have differential effects for low and high ability students. For example, we show that the negative effects of lower social class are stronger at the higher percentiles of achievement and not statistically significant for those at

[8] As an extension to this analysis we also used decomposition methods to further examine the gender gap in attainment. In particular we applied the conventional Blinder-Oaxaca decomposition to the mean (i.e. using the OLS models) as well as across the distribution. Overall this decomposition analysis did not reveal any particularly interesting or informative results and therefore we do not present them here. They are however available from the authors on request.

the 20th percentile. Therefore, for weaker students, they are generally not helped nor hindered by their socioeconomic background but those at higher percentiles are negatively impacted by lower social class. This is important as who gets high points determines access to more prestigious university courses. From a policy perspective, it suggests that attention should also be paid to potential socioeconomic gradients in the type of programmes young people enter in higher education, as well as the more general question of participation.

In considering the results of this analysis, a number of caveats should be borne in mind. Firstly, the data utilised is relatively dated. However, as the SLS was discontinued after the 2007 wave, it is the latest available dataset to contain information on students' terminal upper secondary examination performance in Ireland. While more recent data would be desirable, we have no evidence or reason to believe that the relationships observed in our analysis should have deviated to any great extent in the past ten years. Another caveat to highlight is the potential endogeneity of some of our explanatory variables. While causal identification of the effects of these factors on upper secondary exam performance would be preferred, limitations with our data mean this is not possible here. This may provide fertile grounds for future enquiry.

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REFERENCES

Agyire-Tettey, F., Ackah, C.G., and Asuman, D. (2017). An unconditional quantile regression based decomposition of spatial welfare inequalities in Ghana. *The Journal of Development Studies*, DOI: 10.1080/00220388.2017.1296571.

Blundell, R., Dearden, L., Goodman, A. and Reed, H. (2000). The returns to higher education in Britain: Evidence from a British cohort. *The Economic Journal*, 110, 82-99.

Borah, B. and Basu, A. (2013). Highlighting difference between conditional and unconditional quantile regression approaches through an application to assess medication adherence. *Health Economics*, 22, 1052-1070.

Bradley, S. and Taylor, J. (1998). The effect of school size on exam performance in secondary schools. *Oxford Bulletin of Economics and Statistics*, 60, 291-234.

Bradley, J, Keane, F and Crawford, S. (2013). School sport and academic achievement. *Journal of School Health*, 83, 8-13.

Byrne, D., McCoy, S. and Watson, D. (2008). *School Leavers' Survey Report 2007*. Dublin: Economic and Social Research Institute and Department of Education and Science.

Chowdry, H., Crawford, C., Dearden, L., Goodman, A. and Vignoles, A. (2013). Widening participation in higher education: Analysis using linked administrative data. *Series A (Statistics in Society)*, 176, 431-457.

Cullinan, J., Flannery D., Walsh, S. and Mc Coy, S. (2013). Distance effects, social class and the decision to participate in higher education in Ireland. *The Economic and Social Review*, 44, 19-51.

Dearden, L., Ferri, J. and Meghir, C. (2002). The effect of school quality on educational attainment and wages. *Review of Economics and Statistics*, 84, 1-20.

Dearden, L., McGranahan, L. and Sianesi, B. (2004). *The Role of Credit Constraints in Educational Choices: Evidence from the NCDS and BCS70*. CEEDP 48: Centre for the Economics of Education, London School of Economics.

Denny, K. (2014). The effect of abolishing university tuition costs: Evidence from Ireland. *Labour Economics*, 26, 26-33.

Denny, K. (2010). What did abolishing university fees in Ireland do? UCD Geary Institute Discussion paper series 2010/26.

Denny K., Flannery D. (2017). The economics of higher education participation. In: Cullinan J., Flannery D. (Eds) *Economic Insights on Higher Education Policy in Ireland*. Cham: Palgrave Macmillan.

Denny, K. and Oppedisano, V. (2013). The surprising effect of larger class sizes. *Labour Economics*, 23, 57-65.

Department of Education and Science (2005). *Delivering Equality of Opportunity in Schools: An Action Plan for Educational Inclusion*. Dublin: Department of Education and Science.

Department of Education and Skills (2017). *Data on Indivdual Schools: Post Primary Schools List*. Available at https://www.education.ie/en/Publications/Statistics/Data-on-Individual-Schools/

Dickson, M. and Harmon, C. (2011). Economic returns to education: What we know, what we don't know, and where we are going—some brief pointers. *Economics of Education Review*, 30, 1118-1122.

Dolton, P. and Sandi, M. (2017). Returning to returns: Revisiting the British education evidence. *Labour Economics*, 48, 87-104.

Edie, E., and Showalter, M.H. (1998). The effect of school quality on student performance: A quantile regression approach. *Economics Letters*, 58, 345-50.

Eyles, A., Hupkau, C., and Machin, S. (2016). School reforms and pupil performance. *Labour Economics*, 41, 9-19.

Firpo, S., Fortin, N.M., and Lemieux, T. (2009). Unconditional quantile regressions. *Econometrica*, 77, 953-973.

Flannery, D., and Cullinan, J. (2014). Where they go, what they do and why it matters: the importance of geographic accessibility and social class for decisions relating to higher education institution type, degree level and field of study. *Applied Economics*, 46, 2952-2965.

Flannery D., and Cullinan J. (2017). Economics and higher education policy. In: Cullinan J., Flannery D. (Eds) *Economic Insights on Higher Education Policy in Ireland*. Cham: Palgrave Macmillan.

Flannery D., and O'Donoghue C. (2017). The returns to third level education. In: Cullinan J., Flannery D. (Eds) *Economic Insights on Higher Education Policy in Ireland*. Cham: Palgrave Macmillan.

Flannery D. and O'Donoghue C. (2009). The determinants of higher education participation in Ireland: A micro analysis. *The Economic and Social Review*, 40, 73-107.

Foreman-Peck, J. and Foreman-Peck, L. (2006). Should schools be smaller? The size performance relationship for Welsh schools. *Economics of Education Review*, 25, 157-171.

Fortin, N., Lemieux, T., and Firpo S. (2011). Decomposition methods in economics. In: Card,

D. and Ashenfelter, O. (Eds) *Handbook of Labor Economics*, Volume 4. North-Holland, Amsterdam.

Fuchs, T. and Weissman, L. (2007). What accounts for international differences in student performance? A re-examination using PISA data. *Empirical Economics*, 32, 433-64.

Galego, A. and Pereira, J. (2014). Decomposition of regional wage differences along the wage distribution in Portugal: the importance of covariates. *Environment and Planning A*, 46, 2514-2532.

Gorry, D. (2016). Heterogenous effects of sports participation on education and labor market outcomes. *Education Economics*, 24, 622-638.

Gronqvist, E. and Vlachos, J. (2016). One size fits all? The effects of teachers' cognitive and social abilities on student achievement. *Labour Economics*, 42, 138-150.

Guimarães, J. and Sampaio, B. (2013). Family background and students' achievement on a university entrance exam in Brazil. *Education Economics*, 21, 38-59.

Haile, G.A. and Nguyen, A.N. (2008). Determinants of academic attainment in the United States: A quantile regression analysis of test scores. *Education Economics*, 16, 29-57.

Heckman J.J. and Carneiro, P. (2002). The evidence on credit constraints in post-secondary schooling. *Economic Journal*, 112, 705-734.

Hinnerich, B.J. and Vlachos, J. (2017). The impact of upper-secondary voucher school attendance on student achievement. Swedish evidence using external and internal evaluations. *Labour Economics*, 47, 1-14.

Humlum, M. K., and Smith, N. (2015). Long-term effects of school size on students' outcomes. *Economics of Education Review*, 45, 28-43.

Jepsen, C. (2015) Class size: does it matter for student achievement? IZA World of Labor 2015: 190 doi: 10.15185/izawol.190.

Kelly, E., O'Connell, P. J. and Smyth, E. (2010). The economic returns to field of study and competencies among higher education graduates in Ireland. *Economics of Education Review*, 29, 650-657.

Krassel, K. and Heinesen, E. (2014). Class-size effects in secondary school, *Education Economics*, 22, 412-426.

Koenker R. and Bassett G. (1978) Regression Quantiles. *Econometrica*, 46, 33-50.

Leithwood K., Jantzi D. (2009). A review of empirical evidence about school size effects: A policy perspective. *Review of Educational Research*, 79, 464-490.

Lounkaew, K. (2013). Explaining urban–rural differences in educational achievement in Thailand: Evidence from PISA literacy data. *Economics of Education Review*, 37, 213-225.

Lunn, P., Kelly, E. and Fitzpatrick, N. (2013). *Keeping Them in the Game: Taking Up and Dropping Out of Sport and Exercise in Ireland*. ESRI Research Series 33. Dublin: ESRI.

McCoy, S. and Smyth, E. (2011). Higher education expansion and differentiation in the Republic of Ireland. *Higher Education*, 61, 243-260.

O'Connell, P.J., Clancy, D. and McCoy, S. (2006). *Who Went to College in 2004? A National Survey of New Entrants to Higher Education*. Dublin: Higher Education Authority.

Oreopoulos, P. and Salvanes, K.G. (2011). Priceless: The non-pecuniary benefits of schooling.

Journal of Economic Inquiry, 25, 159-184.

Pfefferman, D. and Landesman, V. (2011) Are private schools better than public schools? Appraisal for Ireland by methods for observational studies. *Annals of Applied Statistics*, 5, 1726-1751.

Pfeifer, C. and Cornelißen, T. (2010) The impact of participation in sports on educational attainment- new evidence from Germany. *Economics of Education Review*, 29, 94-103.

Smyth, E. (1999). *Do Schools Differ?* Dublin: Oak Tree Press/ESRI.

Smyth, E. (2009). Buying your way into college? Private tuition and the transition to higher education in Ireland, *Oxford Review of Education*, 35, 1-22.

Smyth, E. and Hannon, C. (2007). School processes and the transition to higher education. *Oxford Review of Education*, 33, 175-194.

Smyth, E. and McCoy, S. (2013). Learning from the evidence: Using educational research to inform policy. In Lunn, P. and Ruanne, F. (Eds) *Using Evidence to Inform Policy*. Dublin: Gill & Macmillan.

Sullivan, A. and Heath, A. (2003). Intakes and examination results at state and private schools. In: G. Walford (Ed) *British Private Schools: Research on Policy and Practice*. London: Woburn Press.

Sullivan, A., Parsons, S., Wiggins, R., Heath, A. and Green, F. (2014). Social origins, school type and higher education destinations. *Oxford Review of Education*, 40, 739-763.

Weissman, L. (2016). The importance of school systems: Evidence from international differences in student achievement. *Journal of Economic Perspectives*, 30, 3-32.

Table 1: Variable Definitions and Sample Descriptive Statistics

Variable Name	Variable Description	% or Mean (SD)
Dependent Variable		
CAO Points	= Number of points achieved in the Leaving Certificate examination	340.65 (128.82)
Independent Variables		
Age 20+	= 1 if student was aged > 20 when taking Leaving Certificate; 0 else	20.44%
Female	= 1 if student is female; 0 else	54.84%
Disability	= 1 if student has chronic illness or disability; 0 else	4.10%
Social Class	= 1 if father's/mother's social class is higher or lower professional = 2 if father's/mother's social class is non-manual or skilled manual = 3 if father's/mother's social class is semi-skilled or unskilled manual = 4 if father's/mother's social class is unspecified	39.34% 42.24% 16.76% 1.66%
Mother Homemaker	= 1 if mother is a homemaker; 0 else	26.16%
Father Disabled	= 1 if father is disabled; 0 else	3.20%
Father Unemployed	= 1 if father is unemployed; 0 else	5.03%
Mother Unemployed	= 1 if mother is unemployed; 0 else	3.01%
Worked Part-time	= 1 if student worked part-time during term time in school; 0 else	53.39%
Private Tuition	= 1 if student undertook extra private tuition; 0 else	49.70%
Sports	= 1 if student was involved in regular sporting activity during Leaving Certificate year; 0 else	31.78%
Transition Year	= 1 if student undertook a transition year in school; 0 else	46.02%
Fee Paying School	= 1 if student attended a private fee paying school; 0 else	7.65%
DEIS School	= 1 if student attended a DEIS designated school; 0 else	15.89%
Large School	= 1 if student attended a large school; 0 else	47.57%
Applied for Higher Education	= 1 if student applied to go to higher education; 0 else	82.84%
Observations		1,032

Source: Analysis of SLS data for 2007.

Table 2: Linear Regression Models of Upper Secondary Performance

	Dependent Variable: *CAO Points*			
	(1)	**(2)**	**(3)**	**(4)**
Age 20+	-17.1	-15.5	-14.7	-13.2
	(7.50)***	(6.79)***	(6.12)***	(5.54)***
Female	22.6	31.4	33.9	32.9
	(2.98)**	(4.15)***	(4.68)***	(4.67)***
Social Class 2	-59.9	-54.1	-41.4	-37.0
	(7.23)***	(6.62)***	(5.10)***	(4.72)***
Social Class 3	-69.7	-61.1	-50.5	-49.0
	(6.52)***	(5.79)***	(4.92)***	(4.93)***
Social Class 4	3.0	-2.9	0.8	-9.0
	(0.08)	(0.08)	(0.02)	(0.28)
Mother Homemaker	-23.7	-23.0	-20.6	-19.2
	(2.78)**	(2.73)**	(2.53)*	(2.50)*
Father Disabled	-66.2	-60.5	-58.6	-52.2
	(3.07)**	(3.17)**	(2.98)**	(2.84)**
Father Unemployed	-40.8	-36.7	-26.1	-20.6
	(2.32)*	(2.11)*	(1.62)	(1.38)
Mother Unemployed	-68.3	-58.5	-50.6	-50.4
	(2.99)**	(2.66)**	(2.29)*	(2.21)*
Worked Part-time		-30.9	-31.9	-32.7
		(4.02)***	(4.31)***	(4.59)***
Private Tuition		28.5	19.5	13.1
		(3.81)***	(2.74)**	(1.90)
Sports		32.8	28.1	28.4
		(4.13)***	(3.68)***	(3.84)***
Transition Year			44.1	41.0
			(5.71)***	(5.56)***
Fee Paying School			26.1	19.0
			(1.75)	(1.29)
DEIS School			-66.2	-60.6
			(5.97)***	(5.76)***
Large School			-16.8	-18.0
			(2.09)*	(2.31)*
Applied for Higher Ed.				81.1
				(7.56)***
Constant	728.2	679.1	696.8	597.1
	(15.72)***	(14.45)***	(14.81)***	(12.20)***
Observations	1,032	1,032	1,032	1,032
R^2	0.165	0.204	0.271	0.323
Adj-R^2	0.151	0.188	0.252	0.306

Source: Analysis of SLS data for 2007.

Notes: The table presents estimated coefficients from linear regression models of *CAO Points* estimated using OLS. All models include NUTS 3 regional dummies (coefficients not shown). Absolute t statistics are in parentheses. *** denotes statistically significant at 1%, ** denotes statistically significant at 5%, and * denotes statistically significant at 10%. Standard errors are robust and clustered at school level.

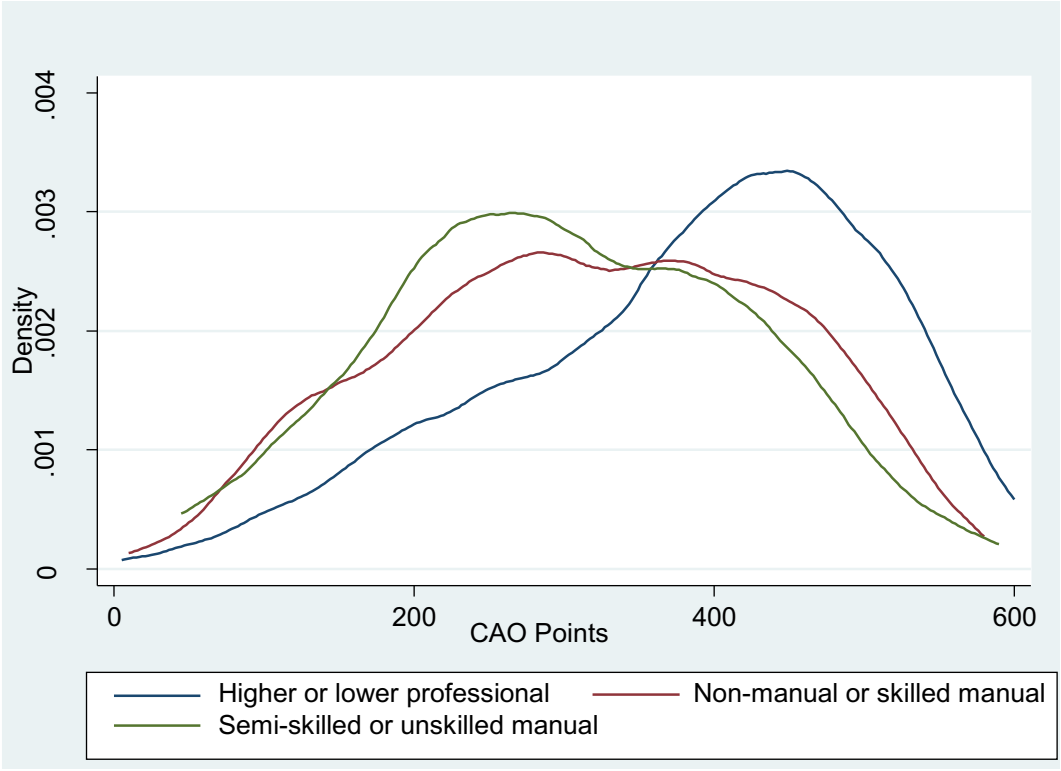
Table 3: Unconditional Quantile Regression Models of Upper Secondary Performance

	OLS	RIF 20	RIF 40	RIF 60	RIF 80
Age 20+	-13.2	-3.40	-25.2	-21	-12.5
	(5.54)***	(-0.68)	(5.05)***	(7.12)***	(6.09)***
Female	32.9	26.7	47.9	53.7	34.7
	(4.67)***	(-1.94)	(3.80)***	(4.81)***	(3.20)**
Social Class 2	-37.0	-16.8	-43.8	-56.2	-42.3
	(4.72)***	(-1.30)	(3.35)***	(4.59)***	(3.57)***
Social Class 3	-49.0	-18.6	-72.4	-81.5	-74.2
	(4.93)***	(-1.02)	(3.96)***	(5.24)***	(5.23)***
Social Class 4	-9.0	-4.9	-4.5	21.26	38.5
	(0.28)	(0.13)	(0.11)	(0.48)	(0.81)
Mother Homemaker	-19.2	-18.4	-27.7	-29.1	-13.1
	(2.50)*	(-1.26)	(1.83)	(2.54)*	(1.17)
Father Disabled	-52.2	-93.5	-88.4	-54.6	-32.6
	(2.84)**	(2.35)*	(2.38)*	(1.97)*	(1.55)
Father Unemployed	-20.6	-30.9	-25.4	-1.3	-12.7
	(1.38)	(-0.98)	(1.01)	(0.06)	(0.64)
Mother Unemployed	-50.4	-110.6	-89.4	-57.0	-10.9
	(2.21)*	(2.70)**	(2.25)*	(2.08)*	(0.42)
Worked Part-time	-32.7	-23.5	-49.2	-39.1	-46.6
	(4.59)***	(2.09)*	(3.96)***	(3.56)***	(4.71)***
Private Tuition	13.1	45.6	19.2	4.5	-10.3
	(1.90)	(3.68)***	(1.63)	(0.42)	(0.98)
Sports	28.4	16.5	41.6	52.4	24.5
	(3.84)***	(-1.25)	(3.44)***	(4.65)***	(1.87)
Transition Year	41.0	43.1	48.2	57.7	51.8
	(5.56)***	(3.73)***	(3.77)***	(4.86)***	(4.72)***
Fee Paying School	19.0	8.4	18.8	32.7	35.5
	(1.29)	(-0.37)	(0.79)	(1.46)	(1.35)
DEIS School	-60.6	-64.7	-92.4	-51.2	-26.5
	(5.76)***	(3.07)**	(5.04)***	(3.60)***	(2.27)*
Large School	-18.0	-14.9	-19.1	-29.4	-35.7
	(2.31)*	(-1.12)	(-1.38)	(2.43)*	(3.32)***
Applied for Higher Ed.	81.1	153.9	121.3	55.9	13.3
	(7.56)***	(6.41)***	(6.80)***	(4.38)***	-1.19
Constant	597.1	209.1	807.1	866.7	814.8
	(12.20)***	(2.08)*	(8.26)***	(14.15)***	(19.60)***
Observations	1,032	1,032	1,032	1,032	1,032
R^2	0.323	0.205	0.262	0.245	0.160
Adj-R^2	0.306	0.185	0.243	0.226	0.139

Source: Analysis of SLS data for 2007.

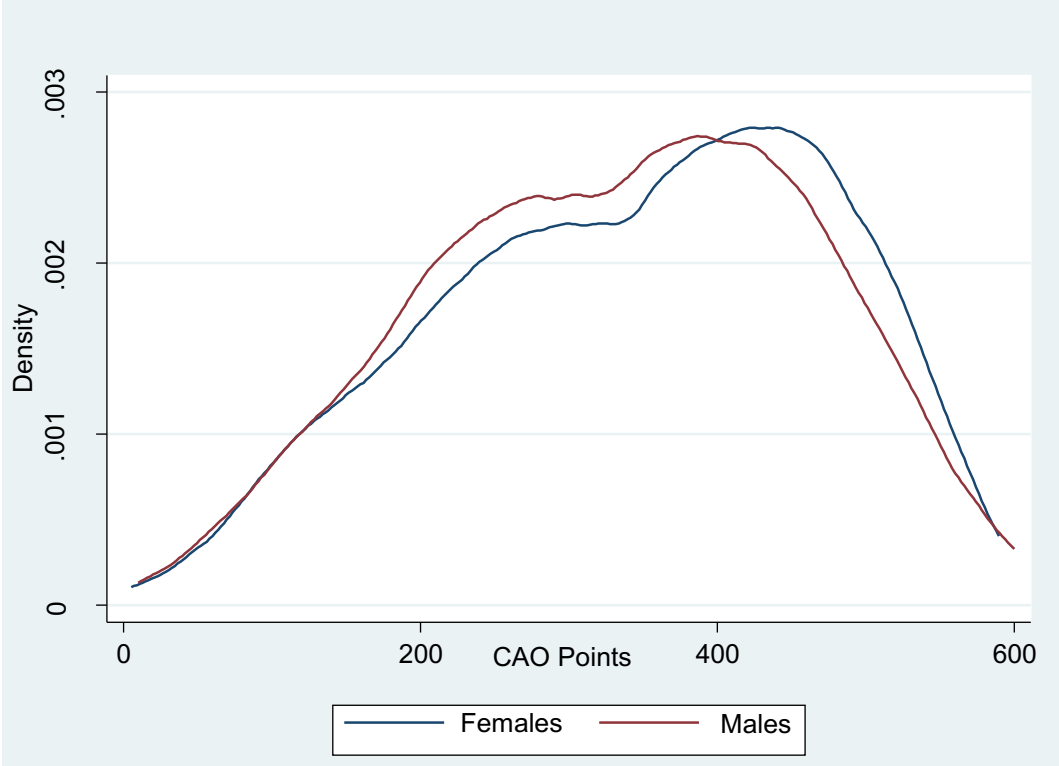
Notes: The table presents estimated coefficients from unconditional quantile regressions of *CAO Points* with results for the 20th, 40th, 60th and 80th percentiles. All models include NUTS 3 regional dummies (coefficients not shown). Absolute t statistics are in parentheses. *** denotes statistically significant at 1%, ** denotes statistically significant at 5%, and * denotes statistically significant at 10%. Standard errors are robust and clustered at school level.

Figure 1: CAO Points Distribution by Social Class



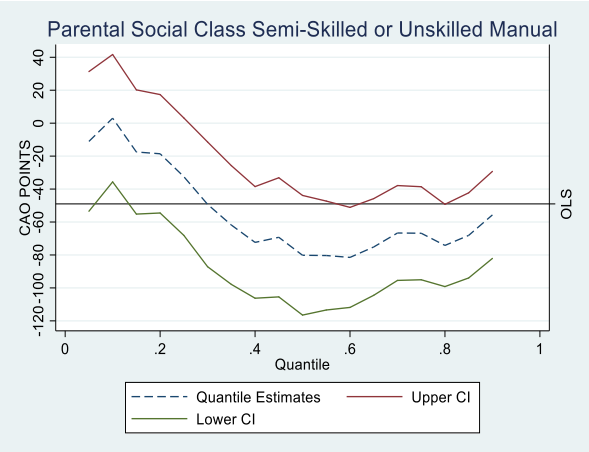
Source: Analysis of SLS data for 2007.

Figure 2: CAO Points Distribution by Gender

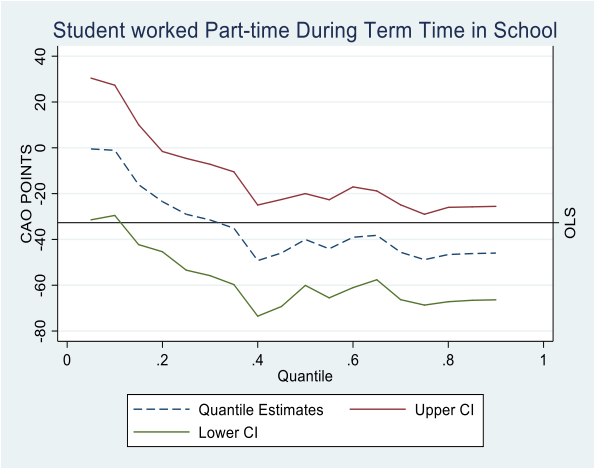


Source: Analysis of SLS data for 2007.

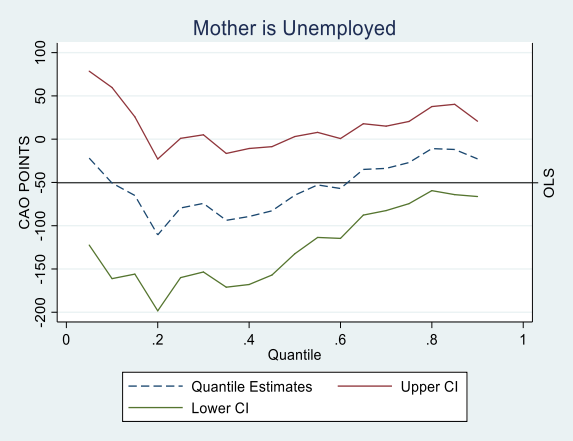
Figure 3: Estimated Quantile Effects for Selected Variables



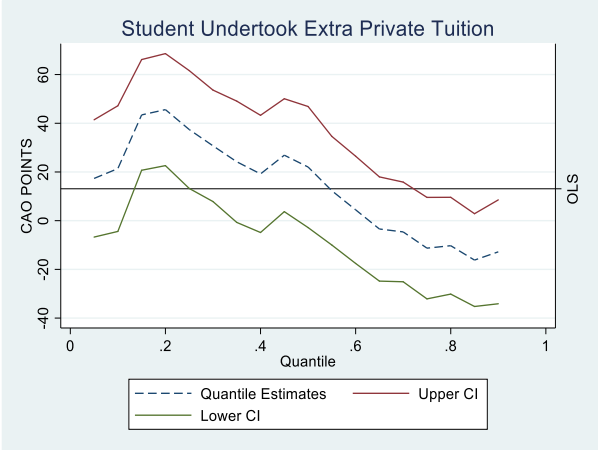
(a) Social Class



(b) Worked Part-time



(c) Mother Unemployed



(d) Private Tuition

Source: Analysis of SLS data for 2007.

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