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Consumers' Valuation of Academic and Equality-inducing Aspects of School Performance in England

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Consumers' Valuation of Academic and Equality-inducing Aspects of School Performance in England*

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Abstract

This paper investigates the willingness of households to pay for academic and equality-inducing (deprivation-compensating) components of the Contextual Value Added (CVA) indicator of school quality used in England. Semi-parametric and parametric analysis shows that consumers are willing to pay for houses in the catchment area of primary and secondary schools with high academic achievement, as measured by the mean score; whereas, the component of the CVA indicating equality-inducing aspects of school performance is found to have a positive effect only on the price of houses in the catchment area of primary schools in London; its impact on the price of houses elsewhere is mostly negative. The role played by the CVA as a guide to choosing a school and the implications which our results can have for school funding are considered.

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Keywords: *Consumer Valuation, Education Equality, School Performance, Hedonic Analysis, Contextual Value Added*

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1. Introduction

This paper examines how the willingness of households to pay in order to locate themselves in the catchment area of state schools exhibiting high level academic performance, as measured by the mean score achieved in examinations, is modified to also account for equality-inducing school characteristics, as measured by the incidence of pupil- and neighbourhood-specific deprivation characteristics.

Motivating the question above is the emphasis placed on promoting education equality in the UK and other countries through policies that encourage redistribution of education funding in favour of schools with a large disadvantaged intake. The 2010 Spending Review in the UK announced the creation of a premium targeted at deprived pupils (Chowdry and Sibieta, 2011); while the Department for Children, Schools and Families in England has recently adopted the Contextual Value Added (CVA) indicator, which conditions the academic progress of schools on deprivation characteristics of their intake. In the US the grant program of President Barack Obama, which was introduced in response to the 2008 economic crisis, urges federal officials to focus their proposals, among others, on turning around low-performing schools (Perlman and Redding, 2011).

Household willingness to pay for better quality education through purchasing a house at a premium in the catchment area of high performing state schools is theoretically rationalised by a Tiebout-type approach (e.g. Barrow, 2002; Hoxby, 2000) and empirically supported by a large number of studies (see review by Black and Machin, 2011). These studies, based on the hedonic approach (Rosen, 1974), mostly focus on average test score statistics to measure school quality (e.g. Black, 1999; Gibbons and Machin, 2008) and do not examine potential effects on house prices from distributional aspects of these statistics. Yet, household decisions can be influenced by equality-inducing aspects of school quality, in the sense that improving the education achievement of disadvantaged pupils can generate positive externalities that raise the quality of life in the local community. Evidence based on instrumental variable (Lange and Topel, 2006) and contingent valuation (Clinch and Murphy, 2001) methods supports this argument.

In the context of hedonic analysis, Black (1999) finds a statistically significant link between household willingness to pay for high quality state schooling and the quality of life in the local community. More precisely, the author shows that the (unconditional) positive effect of mean score on house prices exaggerates the contribution of high quality schooling to household welfare. This is because this effect incorporates the premium price tag attached to houses in neighbourhoods without deprivation characteristics (crime, unemployment, poverty, pupils' ethnic background) that lessen household welfare. In Black (1999) and other studies (e.g. Cheshire and Sheppard, 2004) household willingness to pay through housing for better quality education appears to decreases with neighbourhood- and pupil-specific deprivation characteristics. This is interpreted as unwillingness on behalf of the households to accept these characteristics to the detriment of their children's academic performance. To our knowledge, how far the negative effect of deprivation characteristics on consumers' valuation of school quality can be offset by schools paying more attention to disadvantaged pupils is a question not addressed in the hedonic analysis literature.

In general, it is not clear how the location decision of households - motivated by preferences about school quality - can be influenced by measures of incidence and treatment of deprivation characteristics. Surely, households should not be willing to trade academic performance of their own child for equality-inducing education outcomes; thus house prices should be higher in the catchment area of schools with the capacity to reach a high score rather than accommodate a large disadvantaged intake. On the other hand, the answer may not be so clear when the household's choice is between schools with the same academic achievement (i.e. same score) but different equality-inducing outcomes, especially when school performance is measured using a value added indicator.

Questions about the information content of value-added measures and their appropriateness (vis-à-vis a test score) as indicators of school quality have been raised in the literature, among others, by Haurin and Brasington (2006) and Gibbons, Machin and Silva (2009). In principle, the CVA is believed to be a better measure of academic progress than simple value added indicators because it adjusts changes in score to account for the fact that schools start off with pupils of different abilities and backgrounds. By making this adjustment the CVA indicator signals to parents what they would normally wish to know: the real gain in academic achievement that their child could expect from the school given their own child's abilities. The equality-inducing component of CVA can play a role only insofar as it can modify this signal to account for other considerations, like the initial score which the value added is measured from, or positive externalities associated with the promotion of education among deprived children.

As regards the level from which value added is measured, parents may be willing to pay more for an increase from middle to high rather than from low to middle score, e.g. a change from C to A may have more value than a change from D to B. In other words, a given score improvement by schools with a large disadvantaged intake may be seen as a lesser academic achievement than the same score improvement attained by schools with a smaller disadvantaged intake, because it starts from a low base. Thus, a low prior score achievement signalled by a large disadvantaged intake can result in negative valuation of the equality-inducing CVA component. More generally, a negative valuation of this CVA component can arise from it indicating limitations about the school's capacity to reach figures high up in the level score chart.

On the other hand externalities can cause the equality-inducing component of CVA to be positively valued. This is because households may consider schools with a large disadvantaged intake as offering a service to the community, insofar as they promote education among deprived children without sacrificing the school's overall academic performance. The positive externalities of equality-inducing school outcomes can improve the overall quality of life in the local community (e.g. less crime, better health, lower drug addiction, less ethic tension), through the social inclusion of those benefiting from equality-inducing education outcomes. A positive valuation of the equality-inducing CVA component can, therefore, arise when the positive effects of education externalities are large enough to more than offset the negative effects of low prior achievement and other deprivation characteristics.

It follows from the discussion above that the equality-inducing component of the CVA indicator can have a positive or negative net value to consumers, depending on which aspects of it dominate in the process of making house buying decisions that are motivated by preferences about school quality. In this paper we investigate this question using parametric and non-parametric hedonic analysis based on the score and equality-inducing components of the CVA indicator of school performance published by the Department for Children, Schools and Families in England. This indicator is thought to serve as a measure of school accountability to the Local Authority (LA) and as a guide to parents for choosing a school for the education of their children to (Allen and Burgess, 2011); but has also been characterised as incomplete (Dearden et al, 2011) and ambiguous (Leckie and Goldstein 2011). Our empirical investigation covers primary and secondary schools separately, because household behaviour vis-à-vis the questions asked in the paper can differ between these two levels of education.

The paper has the following structure. Section 2 describes the methodology followed in order to estimate the (marginal) contribution of various groups of variables entering a broadly defined CVA indicator of school quality. Section 3 describes the data and presents the estimates obtained from semi-parametric and parametric hedonic analysis. Section 4 concludes the paper.

2. Modelling the effect of CVA on house prices

In this section we first deliberate on the components of a CVA indicator with a view to modelling their effect on house prices in a way that facilitates the interpretation of empirical results; then, we focus on the CVA version used in the paper.

The equality-inducing (deprivation compensating) component of CVA indicator of school performance can be thought of as that part of the CVA above what is expected based on the mean score. It accounts for characteristics that are not conducive to learning and can include: (i) pupil/household-specific characteristics such as low ability/age, not indigenous ethnic background, low prior achievement, low parents' education/income/social class etc; and (ii) neighbourhood/environment-specific characteristics such as high poverty/unemployment/crime rates, poor hygiene/health amenities, extensive ethnic heterogeneity, increased noise/environmental pollution, etc. Denoting the first and second category of these characteristics by the vectors Z and

Y, respectively, the CVA can be defined as the expected score X achieved at given values of Z and Y, i.e. $V = E(X|Z,Y)$.

The question of interest here is how CVA reflects on households' perception of school quality and, thereby, on willingness to pay for this quality through purchasing - at higher price - a house in the school's catchment area. We examine this question in the context of hedonic analysis, writing the logarithmic price (thereafter price, for short) P of house $i = 1, \dots. S$, in the catchment area of school $s = 1, \dots S$, as

$$P_{si} = a + \beta V_s + \Sigma_m \varepsilon_m Y_{ms} + \Sigma_k \gamma_k Q_{ki} + u_{si}, \tag{1}$$

where $Y_{ms}\, all\, m = 1, \dots., M$ is the vector of neighbourhood deprivation variables; $Q_{ki}, all\, k = 1, \dots., K$ the vector of house-specific variables (size, type etc); $a, \beta, \gamma_k, all\, k = 1, \dots., K,$ and $\varepsilon_m, all\, m = 1, \dots., M$ are parameters; and u_{si} is a randomly distributed error. The parameters ε_m should be negative, given the negative externalities to the quality of life associated with living in a deprived neighbourhood; whereas the sign of the parameters γ_k would depend on how the house-specific variables are defined.

The effect of V_s on house prices needs to be further elaborated. As said in the introduction, the CVA indicator rewards schools for achieving a given academic outcome while promoting education among disadvantaged pupils. It does so by augmenting the school's mean score to account for disadvantaged intake. To keep matters simple we assume that the CVA indicator can be written as the mean score linearly modified to account for pupil- and neighbourhood-specific deprivation characteristics, i.e.

$$V_s = a + bX_s + \Sigma_m e_m Y_{ms} + \Sigma_j d_j Z_{js}, \tag{2}$$

where $Z_{js}, all\, j = 1, \dots, J$ is a vector of pupil-specific deprivation characteristics; and a, b, $d_j, all\, j = 1, \dots, J,$ and $e_m\, all\, m = 1, \dots, M$ are some unknown parameters. The parameter b in (2) should be positive because the CVA indicator awards higher marks to schools achieving a higher mean score under given pupil- and neighbourhood-specific deprivation characteristics. The same is also true for the parameters d_j and e_m, because the CVA awards higher marks to schools that achieve the same mean score under worse pupil- and neighbourhood-specific deprivation characteristics .

In principle, equations (1) and (2) above can be estimated jointly by 2-SLS (or by some other system estimation method), as the parameters of the house price equation (1) can be identified by zero restrictions on pupil-specific characteristics $Z_{js}, all\, j = 1, \dots, J$, not normally affecting house prices; and the parameters of the CVA equations by zero restrictions on house-specific characteristics $Q_{ki}, all\, k = 1, \dots, K$, not normally affecting school performance, when controlling for the characteristics of the neighbourhood. In the context of our investigation, however, this is not possible because, as is usually the case with composite school performance indicators, we do not know exactly how the effects of the mean score and the pupil- and neighbourhood-specific characteristics are incorporated in the calculation of the CVA. We circumvent this problem as follows.

Our data include the CVA index (V_s) and mean score (X_s) for each school. However, they do not include information about the components of V_s, which account for the pupil- and neighbourhood-specific deprivation characteristics Z_{js} and Y_{ms}, respectively. To sidestep this problem we combine the two sets of deprivation characteristics in a sub-index capturing the non-score component of the CVA. We define this sub-index as the equality-inducing (deprivation compensating) component of CVA; we denote it by $V_s^* = E(V_s|X_s)$ and estimate it as the residual obtained from the regression of V_s on X_s.[1] The house price equation is then expressed as

$$P_{si} = a + \mu X_s + \rho V_s^* + \Sigma_k \gamma_k Q_{ki} + \Sigma_m \varepsilon_m Y_{ms} + u_{si}, \qquad (3)$$

where the parameters μ and ρ capture the effects of the score and the equality-inducing component of CVA on house prices, respectively. Thus, μ should be significantly positive, a conjecture strongly supported by the empirical literature discussed in the introduction. The sign and significance of ρ, however, is not so clear for reasons discussed in the introduction and reiterated below.

In the first place, it is important to bear in mind that ρ captures the effect of the equality-inducing component of the CVA indicator on house prices at given score level, characteristics of the house and neighbourhood characteristics. In this context, and

[1] The fact that V_s^* is calculated as a residual implies that it may be contaminated by measurement errors. We shall return to this point in the discussion of the empirical results in sub-section 3.3.

assuming that parents are adequately informed, one would expect ρ to be insignificant, because parents are normally expected to be concerned with the academic (score) achievement of their own child rather than the size of the disadvantaged intake of the school. Thus, a negative ρ can be an indication that parents consider the promotion of education among disadvantaged pupils as handicapping the school's capacity to reach a score at the higher end of the academic performance charts. In contrast, a positive ρ, can indicate that parents see benefits from the promotion of education among deprived children in the form of positive spillovers (less crime, better health, etc) to the local community. Therefore, schools providing for the education needs of deprived children while achieving the same score as other schools, not so caring for the needy, rank higher in their valuations.

It follows from the discussion above that an insignificant ρ in empirical analysis is not necessarily an indication that parents have no concern about the disadvantaged intake of the school, as it can also be the result of this concern being more or less balanced by the expectation of beneficial spillovers generated by the promotion of education among deprived pupils.

3. Empirical analysis

In this section we apply econometric analysis to primary and secondary school data in England to estimate equations (1) to (3) and investigate the consumers' valuation of the academic score and equality-inducing components of the CVA indicator, along with other issues considered in the paper.

3.1 Data

The two main school quality indicators used in our empirical investigation, the score (X_s) and CVA (V_s), come from the primary and secondary education performance tables, published by the Department for Children, Schools and Families[2]. These tables include background information about schools in 2007.

[2] School performance tables include background information such as type of schools and the range and gender of pupils (website: www.dcsf.gov.uk/index.htm).

- For primary education the score indicates the proportion of pupils reaching Level 4 in the Key Stage 2 (KS2) standard assessment tests administered at age 11; in our sample this proportion averages to around 81%.
- For secondary education the score indicates the proportion of pupils aged 15 years who pass five or more General Certificate of Secondary Education (GCSE) subjects at grades A to C; in our sample this proportion is, on average, around 47%.

The CVA indicator is constructed by applying multilevel modelling methods to annual pupil-level data collected by the Pupil Level Annual Schools Census (PLASC) – see Appendix A for details. Effectively, the CVA indicator reflects the difference between the pupil's own 'output' point score and the median achieved by others with the same or similar 'starting' (or 'input') point score, after taking account the contextual factors (deprivation characteristics) collected by PLASC. In our sample the average CVA indicator is equal to 99.92 for primary schools and 1002.02 for secondary schools.

Data on deprivation indices and other neighbourhood characteristics come from the UK Office of National Statistics[3]. They span the period June-September 2008 and cover income, crime, environment, housing barriers, health, employment, and information about the density and non-domestic buildings in the school's catchment area.[4]

Finally, the individual house price data are collected for 2008 from the internet site "Up my Street", which advertises houses for sale in the UK.[5] In addition to prices, P_{si}, also collected from this site are the house-specific variables denoted by the vector $Q_{ki}, k = 1, \dots, K$ in equation (3), i.e. number of bedrooms, number of total rooms, type

[3] Website: www.neighbourhood.statistics.gov.uk/dissemination.

[4] As there is no straightforward mapping of residence and school attendance in the UK, houses are allocated to the catchment area of a particular school when, on average, are within a radius of 0.2 miles (range 0 to 1 miles). The empirical results are not sensitive to the house-to-school maximum distances (0.5 miles and 0.2 miles are used). This suggests that the catchment area may cover a fairly large radius around the school.

[5] The side, now acquired by Zoopla (http://www.zoopla.co.uk/), gives information about properties bought and sold in the whole of England.

of the house, postal code etc. The average house price in our sample is around 252.000 GBP and 272.000 GBP for primary and secondary school datasets, respectively.[6]

To obtain a better idea about how the CVA and its components behave, Table A2.2 in the Appendix reports the parameter estimates obtained from regressing them on the neighbourhood deprivation characteristics and dummy variables to capture the effect of regions. No intercept is included in the regressions so as to be able to interpret the parameters as conditional means. Some notable features coming out of this exercise include the significant association between the low score and high non-score components of CVA with particular neighbourhood deprivation characteristics, like crime and poor housing. As regards regional distribution, primary schools in London appear to have the highest CVA by virtue of their disadvantaged intake. At the secondary education level this appears to be the case for schools in North East and East Midlands.

3.2 Semi-parametric analysis

The CVA indicator is an arbitrarily normalised 'ordinal' measure of school performance, as are most published indicators of school performance. This often creates problems of comparison and interpretation in empirical analysis. To elude such problems investigators often (re)normalise school performance indicators to measure standard deviations from the mean. Here, we follow the same practice for the CVA indicator and use semi-parametric analysis to investigate non-linear and/or non-monotonic aspects of the relationship between this school performance indicator and house prices. The results obtained from this investigation guide the parametric analysis of the CVA effects on house prices in the next sub-section.

The semi-parametric estimator used is based on 'nearest neighbour' (Estes and Honore, 1995)[7] and is briefly described as follows.

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[6] It is important to note here that the postal address of households participating in official UK surveys is confidential. Thus, one cannot perform hedonic analysis associating house prices and local school performance with individual household characteristics available in these surveys.

[7] This semi-parametric estimator is less efficient than Robinson's (1988) estimator but has computational advantages and is easier to implement. To eliminate kernel estimates based on a small number of observations we drop 2% of the sample from each end of the distribution.

Write equation (1) as

$$P_{si} = a + f(V_s) + \Sigma_k \gamma_k Q_{ki} + \Sigma_m \varepsilon_m Y_{ms} + u_{si} \qquad (4)$$

where $f(V_s)$ is an unknown function, and all variables and notation are as defined in (1). Next we sort the data by V_s, and compute the differences $\Delta P_{si} = P_{si} - P_{si-1}$, $\Delta Q_{ki} = Q_{ki} - Q_{ki-1}$ all k; and $\Delta Y_{ms} = Y_{ms} - Y_{ms-1}$ all m, where '-1' in the subscript indicates the previous observation.[8]

We then estimate the regression

$$\Delta P_{si} = \Sigma_k \gamma_k \Delta Q_{ki} + \Sigma_m \varepsilon_k \Delta Y_{ms} + u_{si}, \qquad (5)$$

(the difference $\Delta f_x(V_s) \approx 0$ and is ignored) and use the parameter estimates to compute the part of P_{si} not explained by the right hand side variables,

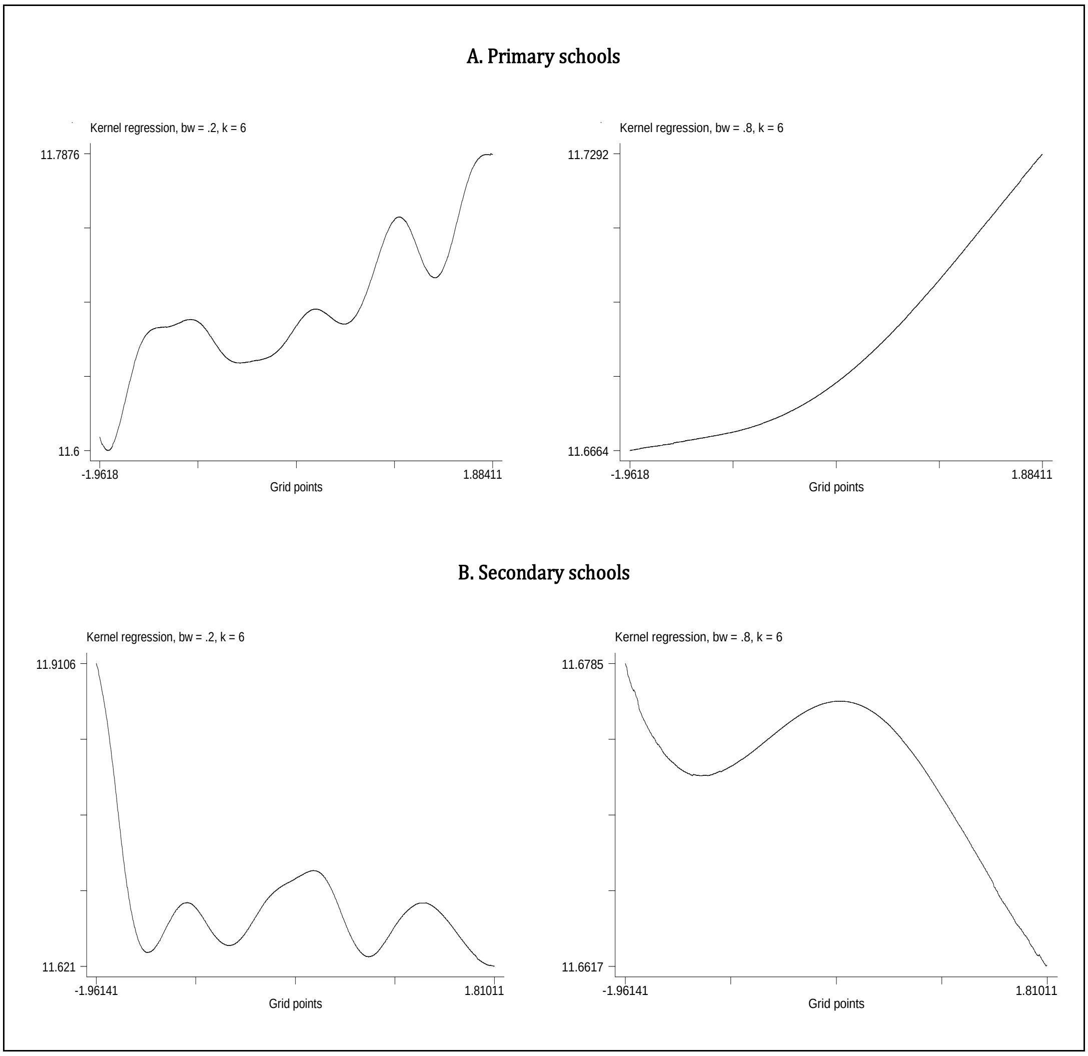
$$\hat{r}_{si} = P_{si} - \Sigma_k \hat{\gamma}_k \Delta Q_{ki} - \Sigma_m \hat{\varepsilon}_k \Delta Y_{ms}.$$

We have performed separate semi-parametric regression of $\hat{r}_{si}$ on CVA using two alternative bandwidths, 0.2 and 0.8: the smaller bandwidth highlights details in the data, whereas the bigger bandwidth helps towards specifying a parsimonious parametric model.

Figure 1 plots the weighted Gaussian kernel estimates of the relationship between house prices and CVA for primary (part A) and secondary (part B) schools. In the case of primary schools it is clear that this relationship is positive for both bandwidths employed. For secondary schools no (positive or negative) relationship appears to exist between house prices and the CVA indicator of school performance with the 0.2 bandwidth; whereas when the 0.8 bandwidth is used a cubic pattern arises, where the effect of CVA on house prices is negative, positive and negative for values of CVA below -0.83, between -0.83 and +0.73, and above +0.73 deviations from the mean, respectively.

[8] The semiparametric estimator relies on the continuity of the CVA index, V_s . This variable is continuous by construction and, upon using a standard Kernel density, is also found to be smooth across its full range for both primary and secondary school data.

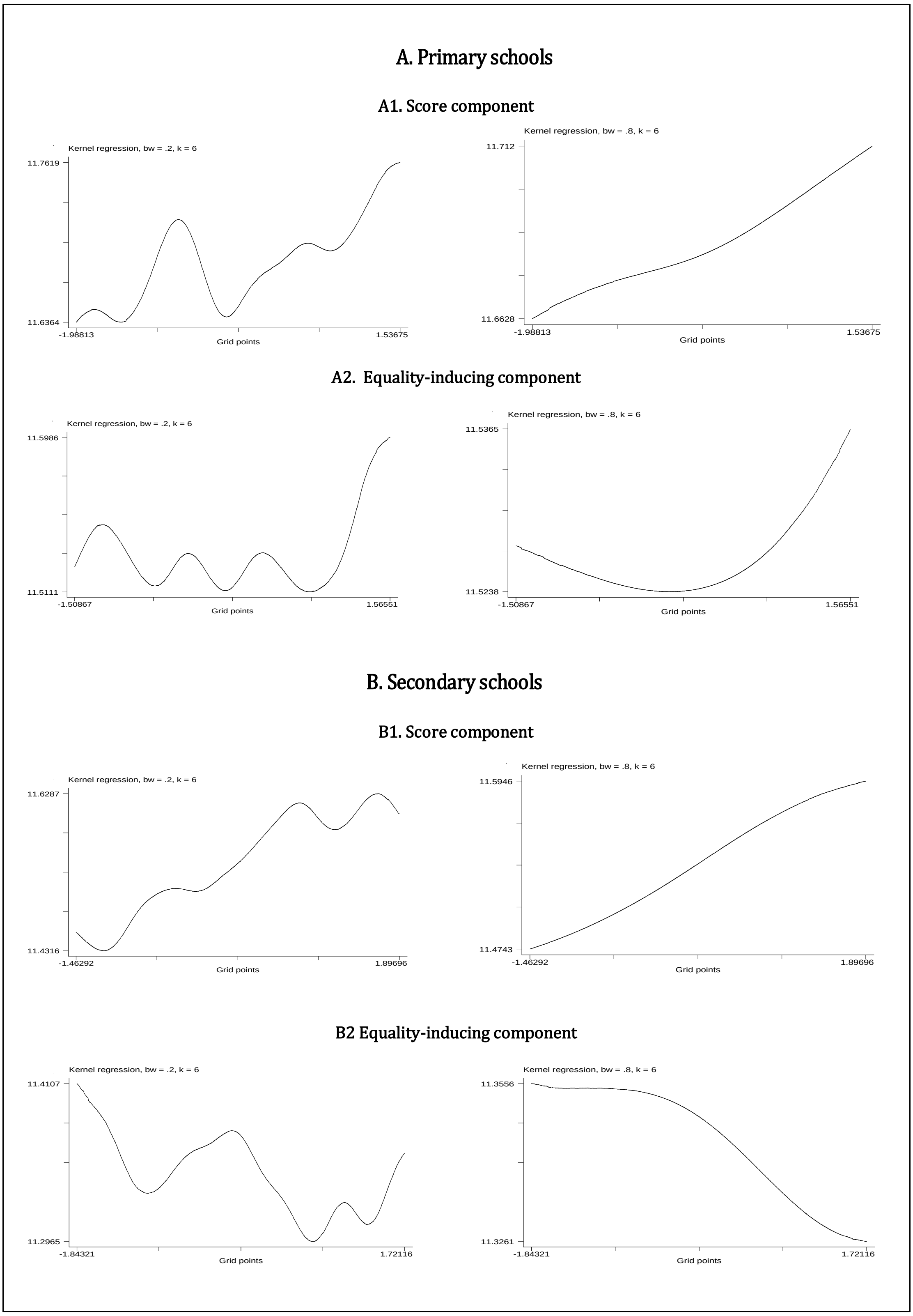
Fig. 1: Kernel estimates for CVA



The implications of our semi-parametric findings for parametric modelling and estimation of the effect of CVA on house prices are discussed in the next sub-section. The rest of this sub-section focuses on investigating how the mean score and equality-inducing components of CVA are responsible for shaping the lines plotted in Figure 1. For this we perform semi-parametric regression of P_{si} on X_s and V_s^*, using the same nearest neighbour estimator described above.[9] The Gaussian kernel weighted estimates obtained from these regressions (again, using two bandwidths, 0.2 and 0.8) are plotted in Figure 2.

[9] As V_s^* is the residuals from regressing CVA on its score component. Given the orthogonality of X_s and V_s^* one can investigate the semi-parametric relationship between $\hat{r}_{si}$ and each of these variables separately.

Fig. 2: Kernel estimates of the score and equality-inducing CVA component effects on house prices



Part A1 of Figure 2 reports the effect of score and Part A2 the effect of the equality-inducing component of CVA on house prices, which are obtained from the analysis of primary school data. The plots show that the effect of the score component is positive, although at the 0.2 bandwidth this relationship is interrupted for middle values of this component. The relationship between the equality-inducing component of CVA and house prices does not appear to have a clear pattern except for large values of this component, where it becomes positive. Put together, these results suggest that the positive relationship between the CVA indicator of school performance and house prices shown for primary schools in Figure 1 (Part A) is dominated by the score component of this indicator.

The results obtained from the semi-parametric analysis of secondary school data also show a clearly positive relationship between house prices and the score component of CVA (Figure 2, Part B1). In contrast, the relationship between the equality-inducing component and house prices (Figure 2, Part B2) appears to be negative, albeit not robustly so. The fact that for secondary school data the score and equality-inducing components of CVA affect house prices in opposite direction is probably behind the finding that the CVA effect on house prices is insignificant (Figure 1, Part B).

3.3 Parametric Analysis

The effect of CVA on house prices is estimated using the hedonic regression

$$P_{si} = a + \sum_{\ell} \beta_{\ell} (V_s D_{\ell}) + \Sigma_k \gamma_k Q_{ki} + \Sigma_m \varepsilon_m Y_{ms} + u_{si}, \qquad (1')$$

where D_{ℓ} for l= ℓ …L are dummy variables capturing the non-linearity and non-monotonicity CVA effects on house prices, which are indicated by the semi-parametric analysis of the previous sub-section.

In the analysis of primary school data we include in (1') two dummy variables: D1=1 if CVA<−1.75 and D1=0 otherwise; and D2=1 if D1=0 and D2=0 otherwise. This allows for the effect of CVA on house prices to differ between values below and above the threshold suggested by the semi-parametric results of primary school data reported in Figure 1 (Part A). In the analysis of secondary school data three dummy variables are included in (1'): D1=1 if CVA<−0.83 and D1=0 otherwise; D2=1 if

−0.83<CVA≤+0.73 and D2=0 otherwise; and D3=1 if CVA>+0.73 and D3=0. Again, the idea here is to investigate whether the effect of CVA on house prices is negative, positive and negative for values of CVA below −0.83, between −0.83 and +0.73, and above +0.73 deviations from the mean, respectively, a possibility arising from the semi-parametric analysis in the previous section (Figure 1, Part B).[10]

The effects of the score and equality-inducing components of CVA on house prices are estimated from the hedonic regression

$$P_{si} = a + \mu X_s + \sum_{\ell} \rho_{\ell} \, (V_s^* D_{\ell}) + \Sigma_k \gamma_k Q_{ki} + \Sigma_m \varepsilon_m Y_{ms} + u_{si}. \qquad (3')$$

As in (1′) dummy variables are included in (3′) to incorporate findings of the semi-parametric analysis, i.e. in the analysis primary school data a dummy variable is included to allow the effect of V_s^* on house prices to differ for values of CVA below and above −1.75 deviations from the mean; and, likewise, for values of CVA below −0.83, between −0.83 and +0.73, and above +0.73 deviations from the mean in the analysis secondary school data.

In all estimations the intercept of the equation, a, is allowed to vary in order to capture differences in the mean house price across Regions and Local Authorities. Furthermore, following preliminary analysis, the parameters corresponding to the effects of the CVA and its score and equality-inducing components on house prices are also allowed to differ between London and other regions in England. This is a natural extension of the model, given the importance of London not only because of its strategic role in shaping education policy decisions in England, but also because of differences in the level and distribution of some pupil- and neighbourhood-specific characteristics compared to other regions; and the fact that for parents living in the densely populated communities of London deprivation characteristics (crime, drug addiction, ethnic heterogeneity etc) are likely to be a greater cause of concern than that for parents living in other not so densely populated English regions.

[10] As an additional test for the change in the effect of CVA (and its components) on house prices we use a trend-break specification model. Ignoring other characteristics, this specification reduces (1′) to $\mathrm{P_{si}} = \mathrm{a} + \mathrm{b_1}(\mathrm{V_s^*}) + \mathrm{b_2 D_2}\big(\mathrm{V_s^*} - (-1.75)\big) + \mathrm{u_{si}}$, where D2=1 if CVA≥−1.75. The results obtained suggest significant breaks at similar values of $\mathrm{P_{si}}$ as the semi-parametric approach.

The complete results obtained from the estimation of (1') and (3') are reported in a separate Appendix B (Tables B1 to B5) available from the authors on request. Here, Table 1 reports only parameters of interest: (i) those showing the aggregate effect of the CVA indicator on house prices; and (ii) those showing the effect of the score and equality-inducing components of this indicator. These parameters are estimated separately for primary and secondary schools; and, as said in the previous paragraph, they are allowed to differ between London and other regions.

In the column under the heading 'Model I' we report the parameter estimates of (1'), where the effect of CVA on house prices is allowed to differ for values above and below the thresholds indicated by semi-parametric analysis. For primary schools the effect of CVA on house prices is positive and significant only for values above −1.75 standard deviations from the mean. For secondary schools, this effect is generally negative, but significant only for values above +0.73 standard deviations from the mean.

In the column under the heading 'Model II' we report the parameter estimates obtained from (3'), where the effects of score and equality-inducing components of CVA on house prices are estimated separately. The results demonstrate the positive and very significant effect of the score component on house prices for both primary and secondary schools. In contrast, the effect of the equality-inducing component is negative, but significant only for secondary education and for CVA values above -0.82 standard deviations from the mean.

The parameters reported in the columns under the headings 'Model III' and 'Model IV' in Table 1 are those obtained from the estimation of (1') and (3') when the parameters capturing the varying effect of CVA and its components on house prices are dropped out of the regression, i.e. setting $\beta_\ell = \beta$ and $\rho_\ell = \rho$ for all $\ell = 1 \ldots L$. We find that an F-test on this hypothesis cannot be rejected in the case of both primary and secondary school data. [11] This is not surprising given that in each case where dummies are used in the hedonic regression to allow the CVA effect on house prices to vary, only one of the dummies used is statistically significant.

[11] The F-values are: 0.66 for $\beta_1 = \beta_2 = \beta$ in primary and 0.31 for $\beta_1 = \beta_2 = \beta_3 = \beta$ in secondary education; and 0.11 for $\rho_1 = \rho_2 = \rho$ in primary and .50 for $\rho_1 = \rho_2 = \rho$ in secondary education.

Table 1: The effect of CVA and its components on house prices
(Robust standard errors in brackets)

A. Primary schools

Variable	Para-meter	Model I	Model II	Model III	Model IV	Model IV (2SLS)
CVA	β			0.014		
				(0.009)		
CVA*London				0.040*		
				(0.024)		
CVA<−1.75	β_1	0.068				
		(0.060)				
CVA≥−1.75	β_2	0.019**				
		(0.009)				
Score component	μ		0.034***		0.028**	0.064**
			(0.008)		(0.010)	(0.034)
Score component*London					0.022	-0.012
					(0.018)	(0.035)
Equality-inducing component	ρ				-0.193	-0.018
					(0.012)	(0.012)
Equality-inducing component*London					0.071***	0.066***
					(0.025)	(0.025)
Equality-inducing component×(V* <−0.93)	ρ_1		-0.024			
			(0.018)			
Equality-inducing component×(V*≥−0.93)	ρ_2		0.008			
			(0.013)			
R-squared		0.851	0.852	0.851	0.852	0.849
No. of observations		1385	1385	1385	1385	1385

B. Secondary schools

Variable	Para-meter	Model I	Model II	Model III	Model IV	Model IV(2SLS)
CVA	β			-0.023**		
				(0.010)		
CVA*London				-0.017		
				(0.025)		
CVA<-0.83	β_1	-0.016				
		(0.017)				
-0.83≤CVA<0.73	β_2	-0.026				
		(0.021)				
CVA≥0.73	β_3	-0.035**				
		(0.015)				
Score component	μ		0.038***		0.044***	0.081***
			(0.010)		(0.011)	(0.030)
Score component*London					-0.017	-0.051
					(0.022)	(0.034)
Equality-inducing component	ρ				-0.038***	-0.039***
					(0.010)	(0.012)
Equality-inducing component*London					-0.026	-0.026
					(0.028)	(0.027)
Equality-inducing component×(V*<-0.82)	$\rho 1$		-0.031***			
			(0.020)			
Equality-inducing component ×(V*≥-0.82)	$\rho 2$		-0.048***			
			(0.012)			
R-squared		0.837	0.84	0.837	0.84	0.838
Number of observations		1209	1209	1209	1209	1209

The parameter estimates obtained from Model III suggest that for primary schools the overall CVA effect on house prices is positive but significant only in London; whereas for secondary schools the same effect is negative and significant in all regions (i.e. the London dummy here is insignificant). When the CVA effect on house prices is estimated separately for its score and equality-inducing component (Model IV), the results show more clearly how these two CVA components are valued by households. At both primary and secondary school level the score appears to have a positive and strongly significant effect on house prices, indicating a clear and strong willingness of parents to pay for their child's admission to primary and secondary schools with high academic performance. The same clarity, however, does not characterise the role played by the equality-inducing CVA component. In the case of primary schools, this component has a significantly positive effect only in London. In contrast, for secondary schools its effect is strongly negative in all English regions.

'Model IV' is also estimated by 2SLS (last column of Table 1) in order to get round the problem of potential endogeneity and measurement error due to the school performance being related to house prices through factors other than school quality (Gibbons and Machin, 2003). Furthermore, correction for measurement error is critical in the context of our analysis because the equality-inducing component of the CVA indicator, V_S^*, is computed as a residual using the procedure described in section 2.

We instrument school quality indicators with variables that are available in the school performance tables; more specifically, the school type, the admissions age-range and the student gender (available only for secondary schools). The 2-SLS results suggest that the effect of the score component of CVA on house prices is higher than that obtained from OLS estimation. This is the case for both primary and secondary schools and is consistent with the results reported by Gibbons and Machin (2003), suggesting that measurement errors may be a more serious source of estimation bias than unaccounted endogeneity.[12] In contrast, the effect of the equality-inducing component on house prices obtained from 2-SLS is similar to that obtained from OLS.

[12] One can be sceptical about the validity of the exclusion restrictions because variables such as school type and gender mix can be correlated with unobservable local area amenities and can, therefore, influence house prices through a separate channel. Furthermore, the IV estimates can be associated with a

Overall, our empirical parametric and non-parametric analysis suggests that in the case of primary schools the CVA indicator has a marginally significantly positive effect on house prices only in London. The corresponding effect in the case of secondary schools is negative in all regions. However, when the overall effect of the CVA is separated into its score and equality-inducing components, it becomes evident that this effect is obscured by geographical and CVA component disparities. The score's effect is positive for all schools in all regions; whereas, the equality-inducing component is positive only for primary schools in London, and negative for secondary schools in all regions. Thus, the CVA effect on house prices in the case of primary schools is dominated by the London equality-inducing component effect; and in the case of secondary schools by the fact that the negative equality-inducing effect counteracts the positive score effect.

4. Discussion and Conclusions

In recent years there is growing concern in the literature about education inequality and many countries, including the UK, are actively searching for policies to encourage redistribution of education resources in favour of disadvantaged pupils. At the moment, school funding in England is allocated overwhelmingly on the basis of pupil numbers. Thus, by raising their CVA performance schools can increase their funding through improving their ranking in league tables and, thereby, attracting more applications from parents of school-age children. For this to happen, however, the value attached to the CVA by prospective applicants must be positive.

The willingness of households' to pay in order to purchase a house in the catchment area of state schools demonstrating high academic performance is well documented in the literature. Equally well documented is the households' willingness to pay in order to avoid schools with pupil- and neighbourhood-specific deprivation characteristics. To our knowledge a question not considered so far in the literature is the value which

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Local Average Treatment Effect (LATE), i.e. reflect on observations in the sample to which the instrument is relevant - for instance, changes in CVA can be specific to school type. Nevertheless, the validity of the instruments is supported by high F-statistics (Table B1.1 in Appendix B) and the fact that over-identification tests, based on the R-square, obtained from regressing the predicted errors from the 2-SLS estimation on all exogenous variables, suggest that all models are just identified.

households attach to equality-inducing (deprivation compensating) outcomes, at a given the level of academic performance. This paper argues that finding an answer to this question requires thoughtful investigation, because a given score performance can assume a different valuation depending on the initial score it is measured from. Furthermore, a high equality-inducing school performance can be a blessing to parents appreciating the positive externalities to the local community which can be generated from promoting the education of deprived pupils; and a curse to parents seeing the attention paid to the education of deprived pupils as a burden undermining the ability of the school to climb high not just in the score change but also the score level chart.

The equality-inducing school performance is defined as the difference in the disadvantaged intake between two schools with the same academic performance; and measured by the additional marks awarded by the CVA indicator to a school with the same score but a higher disadvantaged intake. In the context of hedonic analysis we examine whether the extra CVA points which a school gains by virtue of its disadvantaged intake can generate extra value that households are willing to pay for in the form of a house price premium. In principle, equality-inducing attainments should have no (positive or negative) value to parents seeking academic performance for their child as long as they do not affect the school's score performance. Thus, as said above, the valuation of equality-inducing attainments can be positive by households perceiving education equality as a service to the community and negative by households perceiving them as handicapping the school's ability to reach high in the score level charts.

The empirical analysis in this paper applies non-parametric and parametric hedonic analysis to data drawn from the primary and secondary education performance tables of the Department for Children, Schools and Families in England, the UK Office of National Statistics and other sources. The econometric investigation covers both primary and secondary schools, because household behaviour as regards schooling decisions can differ between these two levels of education. It also allows the parameter estimates for London to differ from those of other English regions. Our findings suggest that – other things being equal - the score component of the CVA indicator of school performance has a significant effect on house prices at both levels of education in all regions. The corresponding effect of the equality-inducing component of the CVA, however, appears to be less uniform: for primary schools it is positive in London and zero elsewhere, and for secondary schools negative in all regions.

Interpreting the above results in line with the arguments put forward in the paper it appears that parents are willing to pay for admission of their child to a school, primary or secondary, with the capacity to deliver the highest improvement in score. As regards the equality-inducing component of the CVA, however, parents' behaviour differs according to whether they live in London or elsewhere in England; or their child is in primary or secondary education. At given score performance parents in London are willing to pay more for their child's admission to a primary school with a higher disadvantaged intake; whereas, parents of primary school-age children outside London do not attach positive or negative value to such an intake. Parents of secondary school-age children in all English regions go a step beyond: at given score performance they are willing to pay in order to avoid schools with a high disadvantaged intake.

Unfortunately, we do not have the data to go deeper in the analysis and uncover the role each deprivation characteristic built into the CVA plays in shaping the above results. Nevertheless, our analysis based on the overall impact of the equality-inducing component of the CVA on house prices points to some firm conclusions. Perhaps, the most interesting obe is that everywhere in England parents' willingness to pay for a given score performance at secondary education decreases with the disadvantaged intake of the school. We interpret this to be an expression of concern with the low level of prior achievement associated with a large disadvantaged intake. The low base from which a given progress is achieved inevitably places upper bounds to the score level which the school can reach.

Another firm conclusion emerging from our analysis is that parents of primary school-age children in London behave in exactly the opposite way to parents of secondary school-age children in all English regions: they are willing to pay more for a given score progress achieved by schools with a larger disadvantaged intake. Again, interpreting this result in the light of our analysis, one would say that it reflects the fact that prior score differences are not likely to be particularly important at the primary school level. At primary education level parents are, perhaps, interested only in the academic achievement that their own child can gain from the school. The extent to which the school can also achieve equality-inducing outcomes is not of concern to them, unless these outcomes can affect their welfare through the externalities which they generate, as discussed above. The latter seems to be the case only in London, possibly because parents are more likely to feel the negative spillovers of deprivation in London than other regions, due to the fact that they live in more densely populated neighbourhoods. This makes them appreciate the service to the local community accomplished by the schools which promote the education inclusion of deprived pupils without compromising the academic potential of other pupils.

As regards the link between school performance and funding, our results suggest that under the present system, where funding is mainly based on headcount, a high disadvantaged intake can help schools raise their ranking in the CVA league tables but not also their share in school funding, except for primary schools in London. In fact, secondary schools achieving a higher ranking in league tables by virtue of their higher disadvantaged intake may see this translated into a smaller number of applications from parents of secondary school-age children.

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Appendix

A1. Data sources

Our data come from three sources: (i) the house price and characteristics data have been drawn from the electronic site "Up my Street"; (ii) the school quality data come from the primary and secondary school performance tables, available from the Department for Children, Schools and Families; and (iii) the deprivations indices and other neighbourhood characteristics from the Office of National Statistics. The data collection process from the three different sources was as follows: England is divided in nine regions consisting of one hundred and fifty Local Authorities (LAs). Fifty LAs were chosen, one third from each region, half with a higher and the other half with a lower mean grade than the England average.[13] From each of these LAs six schools were randomly selected, three with a higher and three with a lower grade mean than the LA average. This process was accomplished separately for primary and secondary schools.

Using the school postcode we were able to locate the six houses closest to the school that were up for sale using information from the 'Up my Street' website. We collected information on the selling price of houses, house characteristics and distance from school. The average distance from the local primary or secondary school was around 0.20 miles and in no case more than one mile.

The site of Neighbourhood Statistics provides detailed data within specific geographic areas, including deprivation indices of income, crime, environment, housing barriers, health, employment and other neighbourhood characteristics like population density. To capture neighbourhood characteristics, we used the "lower layer super output area[14]" for each specific postcode and collected the following indicators:

- Income: the proportion of the population living in low income families.
- Employment: involuntary exclusion from work of working age population.
- Health and Disability: rate of premature death, poor health and disability.
- Barriers to Housing and Services: barriers to GP premises, supermarkets, primary schools and post offices, divided into 'geographical barriers' and 'wider barriers'.
- Living Environment: 'Indoors' measuring the quality of housing and 'outdoors' measuring the air quality and road traffic accidents.
- Crime: the rate of recorded crime (burglary, theft, criminal damage and violence).
- Density: the number of persons per hectare (at the time of the 2001 Census).

A2. Value Added and Contextual Value Added

Value added (VA) is a measure of the progress pupils make between different stages of education. The VA score for each pupil, as defined by the Department of Education, Children and Families of the UK, is the difference (positive or negative) between their own 'output' point score and the median - or middle - output point score achieved by others with the same or similar starting point, or 'input' point score. Thus, an individual pupil's progress is compared with the progress made by other pupils with the same or similar prior attainment. In order to calculate this measure the Department used a median line approach.

Contextual Value Added (CVA) has been introduced to account for pupil, family and socioeconomic characteristics affecting academic progress. The technique used to derive a CVA score is called multi-level modelling (MLM) performed in four stages: (1) obtain a prediction of attainment based on the pupil's prior attainment; (2) adjust this to account for pupil characteristics; (3) for key stage 2-4 adjust further to account for school level prior attainment; and (4) calculate the CVA by measuring the difference (positive or negative) between the pupils actual attainment and that predicted by the CVA model.

The data for the calculation of CVA are drawn from the Pupil Level Annual School Census (PLASC), a national dataset for some 600,000 pupils in England.[15] The PLASC was introduced in 2002 with the aim of collecting contextual data on all pupils annually (i.e. not just at the end of each key stage). The main

[13] For regions containing a number of LAs that could not be divided by three, the number of LAs finally chosen was rounded up or down to the nearest one third of the total number of LAs.

[14] Roughly one LA is divided into 100-150 Lower Layer Super Output Areas (LLSOA), with around 1,500 residents each. Also, on average, there are 2, 5 persons per household. Hence, a lower layer area has about 600 households

[15] Some external factors which are commonly thought to impact on pupil's performance (e.g. parental education status/occupation) are not included in the calculation of CVA because no reliable national data are available.

variables in the PLASC data used in the calculation of CVA are gender, special educational needs, ethnicity, eligibility for free schools meals, language, date of entry/mobility, age, being in care and the income deprivation affecting children index.

The CVA measure for primary schools is normalised to 100, whereas for secondary schools to 1000: scores above (below) these norms represent schools where pupils made more (less) progress than similar pupils nationally. Table A2.1 shows the distribution of the CVA score indicator for primary and secondary schools respectively; and Table A2.2 the coefficients obtained from regressing the mean CVA and its score and non-score components on the neighbourhood deprivation characteristics and regions.

Table A2.1 The distribution of the CVA score indicator

Primary schools	Secondary schools	Percentiles nationally
101.5 and above	1041.11 and above	Top 5%
100.6 to 101.4	1013.41 to 1041.10	Next 20%
100.2 to 100.5	1006.11 to 1013.40	Next 15%
99.8 to 100.1	997.61 to 1006.10	Middle 20%
99.4 to 99.7	990.66 to 997.60	Next 15%
98.5 to 99.3	971.54 to 990.65	Next 20%
98.4 and above	971.53 and below	Bottom 5%

Table A2.2: CVA, deprivation characteristics and regions

	Primary Schools			Secondary Schools		
	CVA	Score	Non-score	CVA	Score	Non-score
Neighbourhood characteristics						
Income deprivation	-0.156***	-0.322***	0.018	0.017	0.056***	0.003
	(0.056)	(0.057)	(0.046)	(0.022)	(0.021)	(0.021)
Housing deprivation	0.078***	0.020	0.068***	0.080***	-0.062**	0.095***
	(0.028)	(0.029)	(0.023)	(0.029)	(0.028)	(0.028)
Crime deprivation	0.090***	-0.093***	0.140***	-0.026	-0.069**	-0.009
	(0.027)	(0.028)	(0.022)	(0.031)	(0.030)	(0.030)
Environment deprivation	-0.000	-0.015	0.008	0.011	0.009	0.009
	(0.035)	(0.036)	(0.029)	(0.035)	(0.033)	(0.033)
Health deprivation	-0.131**	-0.322***	0.044	-0.002	-0.368***	0.088
	(0.059)	(0.060)	(0.049)	(0.059)	(0.056)	(0.056)
Employment deprivation	0.178***	0.246***	0.045	0.032	-0.007	0.034
	(0.063)	(0.064)	(0.052)	(0.049)	(0.046)	(0.046)
Densitiy	0.112***	0.099***	0.058**	0.008	-0.007	0.010
	(0.029)	(0.029)	(0.024)	(0.029)	(0.028)	(0.028)
Regions						
East Midlands	-0.520***	-0.297***	-0.359***	0.330***	0.069	0.313***
	(0.102)	(0.104)	(0.084)	(0.107)	(0.102)	(0.102)
East England	-0.143*	-0.244***	-0.010	-0.034	-0.104	-0.009
	(0.084)	(0.086)	(0.069)	(0.099)	(0.094)	(0.094)
London	0.258***	0.102*	0.203***	-0.051	0.102*	-0.076
	(0.055)	(0.056)	(0.046)	(0.059)	(0.056)	(0.056)
North East	0.182*	0.259***	0.042	0.387***	-0.134	0.420***
	(0.094)	(0.096)	(0.078)	(0.094)	(0.089)	(0.089)
North West	0.038	0.279***	-0.113**	0.137**	-0.011	0.139**
	(0.065)	(0.067)	(0.054)	(0.067)	(0.064)	(0.064)
South East	-0.119*	0.056	-0.149***	-0.214***	-0.425***	-0.111
	(0.067)	(0.069)	(0.056)	(0.071)	(0.068)	(0.068)
South West	-0.109*	-0.302***	0.055	-0.095	-0.314***	-0.018
	(0.065)	(0.066)	(0.054)	(0.066)	(0.063)	(0.063)
West Midlands	0.181**	0.137*	0.107*	-0.341***	0.014	-0.344***
	(0.075)	(0.077)	(0.062)	(0.087)	(0.083)	(0.083)
Yorkshire	-0.007	0.216***	-0.124**	0.028	-0.159**	0.067
	(0.076)	(0.078)	(0.063)	(0.072)	(0.069)	(0.069)
Observations	1,385	1,385	1,385	1,209	1,209	1,209
R-squared	0.116	0.207	0.218	0.065	0.235	0.097