Master Thesis

Economics and Business: Policy Economics

Can charter schools improve student achievement? A meta-regression analysis on the literature

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Abstract

The paper looks at the existing literature that estimates the impact of charter schools on student achievement in the United States. A meta-regression analysis is performed, which focuses on papers that employ one of three experimental designs. An overall effect size is calculated for charter school intervention, as well as an effect size at each grade level. It is evident in literature and the estimates found in this meta-analysis, that a significant amount of heterogeneity exists, much of which is true heterogeneity. To explore the heterogeneity, this paper conducts a series of meta-regressions to disentangle study level factors that may contribute to the heterogeneity. The evidence suggests that charter schools can improve educational outcomes. This is more likely for children enrolled in urban charter schools, or in states where charter schools receive a greater level of accountability and autonomy. The impact is most profound in schools that follow the ‘No Excuses’ curriculum, and it is in such schools where the student achievement gap can indeed be reduced.

Table of Contents

1. Introduction

The 2002 'No Child Left Behind' law was the first time the 'achievement gap' was ratified into United States (U.S) law (Whitman, 2008). 21 years and a significant increase in government spending later, the 'achievement gap' between whites and ethnic minorities has not improved (Hanushek et. al, 2019), as traditional public schools struggle to deal with the challenge of equalising opportunity in education. During this time, autonomous-government schools, referred to as charter schools, have provided the biggest innovation to public education in the U.S. Publicly funded but privately run, charter schools have greater autonomy over the hiring of staff, curriculum, budgeting, length of school day and year, amongst other pedagogical factors. In return for greater autonomy, charter schools are subject to greater accountability, as respective state law ensures charter schools meet certain standards in order to renew their license. Since their inception in 1991, charter schools have grown in popularity, now accounting for 7.5% of the total public school student population (National Alliance for Public Charter Schools, 2023), as a growing number of parents look to utilise choice over their child's education. Autonomous-government schools have gained traction over the world, charter-like models have been adopted in the United Kingdom (UK), New Zealand, Sweden, Brazil and South Korea. As charter schools share of the public-school market has grown, so too has the level of interest in the efficacy of their practices. Arguments for school choice and competition date back to Milton Friedman and the 'free-to-choose' network (Friedman, 1955), whilst more recent arguments suggest that greater autonomy and accountability push charter schools to be innovative (Abdulkadiroğlu, et al., 2011). However, critics of charters charge them with "cream skimming" (Rothstein, 2004) and claim that successful charters teach children how to pass exams, not how to think (Horn and Wilburn, 2013).

To estimate the effects of charter schools, a growing body of literature looks at the standard deviation (hereafter, σ) change in Math and ELA results. Overall, the literature finds that charter schools perform similarly to traditional public schools. Yet, strands of the literature find a significant positive impact of charter schools, whilst others find significant negative outcomes. Charter schools appear to be more effective at elementary grade and to improve over time (Baude et al. 2014). There is a strong disparity between the achievements of urban and non-urban charter schools, referred to as the "urban charter advantage" (Angrist et al., 2013). Furthermore, certain curricula appear to be more effective at improving results, such as the “No Excuses” model (Angrist et al. 2013; Dobbie and Fryer, 2013). Whilst charter school effectiveness also appears to differ at state level (Gleason et al, 2010).

This paper set out to address the heterogeneity in the literature via a meta-analysis, with the aim to provide an overall effect size for charter school ELA and Math results. The paper then adds to the literature by conducting a meta-regression to disentangle the study-level factors that contribute to heterogeneity. The benefit of conducting a meta-analysis is to provide external validity to the internal validity of individual studies (Hopewell et. al, 2010). This is particularly pertinent in the charter school literature, given that many studies focus on a specific charter school, charter school network or city. The meta-analysis in this paper will include three research methods, two of which are deemed most likely to estimate the causal effect of charter school on student achievement (Charter School Achievement Consensus Panel, 2006). The first approach utilises over-subscribed lottery systems for charter schools, where lottery winners act as the treatment group and the lottery-losers as the control group. The second group of literature is a variety of value-add models that adopt propensity score matching to generate baseline equivalence between charter school and traditional public-school peers. The third method is a deferred acceptance (DA) matching system, pioneered by Abdulkadiroğlu, et al. (2017), which uses a centralised school enrolment system that places students in either charter or other types of public schools. Two papers using this method are included in the meta-analysis (Abdulkadiroğlu, et al., 2017; Winters and Shanks, 2020) The meta-regression aims to illuminate the study level factors that contribute to the heterogeneity in the literature, with the hope to shed some light on the factors behind good charter schools.

The paper takes the following structure. Section 2 looks at the mechanisms that may or may not contribute to charter school success, Section 3 lays out various critiques of charter schools, Section 4 outlines the methodology for the meta-analysis, Section 5 provides the results from the meta-analysis, Section 6 includes the methodology and results of the meta-regression, section 7 performs robustness checks, Section 8 concludes the paper.

2. How Charter Schools could impact school quality

2.1 *Choice and competition*

The conceptual framework for the role of choice and competition in public schools was first laid out by Friedman (1955). Since then, school choice, charter schools and the market dynamics that interlink them have been explored further. School choice elicits both demand and supply side factors. First, parents and students can exercise choice by selecting themselves into high quality schools, whilst schools and principals can react by improving the product their school provides. Furthermore, the freedom of governance and strategy provided to charter schools, allows for greater product differentiation, as charter schools do not serve a homogenous consumer group (Gulosino and Leibert, 2020). Charter schools tailor their product to different market segments. As Altenhofen et. al (2016) finds, the socio-economic status of parents determines the type of education demanded. Low-income parents in urban areas have a stronger preference for charters that focus on educational achievement (Hastings and Weinstein, 2008), whilst parents in suburban or rural areas lean to more alternative methods of education, such as a focus on arts or dual language programmes (Langhorne, 2018). There is evidence to suggest that charter schools increase the likelihood for parents to exercise choice and increase demand-side forces in the public-school sector. Hanushek et. al (2007) finds that parents respond more elastically to school quality when their child is enrolled in a charter school, although this effect is less profound in low-income households. However, Hasting and Weinstein (2007) find low-income parents will exercise choice when good information is available. Abdulkadiroğlu et. al, (2013) finds that principals factor school choice into their decision making when school quality is improved elsewhere.

A study conducted in North Carolina found that the introduction of charter schools leads to an improvement in student achievement (Holmes et al., 2003). A recent study by Milgraine Campos and Kearns (2023), found that school competition increases test scores Los Angeles. On the other hand, studies conducted by Han and Keefe (2020) and Carr and Ritter (2007) found a drop in test results for traditional public schools due to an introduction of charter schools. Overall, the literature on the effects of school competition on student achievement find modest improvements.

2.2 Management

Charter schools are subject to different institutional structures, regulation and networks than traditional public schools. The level of autonomy is determined by state law, which allows for greater responsibility in the way charter schools are managed. Charter school management and networks, whether non-profit or profit, have greater autonomy over budgeting, hiring of staff and general instruction set by management (Cohodes and Parham, 2021). With greater autonomy comes greater variability in the way schools are managed, leading to a range of efficaciousness in charter school management.

Nisar (2012) finds that charter schools that have greater autonomy on budgeting and hiring decisions lead to better outcomes in student achievement. Furthermore, using panel data in a cross-country study, and developing a management ranking system, using 1 for poor management and 5 for good management, Bloom et. al (2014) finds that more effective management translates to better student outcomes. The study finds significant variation in the level of management within-country, and finds that autonomous government schools, such as Charter Schools in the US or Academy Schools in the UK, have significantly better management scores than their traditional school peers (Bloom et al., 2014). Bloom et. al (2014) finds that the management scores of autonomous government schools are 0.233σ higher than traditional public schools and that a σ improvement in management leads to a 0.425σ improvement in test outcomes. This phenomenon is found in the US, the UK, Sweden and Brazil (Bloom et. al, 2014). The paper attributes much of the improvement to 'principal strategy' and 'principal accountability', both of which will be explored in the following subsections. These findings are in-line with research on the charter school network in the United States, CREDO (2017) finds that charter school networks that operate more than one school and that are non-profit, boost student achievement more effectively.

2.3. Accountability

Charter schools are required to renew their 'charter' on a periodical basis. Many charter schools close due to poor performance (Carlson and Lavertu, 2016; Bross and Harris, 2018), as they are held accountable to the educational standards and requirements set forth in the original charter agreement. Empirical evidence suggests that greater accountability can have a positive impact on student results. Rockoff and Turner (2010) use the introduction of an accountability system in New York City public schools to assess the impact of accountability on student outcomes. The authors find that schools ranked with a low grade respond by improving test scores in ELA and Math over a relatively short time horizon. Rockoff and Turner (2010) also find that a poor accountability ranking leads to a more stringent evaluation of schools by parents, which can lead more elastic decision making over school choice (Hanushek et. al, 2007). By looking at the variance in accountability on a state-to-state level, Hanushek and Raymond (2005), find that the growth in student achievement is stronger with accountability than without it. The evidence provides support to Bloom et al (2014) hypothesis on 'principal accountability', and sheds light on how accountability enhances the charter school product.

2.4 Teacher quality

Charter schools' relationship with teacher and teacher quality is somewhat paradoxical. Charter schools, in particular urban charter schools, tend to employ less qualified and less experienced teachers than their traditional school counterparts (Cohodes et al, 2021). Charter schools suffer from greater attrition and turnover in their teaching staff (Miron and Applegate, 2007). High performing teachers move to traditional public schools, whilst low performing teachers leave the industry (Bruhn et al., 2020; Barrett et al., 2020). Furthermore, many charter teachers are not unionised. Matsudaira and Patterson (2017) find that unionised teachers lead to greater student achievement. However, Abdulkadiroğlu, et al (2013) suggests the lack of unionisation and bargaining power of charter schoolteachers allows them greater flexibility in the amount of instruction time offered, a key component of performing-enhancing charter schools (Dobbie and Fryer, 2011)

Despite the lack of experience and qualifications amongst their teaching staff, select charter schools and charter school networks continue to boost student achievement. In successful Boston charter schools, the distribution of teacher effectiveness appears to be narrower (Cohodes and Parham, 2021). This may be due to the greater emphasis successful charter schools place on curricula and instruction, such as the instructional strategy outlined in '*Teach Like a Champion*', authored by Doug Lemanov, the head Uncommon Charter School network (Dobbie and Fryer, 2011). Research in Pennsylvania finds that charter school networks employ a methodical approach for junior and entry-level teachers which facilitates greater on-the-job training and faster improvement, eventually translating to improved student results (Steinberg and Yang, 2020). Furthermore, effective charters provide a significantly greater level of feedback to teachers in relation to the quality of their instruction in the classroom (Dobbie and Fryer, 2012). Overall, it appears that successful charter schools trade a more stable and experienced teaching staff, for one that receives a greater level of focused training, alongside high-dosage and consistent feedback, as well as a willingness to partake in increased instruction time.

The autonomy of the hiring and firing of staff may lead to positive outcomes for students. As, Adnot et al. (2017) finds, when schools have greater autonomy over the firing of staff, selective attrition in the teaching staff can boost student achievement. Using different teacher training programs in New York City, (Boyd et al. 2008) finds that a greater effectiveness in teacher training transpires to greater student achievement in ELA and math. When teachers can review curriculum and join programs that put greater emphasis on the practical work in the classroom, student outcomes improve (Boyd et al. 2008). The results here are symptomatic of the on-the-job training provided to charter schoolteachers (Whitman, 2008; Dobbie and Fryer, 2012)

2.5 Curriculum

Greater autonomy allows charter schools to implement different pedagogical strategies. The most prominent model for performance enhancing schools is the "No Excuse" model. The 'No Excuse' model, first coined by Thernstrom and Thernstrom (2003) in '*No Excuses: Closing the Racial Gap In Learning'*, adopts four main principles: a culture of college-going and high expectations, strong disciplinary codes, longer school days/year and more focused and data-led instruction for teachers and students who fall behind their peers.

Dobbie and Fryer (2012) find that all four of principles add value to charter school improvement. A culture of 'college-going' is anecdotal to the environment that children of high-income families or children from educated backgrounds are raised in, as 'No Excuse' charter schools try to do work of both parents and schools (Whitman, 2008). The impact of teacher expectations on student outcomes has been found to be significant (Rubie-Davies, 2008). Teachers that have low expectations typically exert a detrimental impact onto their pupils, while those with high expectations improve the outcome of their students (De Boer et al., 2011). Teachers with low expectations appear to be correlated with students' demographic that is composed of ethnic minorities (Glock et al., 2013; Speybroeck et al., 2012), perhaps partially explaining the student achievement gap. Teachers with high expectations provide more opportunity, a greater level of instruction and adopt an approach that is both caring and supportive (Babad, 1992; Jussim et al., 1996). This draws similarities to the environment that 'No Excuses' charters operate within, as (Goodman, 2013) describes, "*If one is not convinced of the teachers' devotion simply by watching them as they move about a classroom with warm individual smiles for everyone who is working, answering, or simply concentrating, then one can just count up the hours they spend in school followed by meetings, phone calls to students' homes*" (Goodman, 2013 Page 90)., and that teachers "*are adamantly optimistic, repeatedly stating their high expectations for student success, both in print and in the class*" (Goodman, 2013 Page 90).

Empirical evidence suggests that longer school days can have a positive influence on student outcomes. In a survey of the literature on the impact of increasing instruction time, Copper and Allen 2010 find that the strongest empirical models produce consistently positive results. In a cross-country study that included 50 countries, Lavy (2010) finds that more instructional time translates to greater student achievement, and that these effects are most profound when schools are subject to more accountability and have more autonomy over the hiring and firing of staff. Dobbie and Fryer (2012) find that the average length of school year for charter schools is 1402.2 hours in New York City (NYC), whilst achievement-increasing charter schools have an average length of school year at 1546 hours. Furthermore, more focused instruction and tutoring is symptomatic of high-achieving schools (Abdulkadiroğlu,, 2011; Angrist, 2013; Nickow et. al, 2020), whilst the impact of greater instruction and feedback for teachers is outlined in section 2.4. The evidence on the necessity of a stringent disciplinary code is less conclusive. Golann and Torres (2020) find that 'No Excuse' disciplinary codes are not necessary for academic success, whilst Angrist et al. (2016) find that tutoring is the most important feature for improving student achievement, not discipline. Utilising a new ruling that limited Massachusetts charter schools' ability to suspend students, Felix (2020) found no change in student achievement. Further criticisms of the 'No Excuse' model will be explored in the forthcoming section.

3. Criticisms of Charter Schools

3.1 "Cream skimming"

Critics of charter schools charge charter schools with "cream skimming". In other words, admitting a student population that is more likely to produce positive outcomes in comparison to traditional public-school peers. When analysing the student population in Knowledge is Power Program (KIPP) charter school network, Rothenstein (2005) suggests that KIPP enrols a student population that is more motivated and capable. Some of the earlier studies focused on Boston found that earlier cohorts included more high achieving students than their traditional school peers (Abdulkadiroğlu et. al, 2011), although this seems to have reversed in later studies in Boston (Setren, 2019). More recent literature finds no evidence for the claim of cream-skimming, as lottery studies find no selection bias between their treatment and control group. Furthermore, much of the gains found in successful charter are predominantly found in a student population that is typically under-achieving and non-white (Angrist et. al, 2013), which tend to lag-behind more privileged counterparts. However, some charter school practices, such as the requirement for parental involvement, may have exclusive elements, especially amongst children with parents not particularly interested in their education. Lottery studies typically control for this element, by using lottery application as a predictor for parental motivation. However, value-added models are not as effective in removing this type of selection bias.

3.2 Children with special needs

A critique that does appear to be substantiated in evidence is charter schools' relationship with special needs students. Charter schools on average appear to lead to negative outcomes for disabled and special needs students when compared to traditional public schools. Furthermore, an audit study that created fictional scenarios for charter school applications, found that students who were described as disabled or special needs, were 7% less likely to be offered a charter school position than non-disabled students (Bergman and McFarlin, 2020). The authors did caveat that their approach explicitly outlined to the charter schools that the students would elicit an increased financial cost to the school, potentially leading to an upward bias in the results (Bergman and McFarlin, 2020). Whitman (2008) finds that the student population for disabled students of select charter schools was around 7-11%, whilst the neighbouring public school's composition was around 12-15%, as many charter schools are ill-equipped to deal with a large number of disabled students (Whitman, 2008). It does appear charter schools have a lot of work to do on this front, especially if they want to make their model replicable for the entirety of the traditional public-school population.

3.3 Criticism of the "No-Excuse" model

Critics of the 'No Excuse' model focus on the paternalistic nature of its practices. Goodman (2013) argues that 'No Excuse' charter schools adopt the model of broken windows, which was conceptualised by Wilson and Kelling (1982). The theory of broken windows posits that small misdemeanours lead to larger ones (Gladwell, 2007). Following this, 'No Excuse' charters implement rules for otherwise innocent acts. For instance, a child wearing an incorrect colour of socks can be punished (Whitman 2008; Goodman, 2013). On the face of it, the colour of socks is not a crime in-itself, however 'No Excuse' employs such rules to foreclose the possibility of misbehaviour (Goodman, 2013). 'No Excuse' charter schools operate slogans such as 'SLANT' (sit up, listen, attend, nod-your-head, track). To maintain silence in the hallway, (Goodman, 2013) observes that children walk in straight lines, silent with their hands behind their back. In addition, 'No Excuse' charter schools use reward and punishment systems based on behaviour (Goodman, 2013). Such charters believe each second of the day needs to be utilised to ensure maximum productivity. When pupils act in contradictory ways to such beliefs, they can be punished.

It is often argued that pupils of such schools have the illusion of choice, acting more out of a fear of consequences (Kazdin, 2001). This may impact the personal development of the pupil, as exercising free will and having a sense of volition is required to develop self-awareness and self-esteem (Damon and Hart, 1988; Deci and Ryan, 1995). Harter (2006) argues that for many students, social approval is important, and thus to act in an environment where you expect to be judged, can lead to a weaker sense of self. Harter (2006) also argues that students who do not come from predictable patterns of behaviour at home, or have experienced trauma, can respond adversely to strong levels of authority.

On the contrary, 'No Excuse' charters deal with the unique challenge of educating children from crime-ridden, low-achieving inner-city neighbourhoods, where paths to a better life are not easily identifiable. Such challenges are yet to be overcome by the public-school sphere. Whitman (2008) argues that ‘No Excuse’ charter schools adopt the role of both the school and the parent. Pupils of ‘No Excuse’ charter schools grow to respect and become fond of their teachers, and many pupils claim that school is their second home (Whitman, 2008). The ‘new paternalism’, as Whitman (2008) describes, is not simply telling pupils how to live, but rather to enlighten the poor on how to overcome social problems and exit socio-economic cul-de-sacs. Such lessons might not be taught at home, and if children do not learn them at school, small misdemeanours in school may lead to larger ones outside of school, á la broken windows. In addition, Goodman (2013) does go on to caveat his critique by suggesting that most pupils respond positively to methods employed by ‘No Excuses’ charters and that it led to an 80% reduction in crime in one inner-city school. Clearly, the appropriateness of the ‘No Excuse’ disciplinary code is a delicate issue, one that should be approached with care, and one where all stakeholders should remain fixed on the betterment of the lives of underprivileged children.

4. Meta-analysis

A meta-analysis aims to provide an overall effect size for a policy intervention based on the existing literature. Primarily used in the medicine industry, meta-analysis has become more widely adopted across disciplines (Hopewell et. al, 2010). Meta-analysis can improve the accuracy of findings, provide external validity to research and it can answer questions that were not posed in the existing literature (Hopewell et. al, 2010). It can also provide an opportunity to address heterogeneity and contradictory claims (Hopewell et. al, 2010). The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) is used as a framework for this meta-analysis.

The three questions this meta-analysis aims to address are the following:

(1) *Do Charter Schools improve students results?*
(2) *What study-level factors contribute to heterogeneity in the effectiveness of charter schools?*
(3) *Can successful charter schools close the “student achievement gap”?*

4.1 Criteria for selecting studies

Studies eligible for selection for the meta-analysis are lottery studies, value-added models using propensity score matching and deferred acceptance (DA) matching systems with propensity score matching. The three different methods are described in depth in the following section. Studies must also be confined to the U.S, as despite the growth in autonomous-government schools globally, the external validity of the meta-analysis may be impaired when trying to estimate an overall effect size between countries with different cultures, models and attitudes towards education. Furthermore, studies must report the necessary statistics to compute the overall effect size and must report a change in the ELA or maths scores of pupils and must be conducted after 1991 (the year of the opening of the first charter school).

4.1.1 Lottery Studies

Lottery studies use archived data from charter schools that operate a lottery system for pupil admission. A charter school must be sufficiently over-subscribed, in other words, have more applicants than available positions within the school. This allows researchers to conduct a quasi-experiment where lottery winners, those who get offered a place, act as the treatment group. Lottery losers, those who are not fortunate enough to be offered a position, act as the control group. Lottery studies typically compute both the intent-to-treat (ITT) and treatment-on-treated (TOT) estimates. The ITT estimates the causal effect on student achievement of pupils that are offered a position, irrespective of whether the pupil decides to enrol. The TOT calculates the causal effect of enrolling in a charter school. The TOT estimates will be used for this meta-analysis.

Lottery studies provide an effective design for measuring the causal effects of charter schools. They remove the issue of selection bias, as both the treatment and control group consist of students and parents who opted for charter schools. However, lottery studies struggle with generalizability. Gleason et. al, 2010 found that only 26% of 492 charter middle schools were sufficiently oversubscribed to conduct a lottery study. Thus, external validity issues arise within lottery studies, a problem this meta-analysis aims to solve.

4.1.2 Propensity score matching

Not all charter schools are sufficiently oversubscribed to conduct lottery experiments, therefore researchers need to explore alternative experimental designs. One such method is a variety of value-added models that utilise propensity score matching, which alongside lottery studies, provides the most valid causal effects of charter school enrolment. (Charter School Achievement Consensus Panel, 2006).

Value added papers use administrative data to find a plausible comparison group between charter school and traditional public-school students. Propensity score matching (PSM) takes the characteristics of a charter school student and tries to find a comparison group that mirrors those characteristics as closely as possible. As Rubin, 1997 states, PSM is used most effectively with large data sets, making it suitable for nationwide studies or studies over a larger geographical context. The CREDO papers used in this meta-analysis adopt a unique form of propensity score matching called virtual control records (VCR), which finds a statistical twin between charter and public-school students (Gulosino and Leibert, 2020). Despite its attempts, propensity score matching does not completely eradicate the issue of selection bias. There are unobservable characteristics, such as parent motivation, that are hard to control for.

In short, lottery studies combat the issue of selection bias, whereas value-added models can overcome the issue of generalizability. A combination of estimates from both study types can help provide an overall effect size that is representative of charter schools at large.

4.1.3 Deferred acceptance (DA) propensity score matching

A growing number of school districts adopt a centralised allocation system for their public school system. Abdulkadiroğlu, et. al (2017) developed a new empirical method using the randomization component of these systems, whilst also implementing a propensity score matching system to control for student preferences and school priorities. Abdulkadiroğlu, et al. (2017) found this method to be robust and an accurate predictor of the causal effect of charter school attendance. This method has been used in two of the studies included in this meta-analysis (Abdulkadiroğlu, et al., 2017; Winters and Shanks, 2022). It provides an important innovation in the charter school literature, as more districts trend to a centralised system in allocating school children across the public-school sphere (traditional public schools, charter schools, magnet schools and innovation schools). Wider adoption of this method needs to be conducted to further draw on its overall efficacy and restrictions.

4.2 Database search

After determining the inclusion criteria outlined in section 2.1, various channels were used to identify adequate studies for the meta-analysis. The following economic journals were used to search to find relevant papers: *National Bureau of Economic Research (NBER), Econometrica, Journal of Labor Economics, American Economic Association (AEA), American Economic Review (AER), Quarterly Journal* as well as being supplemented by *Google Scholar*. The following four combinations were used to identify correct papers through the above channels: "*charter school and randomization*", "*charter school and lottery*", "*charter school and value added*" and "*charter school and propensity score matching*". Each paper was filtered out via three steps: an abstract review, an initial reading of the paper and then a full reading of the paper.

4.2.1 Abstract review

After excluding titles that were not relevant for the meta-analysis, an abstract review was conducted for the remaining papers. After reviewing the abstracts, it was then determined whether the paper met the inclusion criteria outlined in section 3.1. Those papers that met the criteria were then passed onto an initial reading.

4.2.2 Initial reading

As with the abstract review, the purpose of the initial reading was to reveal new information to be passed on to a full in-depth reading where the necessary data would be collected for the meta-analysis.

4.2.3 In-depth reading

An in-depth reading was then conducted to gather all the relevant data and information for the purpose of the meta-analysis. This includes the study citation, location of charter school, whether the study was urban or non-urban, the year of the study, grade level of school (elementary, middle, high school), whether the charter school adopted the 'No-Excuse' model, as well as Math and ELA results and the standard error of the results.

4.2.4 Search results

After conducting the literature search and screening process a total of 30 papers were included in the meta-analysis. Descriptive data on the sample of papers is provide in Table 1. There were some papers that met all criteria but did not provide the necessary statistics to conduct the meta-analysis, (Hoxby and Rockoff, 2004; Ballou et. al 2006).

Table 1: Descriptive data – Meta-analysis

	Frequency	Observations
Studies	30	196
Lottery	11	38
PSM papers	19	158
No Excuses	10	30
Urban	14	82

Notes: This table reports the descriptive data for the sample of papers included in the meta-analysis. The frequency column represents the number of papers for each category. The second column represents the number of observations for each category. There are multiple observations per paper as each paper reports ELA and Math results, whilst some provide estimates for multiple locations.

4.3 Meta-analysis method

There are two main methods that can be adopted for a meta-analysis: the fixed-effects method and the random-effects method (Hopewell et. al, 2010). The fixed-effects method assumes that there is a homogenous treatment group, such that a policy intervention will always lead to the same effect size (Hopewell et. al, 2010). Random effects, on the other hand, assumes that there is heterogeneity in the treatment group, which leads to a range of outcomes for a given policy intervention (Hopewell et. al, 2010). As Borenstein et al. 2009 suggests, the random-effects method is more applicable for educational interventions, given that the effect of the policy intervention will be subject to school and student level characteristics that will inevitably vary between studies, referred to as between-study variance, τ. Given the geographical and demographical breadth charter schools cover, as well as the differing levels of autonomy provided to charter schools and the differences in regulatory framework that govern them, it is reasonable to assume there is a variety outcomes from charter school intervention. Therefore, this paper adopts the random-effects method for the meta-analysis.

A random effects meta-analysis is conducted in two stages. The first stage takes the estimated effect size from each study, Y_i, which in the case of charter school intervention, is the σ improvement in ELA and Math results. The second stage takes a weighted average these estimates to provide an overall effect size (θ). The overall effect size is calculated as per the below:

$$\theta = \frac{Sum\ of\ (estimate\ x\ weight)}{Sum\ of\ weight} = \frac{\sum YiWi}{\sum Wi} \qquad (1)$$

Where Y_i is the effect size estimated in i^{th} study, W_i is the weight given to the i^{th} study. The weight of each study, W_i, is calculated by the inverse of the within-study variance, V_i, plus the variance found between studies, τ^2. The within-study variance V_i is simply the standard error associated with estimate in the i^{th} study. The between study variance can be understood as the heterogeneity amongst the findings in the literature, such that the effect size of i^{th} study is different than that of the j^{th} study. The equation for estimating W_i can be found below.

$$Wi = \frac{1}{Vi+\tau^2} \qquad (2)$$

Therefore, the most precise estimates will receive a higher weighting in the meta-analysis (Hopewell et. al, 2010; Borenstein et. al, 2009). τ^2 becomes larger when there is a considerable amount of heterogeneity in the literature. Given the observed heterogeneity in the literature, it is therefore expected that the distribution of weightings for this meta-analysis will be relatively narrow.

5. Meta-analysis results

5.1 Overall effect size

Table 2 provides a full breakdown of the results from the meta-analysis. The results provide an effect size, that is, a σ improvement in ELA and Math results. In congruence with the wider literature, the σ improvement in Math is larger than ELA. The large improvement in Math may be explained by the research of development psychologists. It has been found the improvement in reading and writing ability happens in a child's formative years, while this period extends way into adolescence for high cognitive requirements (Pinker, 1994). The estimated effect size is 0.035σ for ELA and 0.046σ for Math, both significant at the 1% level. Viewing student performance through σ improvements in ELA and Math is somewhat convoluted for an interest party, say parents, thus a more understandable way of measuring student achievement is provided in section 8 of this paper.

Table 2: Meta-analysis results

	Effect Size	
Grade	ELA	Math
All	0.035***	0.046***
Elementary	0.02	0.03**
Middle	0.06**	0.11***
High	0.07***	0.08***
Elementary/Middle	-0.02	-0.03
Pooled	0.04***	0.04***

Notes: This table reports the results from the meta-analysis. The table reports the main meta-analysis results, which provides an effect size for ELA and Math for all the sample papers. The remaining results are the effect sizes at different grade levels. Elementary grade runs from ages 4 through 11, Middle 11-13 and High from 13-18. Some papers pool results by Elementary/Middle and some pool all the grade levels. The effect sizes can be read as the standard deviation change in charter school results against traditional public schools.

*** represents significance at the 1% level

** represents significance at 5% level

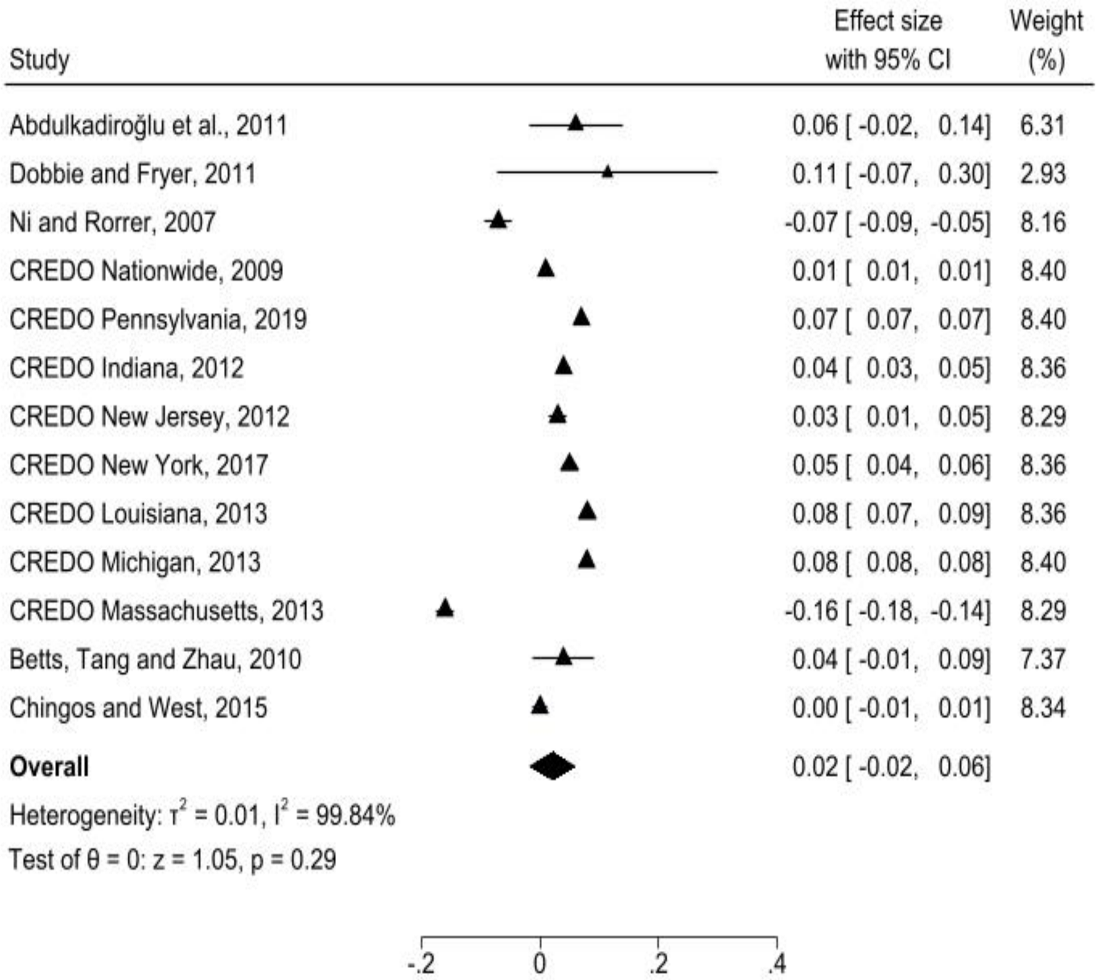
5.2 Effect sizes at the grade level

A more granular breakdown of the meta-analysis can be found in figures 1 through 10, which provide the forest plots for the effect sizes at each grade level. Forest plots can be understood as follows: the left-hand column provides the list of papers included in the forest plot, on the right-hand side we can see the effect size reported by each paper, with its corresponding confidence intervals in brackets. The farthest right column provides the weight assigned to each paper. A visual demonstration of the data is displayed in the middle. The triangle represents the location of the effect size, those papers with larger weights have a larger triangle. The candle sticks either side represent the relative width of the confidence intervals. In the bottom left we can find reported statistics on the heterogeneity. τ, represents the between study variance, whilst I^2 provides the amount of τ that is true variance and not due to statistical error (Hopewell et. al, 2010). The next line runs the null hypothesis on whether the effect size is statistically different from zero.

5.2.1 Elementary School Level

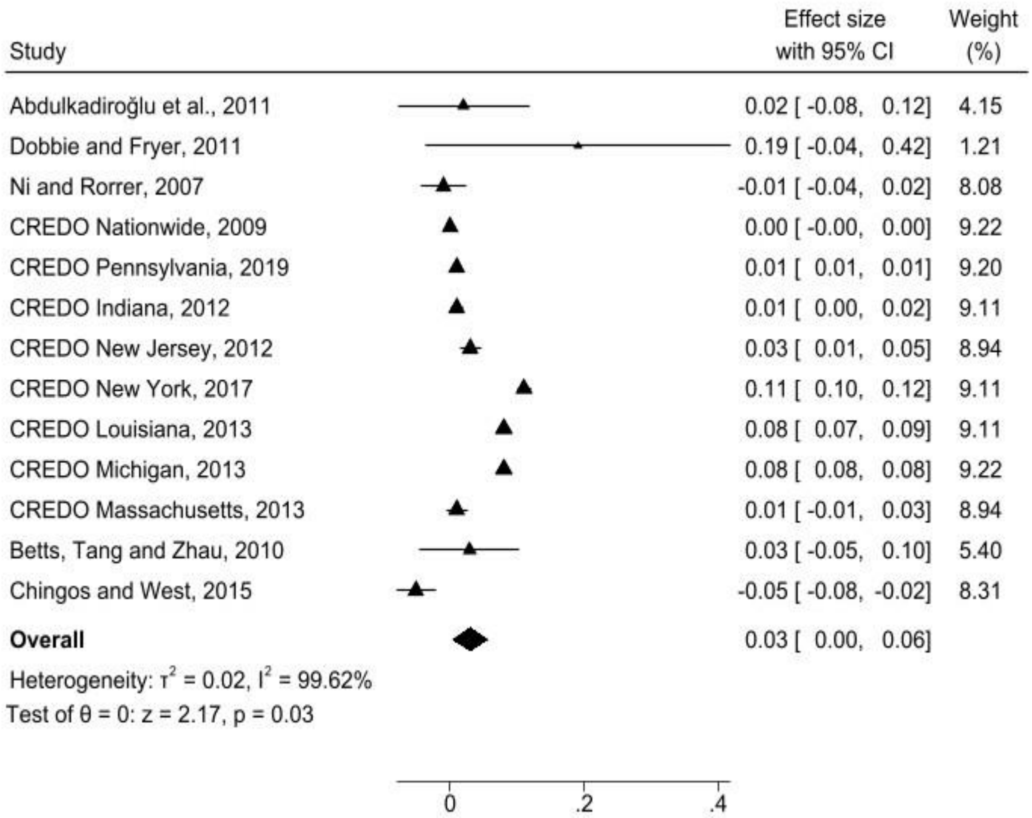
Figure 1 and 2 provide the forest plots for the ELA and Math results at the elementary grade level. The elementary grade level typically includes children from the age 4-11. The effect sizes are 0.2σ and 0.03σ for ELA and Math, respectively. The ELA result was not found to be statistically significant, but the Math result is significant at the 5% level. Abdulkadiroğlu et. al (2011) estimates the impact pf charter schools in the Boston area. Dobbie and Fryer (2011) look at the impact of the Harlem's Children Zone, whilst Ni and Rorrer (2007) look at the impact of Charter Schools in Utah. Betts, Tang and Zhau (2010) look at Charter Schools effect in San Diego. Chingos and West (2015) look at the uneven impact of Charter Schools in Arizona. The remaining papers are a collection of CREDO papers that focus on charter school effects across different states in the US. Two out the thirteen papers find a negative impact in ELA results (Ni and Rorrer, 2007) (CREDO, 2013), while the remaining 10 found positive returns. This is the same for Math results, although it is Chingos and West (2015) and not CREDO Massachusetts that find the negative outcome.

Figure 1: Forest plot for charter school ELA results at the Elementary grade level



Notes: The figure provides the forest plot for the effect size of charter school intervention at the elementary grade level. The left-hand column provides the studies includes in the plot. On the right-hand size, we can see the effect size for each paper and its corresponding weight in the forest plot. Papers are weighted by random-effects meta-analysis. The centre of the plot provides a visual demonstration of the random effects analysis. The triangle provides the location of the effect size, and its size indicates its weight, the candle sticks either side represent the 95 percent confidence interval. The overall effect size is demonstrated by the diamond at the bottom. The bottom left provides statistics regarding the heterogeneity.

Figure 2: Forest plot representing charter school Math results at Elementary Grade Level



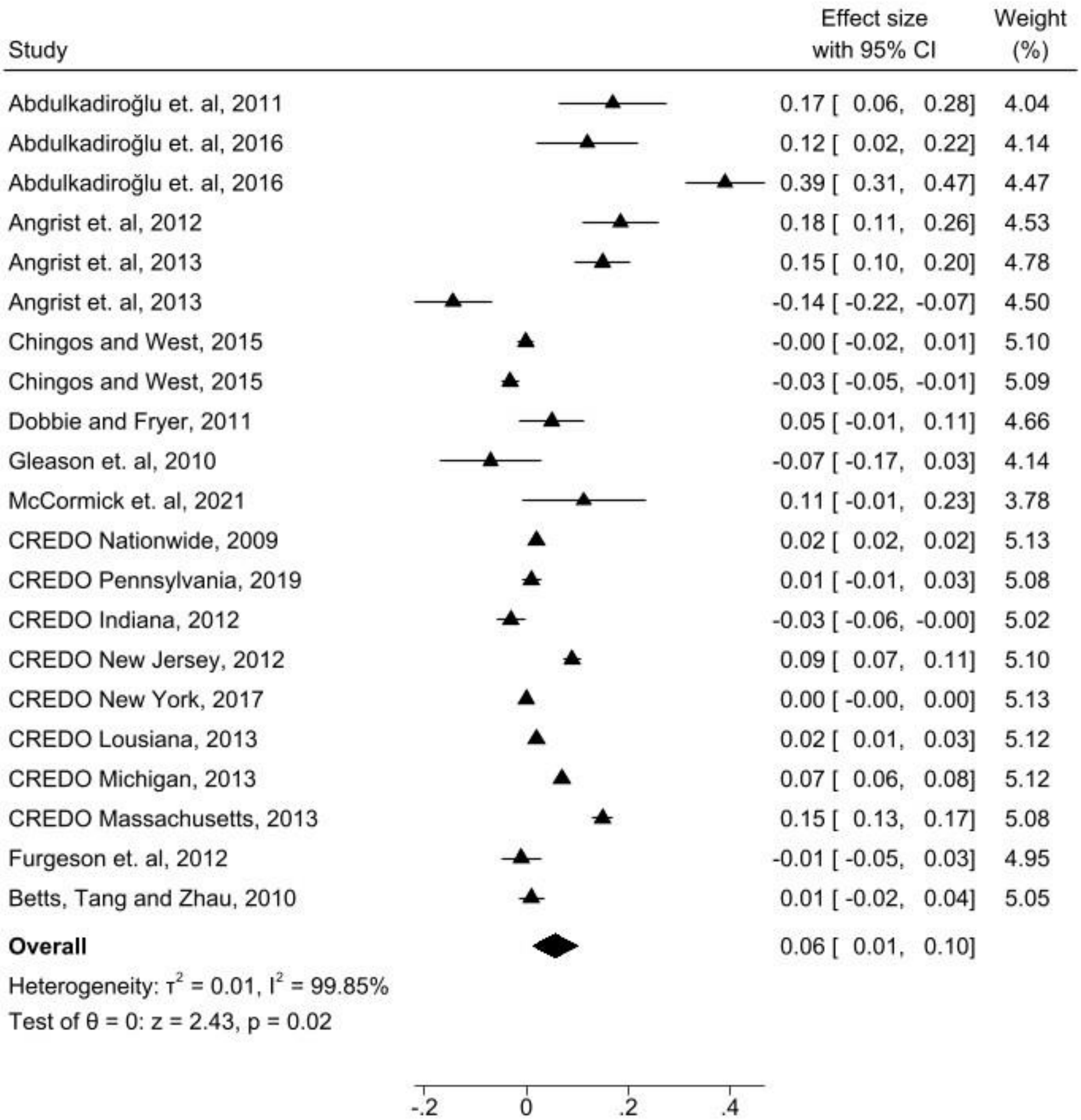
Notes: The figure provides the forest plot for the effect size of charter school intervention at the elementary grade level. The left-hand column provides the studies includes in the plot. On the right-hand size, we can see the effect size for each paper and its corresponding weight in the forest plot. Papers are weighted by random-effects meta-analysis. The centre of the plot provides a visual demonstration of the random effects analysis. The triangle provides the location of the effect size, and its size indicates its weight, the candle sticks either side represent the 95 percent confidence interval. The overall effect size is demonstrated by the diamond at the bottom. The bottom left provides statistics regarding the heterogeneity.

5.2.2 Middle school level

The effect size for ELA and Math results for the middle school grade level (11–13-year-olds) is 0.06σ and 0.11σ, significant at the 5% and 1% level, respectively. The study list for middle school forest plots retains Abdulokoriglu et. al (2011), Chingos and West (2015) (urban and non-urban estimates), Betts, Tang and Zhau (2010), Dobbie and Fryer (2011) and the CREDO papers. The forest plots add Angrist et. al (2012), which focus KIPP Schools in Boston and Lynn, and Angrist et al (2013) which looks at Boston charter schools more broadly. Gleason et. al (2010) conducts a nationwide lottery study at the middle school level, McCormick et al (2021) look at the effects in New Mexico in a lottery design.

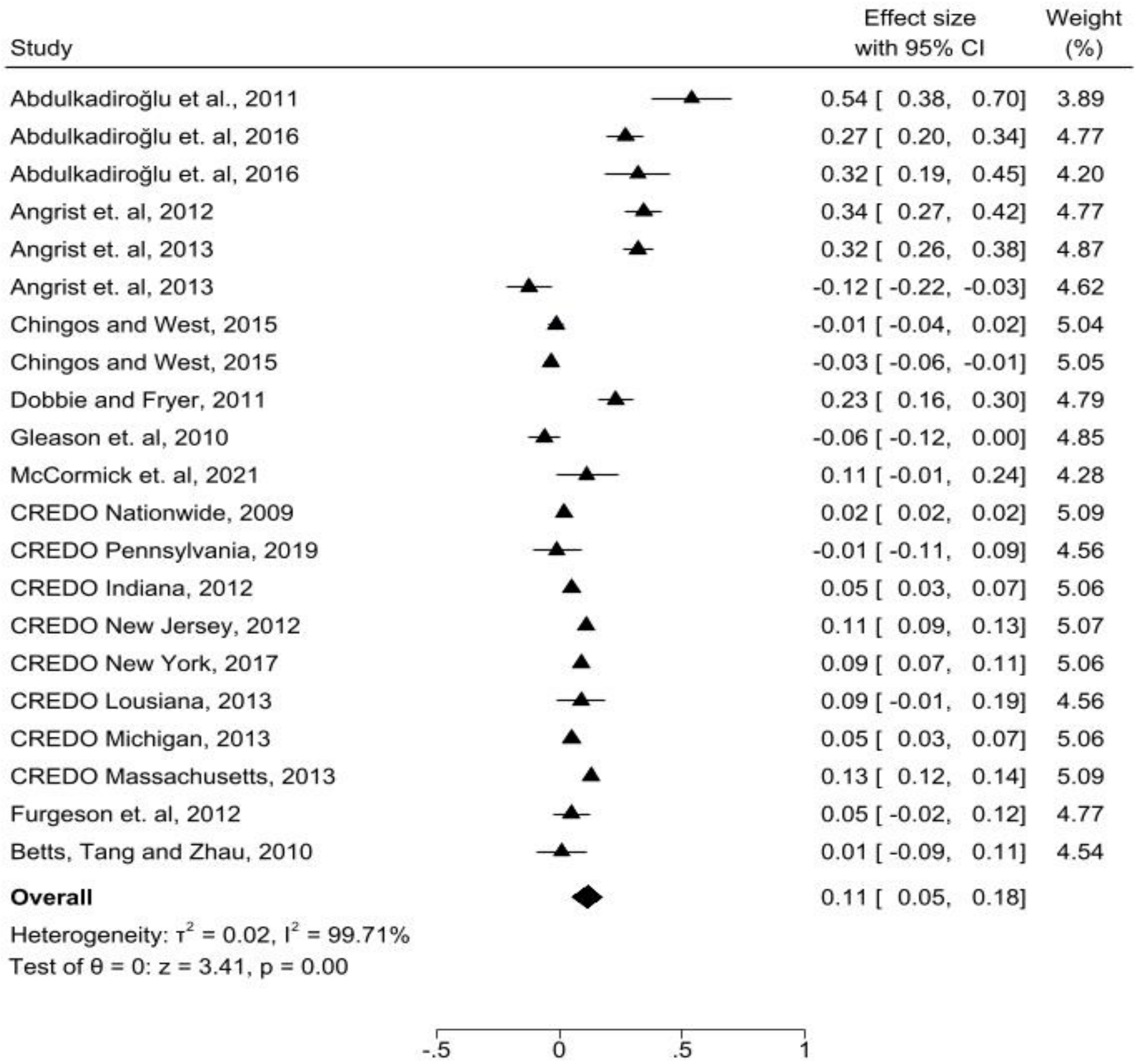
A total of five negative results are found in the ELA results, two of which come from non-urban estimates in the Angrist et. al (2013) and Chingos and West (2015) paper. The two nationwide studies, Gleason et al (2010) and Furgeson (2012), find a negative impact, as well as CREDO Indiana. Angrist et. al (2010), Chingos and West (2015) and Gleason et. al (2010) find negative returns for Math, whilst CREDO Pennsylvania also found a negative impact.

Figure 3: Forest plot representing the ELA effect size of Charter Schools at Middle School level



Notes: The figure provides the forest plot for the effect size of charter school intervention at the middle grade level. The left-hand column provides the studies includes in the plot. On the right-hand size, we can see the effect size for each paper and its corresponding weight in the forest plot. Papers are weighted by random-effects meta-analysis. The centre of the plot provides a visual demonstration of the random effects analysis. The triangle provides the location of the effect size, and its size indicates its weight, the candle sticks either side represent the 95 percent confidence interval. The overall effect size is demonstrated by the diamond at the bottom. The bottom left provides statistics regarding the heterogeneity.

Figure 4: Forest plot representing the Math effect size of Charter Schools at Middle School level.

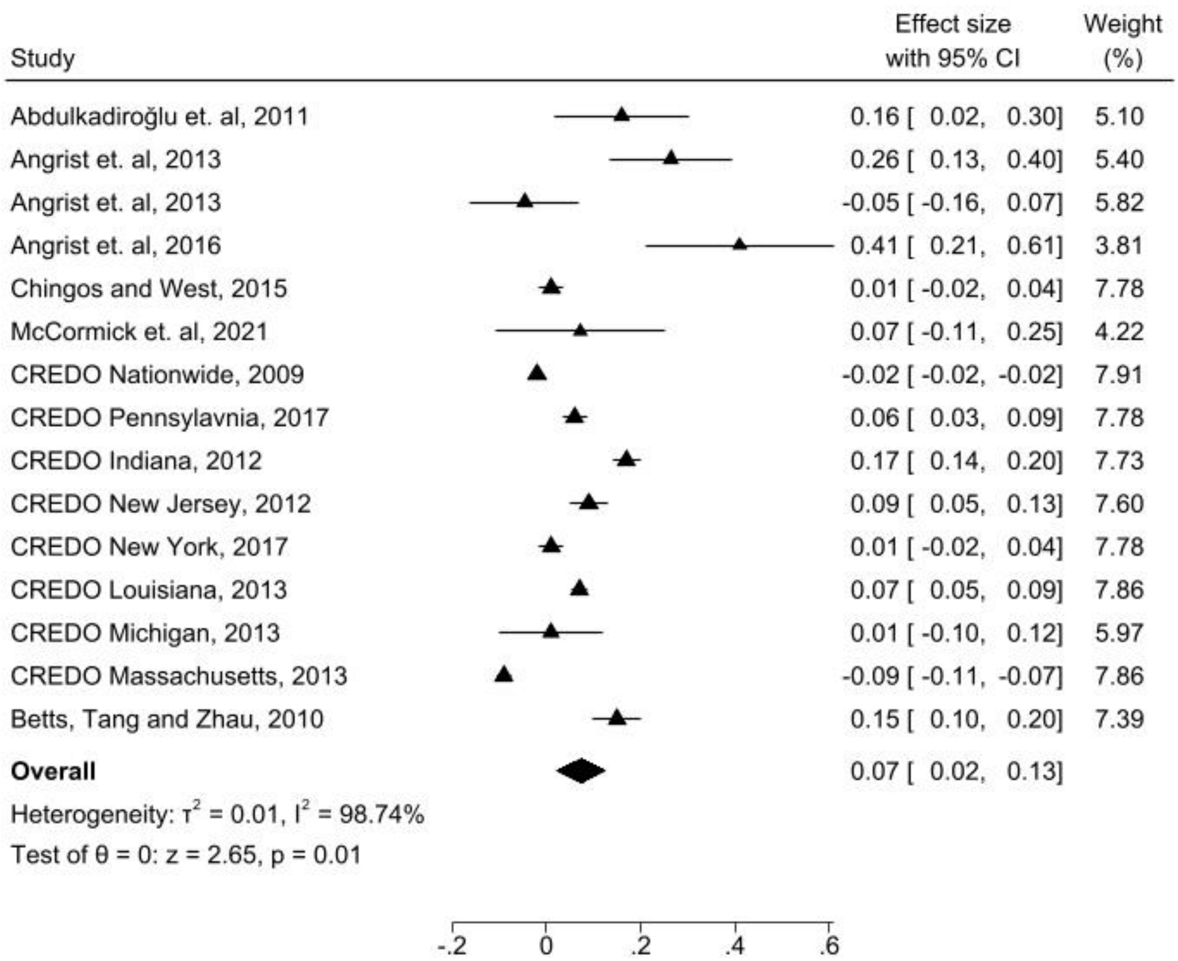


Notes: The figure provides the forest plot for the effect size of charter school intervention at the middle grade level. The left-hand column provides the studies includes in the plot. On the right-hand size, we can see the effect size for each paper and its corresponding weight in the forest plot. Papers are weighted by random-effects meta-analysis. The centre of the plot provides a visual demonstration of the random effects analysis. The triangle provides the location of the effect size, and its size indicates its weight, the candle sticks either side represent the 95 percent confidence interval. The overall effect size is demonstrated by the diamond at the bottom. The bottom left provides statistics regarding the heterogeneity.

5.2.3 High School Level

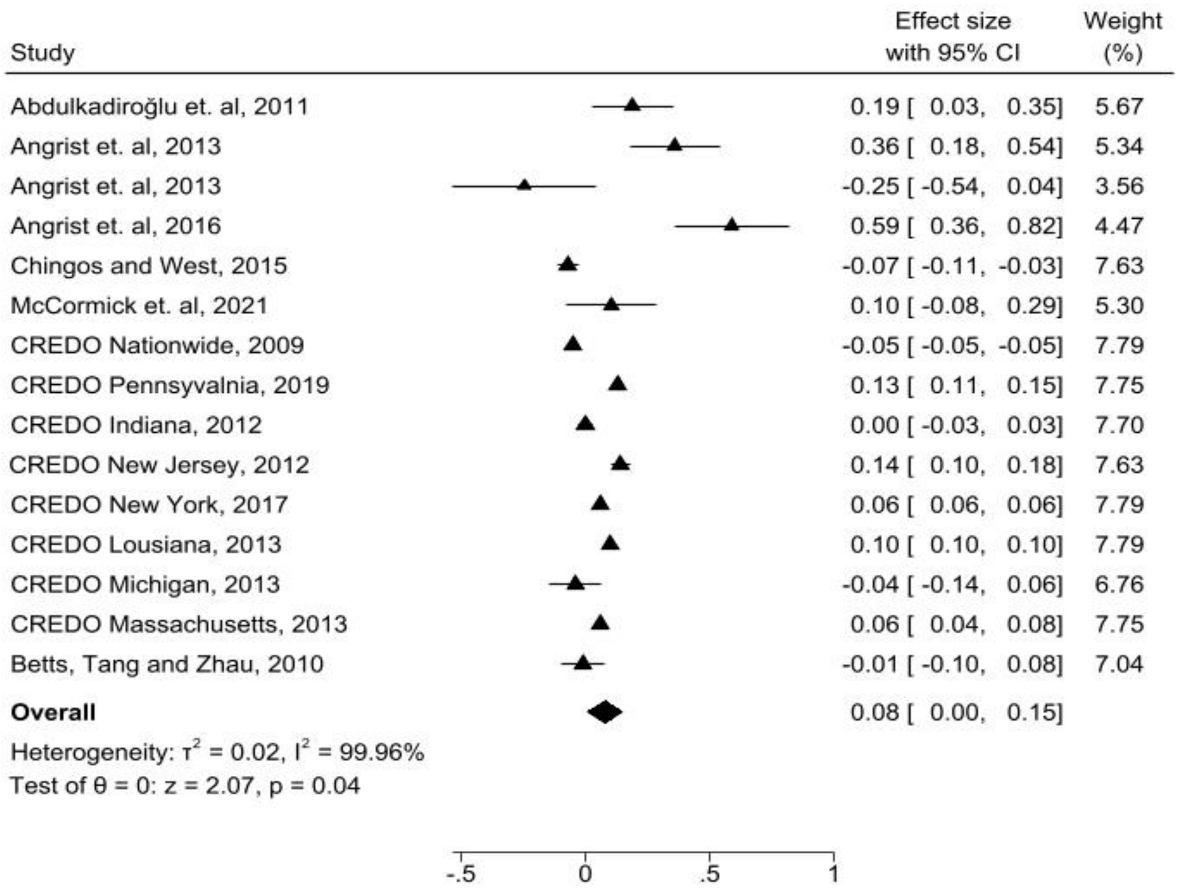
The list of papers in the high-school forest plots closely mirror those at the middle grade level. The effect sizes are 0.07σ and 0.08σ for ELA and Math, respectively. The are three negative results for ELA and five for Math. There is a new entrant into the forest plots in figure 5 and 6, this is a paper by Angrist et. al (2016) to focuses specifically on charter high schools in Boston. The remaining papers are also found in the forest plot for the middle and elementary grade levels. The CREDO nationwide and Massachusetts papers found a negative outcome in ELA, whilst Angrist et. al (2013)'s non-urban estimate also founds a negative return to improvement in ELA results.

Figure 5: Forest plot representing charter school ELA results at High school grade level



Notes: The figure provides the forest plot for the effect size of charter school intervention at the high and middle grade level. The left-hand column provides the studies includes in the plot. On the right-hand size, we can see the effect size for each paper and its corresponding weight in the forest plot. Papers are weighted by random-effects meta-analysis. The centre of the plot provides a visual demonstration of the random effects analysis. The triangle provides the location of the effect size and its size indicates its weight, the candle sticks either side represent the 95 percent confidence interval. The overall effect size is demonstrated by the diamond at the bottom. The bottom left provides statistics regarding the heterogeneity.

Figure 6: Forest plot representing charter school results at High School level

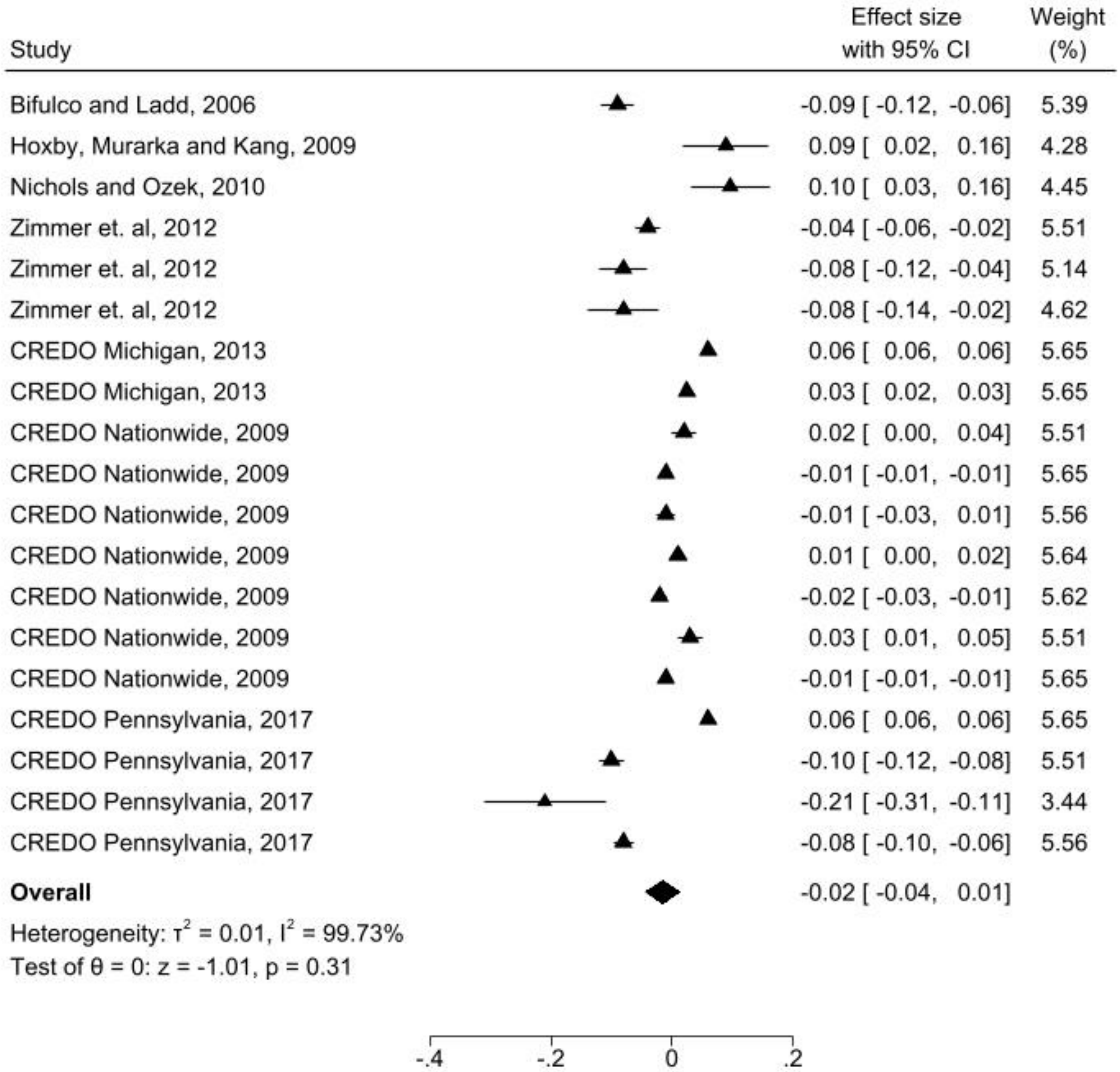


Notes: The figure provides the forest plot for the effect size of charter school intervention at the high school grade level. The left-hand column provides the studies includes in the plot. On the right-hand size, we can see the effect size for each paper and its corresponding weight in the forest plot. Papers are weighted by random-effects meta-analysis. The centre of the plot provides a visual demonstration of the random effects analysis. The triangle provides the location of the effect size, and its size indicates its weight, the candle sticks either side represent the 95 percent confidence interval. The overall effect size is demonstrated by the diamond at the bottom. The bottom left provides statistics regarding the heterogeneity.

5.2.4 Elementary and Middle Level

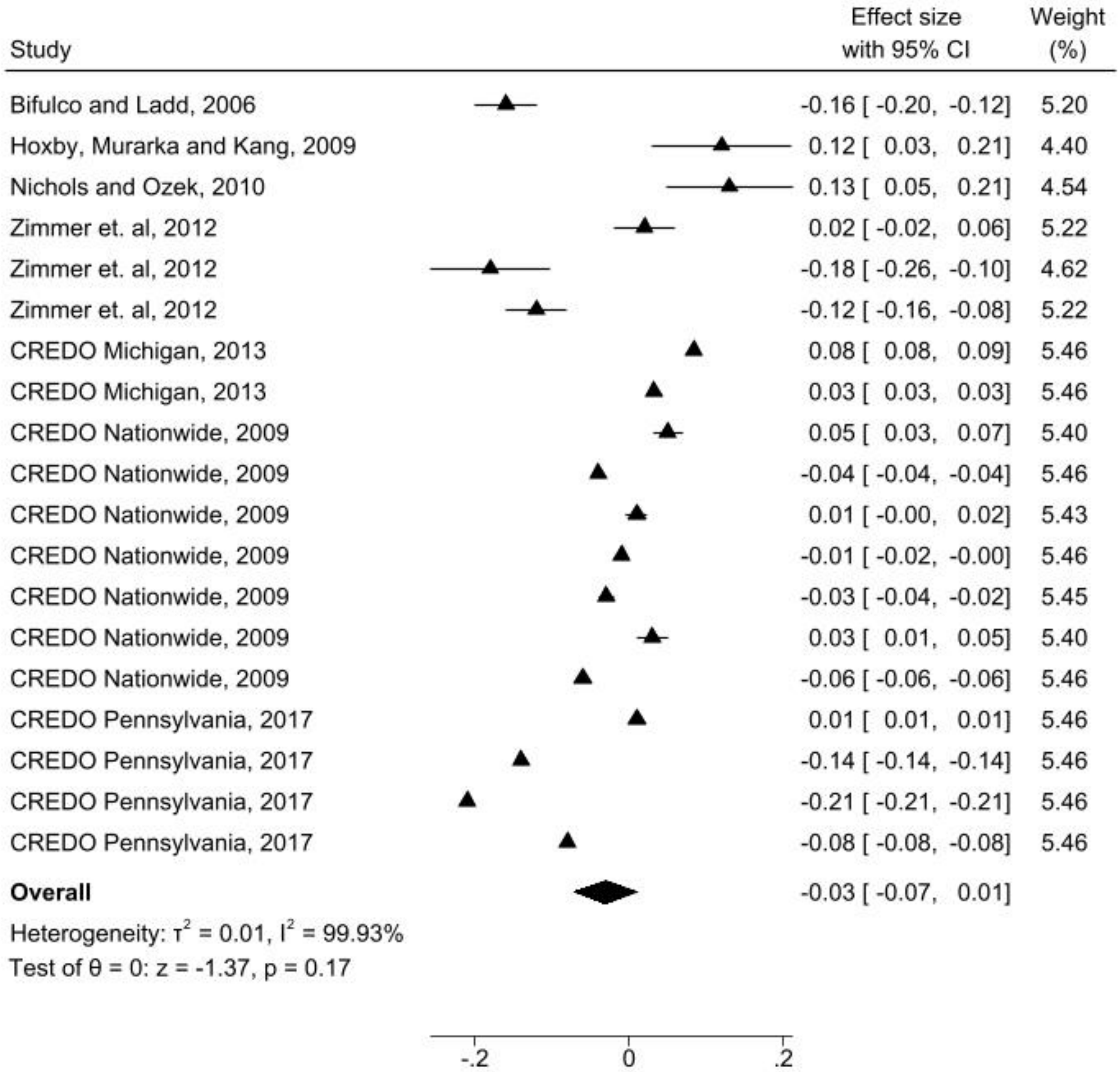
Figures 7 and 8 provide the forest plots for papers that group estimates at the elementary and middle school level. Bifulco and Ladd (2006) is a new entrant that looks at the impact of charter schools on student performance in North Carolina. Hoxby, Murarka and Kang (2009) focus on charter schools in New York City, whilst Nichols and Ozek (2007) look at the impact in the District of Columbia (Washington D.C). The remaining estimates are spread amongst four papers. Zimmer et. al (2012) looks at the impact of charter schools across seven states. The estimates provide in figures 7 and 8 look at Chicago, Ohio and Texas, respectively, whilst the CREDO nationwide estimates focus on Arizona, Arkansas, Washington D.C, Minnesota, Missouri, Georgia and Ohio respectively. The CREDO Michigan and Pennsylvania papers provide negative results for their non-urban estimates. The forest for both ELA and Math in figures 7 and 8 consist of a larger amount of negative results when compared to other forest plots. This is perhaps due to the studies focusing on a larger geographical context and the forest plot experiencing little influence from urban estimates.

Figure 7: Forest plots for charter school intervention grouped at the elementary and middle school grade level.



Notes: The figure provides the forest plot for the effect size of charter school intervention at the elementary and middle grade level. The left-hand column provides the studies includes in the plot. On the right-hand size, we can see the effect size for each paper and its corresponding weight in the forest plot. Papers are weighted by random-effects meta-analysis. The centre of the plot provides a visual demonstration of the random effects analysis. The triangle provides the location of the effect size, and its size indicates its weight, the candle sticks either side represent the 95 percent confidence interval. The overall effect size is demonstrated by the diamond at the bottom. The bottom left provides statistics regarding the heterogeneity.

Figure 8: Forest plot for charter school intervention for Math results group at the elementary and middle school level

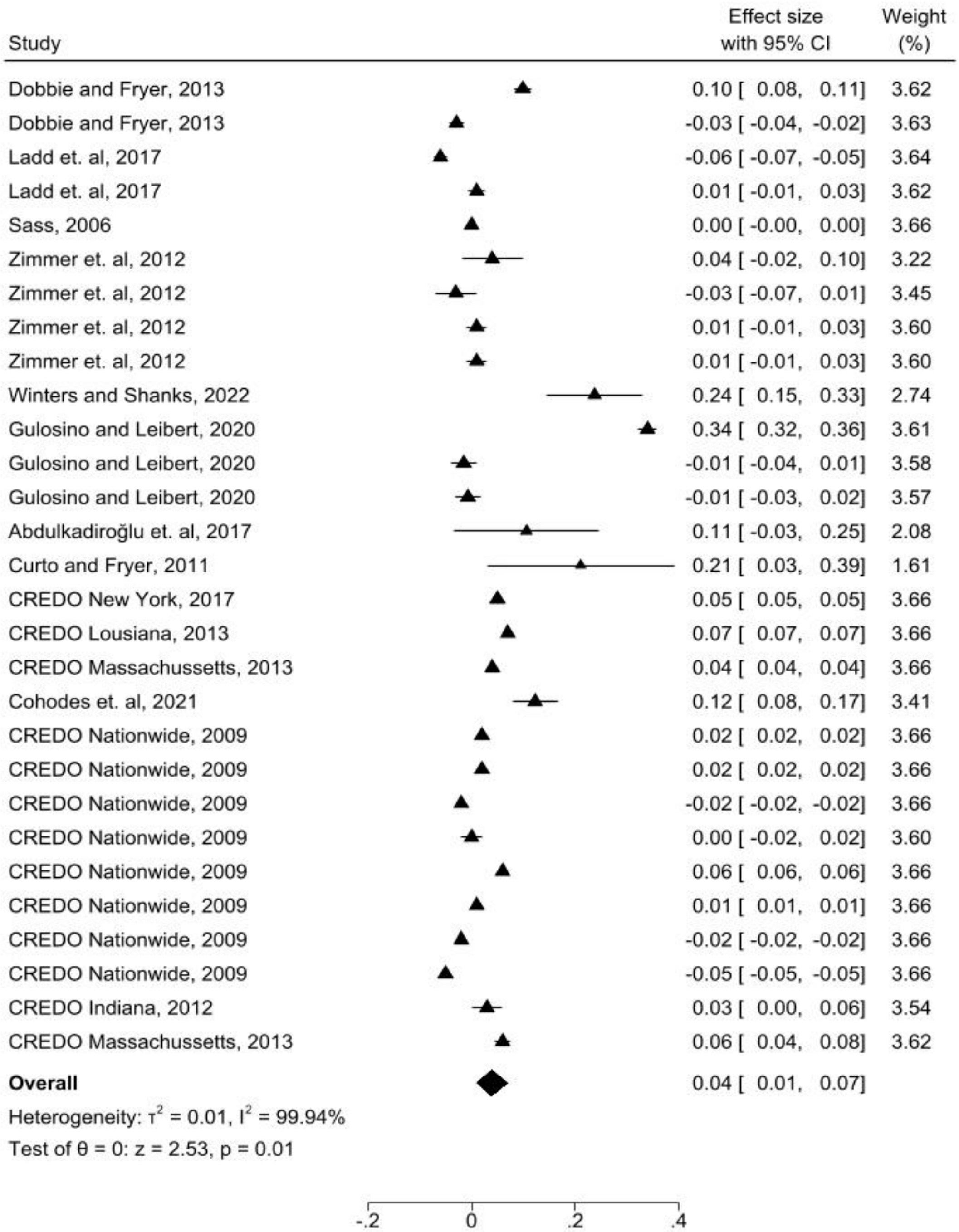


Notes: The figure provides the forest plot for the effect size of charter school intervention at the elementary and middle grade level. The left-hand column provides the studies includes in the plot. On the right-hand size, we can see the effect size for each paper and its corresponding weight in the forest plot. Papers are weighted by random-effects meta-analysis. The centre of the plot provides a visual demonstration of the random effects analysis. The triangle provides the location of the effect size, and its size indicates its weight, the candle sticks either side represent the 95 percent confidence interval. The overall effect size is demonstrated by the diamond at the bottom. The bottom left provides statistics regarding the heterogeneity.

5.2.5 Pooled results

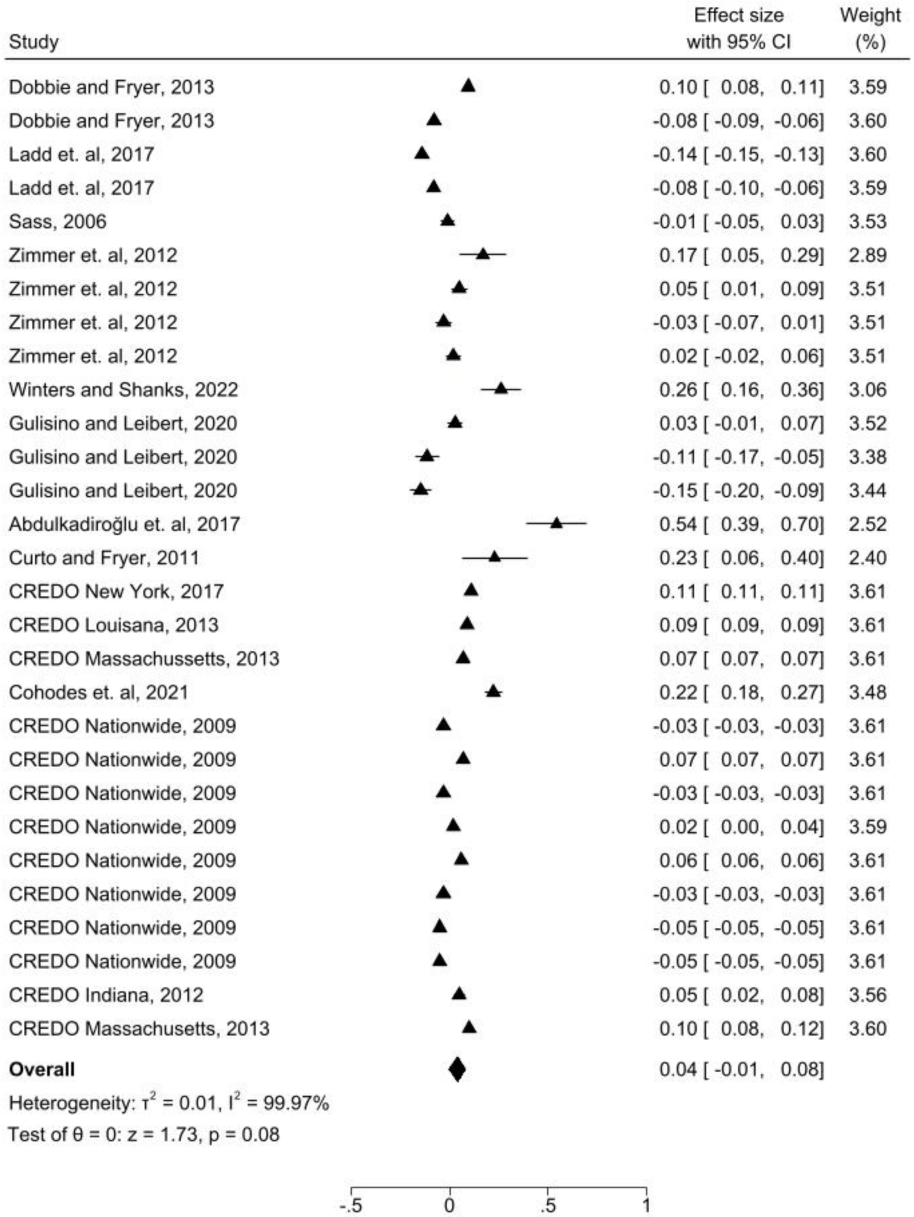
The forest plots found in figures 9 and 10 provide the most extensive list of results found in the forest plots in figures 1 through 10. The effect size for ELA and Math results are equal to 0.04σ and 0.04σ, respectively, both significant at 1% level. Dobbie and Fryer (2013) look at the impacts of charter schools in Texas, proving an urban and non-urban estimate. Ladd et. al (2017) look at North Carolina, Sass (2006) looks at the impact of charter schools in Florida and the Zimmer et. al (2012) estimates focus on Denver, Milwaukee, Philadelphia and San Diego, respectively. Winters and Shanks (2022) use a DA matching system to estimate the impact of charter schools in Newark, whilst Abdulkadiroğlu et. al (2017) uses the same method to provide estimates in Denver. Gulosino and Leibert (2020) look at the impact of charter schools and provide urban and non-urban estimates. Cohodes et. al (2021) looks at the scaling up of No Excuse charter schools in Boston. The non-urban estimates in Dobbie and Fryer (2013), Ladd et. al (2017) and Gulisono and Leibert (2020) find negative returns. The CREDO nationwide paper estimates focus on a variety of states across the U.S

Figure 9: Forest Plot for charter school intervention that pools ELA results at all grade level



Notes: The figure provides the forest plot for the effect size of charter school intervention at the elementary, middle and high school grade level. The left-hand column provides the studies includes in the plot. On the right-hand size, we can see the effect size for each paper and its corresponding weight in the forest plot. Papers are weighted by random-effects meta-analysis. The centre of the plot provides a visual demonstration of the random effects analysis. The triangle provides the location of the effect size and its size indicates its weight, the candle sticks either side represent the 95 percent confidence interval. The overall effect size is demonstrated by the diamond at the bottom. The bottom left provides statistics regarding the heterogeneity.

Figure 10: Forest Plot for charter school intervention that pools Math results at all grade level



Notes: The figure provides the forest plot for the effect size of charter school intervention at the elementary, middle and high school grade level. The left-hand column provides the studies includes in the plot. On the right-hand size, we can see the effect size for each paper and its corresponding weight in the forest plot. Papers are weighted by random-effects meta-analysis. The centre of the plot provides a visual demonstration of the random effects analysis. The triangle provides the location of the effect size, and its size indicates its weight, the candle sticks either side represent the 95 percent confidence interval. The overall effect size is demonstrated by the diamond at the bottom. The bottom left provides statistics regarding the heterogeneity.

5.3 Heterogeneity in the meta-analysis

Across all grade levels there is significant amount of heterogeneity. The chi-squared statistic, which is a formal measure of heterogeneity (Hopewell et. al, 2010), is large and statistically significant across the full sample, as well as the grade-level subgroups. The between study variance, τ, is positive and significant for all forest plots. Nearly all of the variance found in τ appears to be true variance, measured by the I^2. An I^2 of 75% or above resembles considerable heterogeneity and should be explored further (Hopewell et. al, 2010)

The two main methods of exploring heterogeneity are sub-group analysis and a meta-regression. Sub-group analysis takes one study-level variable and explores it at a more granular level. The forest plots for figure 1 through 10 provide a form on sub-group analysis at the grade level. The limitation of sub-group analysis is that it only allows you to explore the impact of one study-level characteristic at a time (Hopewell et. al, 2010), and thus only explains a fraction of the heterogeneity in the literature (Borenstein et. al, 2009). Moreover, as with figures 1 through 10, heterogeneity can exist at the sub-group level (Hopewell et. al, 2010), implying that there are other study-level characteristics that are influencing the effect size of charter school intervention. Therefore, to further explore the heterogeneity in the literature, this paper conducts a meta-regression.

6. Meta-regression

6.1 Overview of meta-regression

A meta-regression provides an extension of sub-group analysis (Hopewell et. al, 2010), as it allows for multiple factors to be explored concurrently (Thompson and Higgins, 2002). Meta-regression is like ordinary least squares (OLS) regressions analysis, in that there is a dependent variable, which is the effect size of a study, and there are explanatory variables, which are study-level characteristics from the papers included in the meta-analysis, commonly referred to as covariates or moderators. Meta-regressions are distinct from OLS regression analysis in two ways. First, as with a meta-analysis, studies are weighted by the precision of their estimates. Thus, a meta-regression takes the form of a weighted least squares (WLS) regression. Furthermore, the error term consists of two elements. First, the within study variances (ε) and secondly, the between study variance (ζ). The regression coefficients obtained will explain how the dependent variable (the effect size, θi) changes by a unit change of a covariate (study-level characteristic). This paper runs multiple meta-regressions, provided in equations (3) through (8). To avoid overfitting, there is a consensus in the literature that a meta-regression should include no more than one covariate for every ten studies (Hopewell et. al, 2010). Given this meta-analysis includes 30 papers, all meta-regressions include exactly three covariates.

The meta-regression equation for this paper is as follows:

$$\theta i = \beta o + \beta 1X1i + \beta 2x2i + \beta 3x3i + \varepsilon + \zeta \qquad (3)$$
$$\theta i = \beta o + \beta 1X1i + \beta 2x2i + \beta 3x4i + \varepsilon + \zeta \qquad (4)$$
$$\theta i = \beta o + \beta 1X1i + \beta 2x2i + \beta 3x5i + \varepsilon + \zeta \qquad (5)$$
$$\theta i = \beta o + \beta 1X1i + \beta 2x4i + \beta 3x5i + \varepsilon + \zeta \qquad (6)$$
$$\theta i = \beta o + \beta 1X2i + \beta 2x4i + \beta 3x5i + \varepsilon + \zeta \qquad (7)$$
$$\theta i = \beta o + \beta 1X2i + \beta 2x3i + \beta 3x4i + \varepsilon + \zeta \qquad (8)$$
$$\theta i = \beta o + \beta 1X2i + \beta 2x3i + \beta 3x5i + \varepsilon + \zeta \qquad (9)$$

θi - effect size of paper i

βo - intercept which represents θ.

X1i - dummy variable if the paper focuses solely on “No-Excuse” charter schools. The dummy is 1 if it does so and 0 if it does not.

X2i - dummy variable if the paper focuses on urban-based charter schools. 1 if it does and 0 if it does not.

X3i – represents the Grade level (elementary, middle and grade)

X4i – is a proxy for the level accountability at the state level, measured by the National Alliance for Public Charter Schools (NAFPCS) model law report.

X5i – is a proxy for the level of autonomy provided to charters at the state level, measured by National Alliance for Public Charter Schools model law report[2].

[2] The National Alliance for Public Charter Schools model law report can be found at https://publiccharters.org/charter-school-state-resources and https://spaces.hightail.com/space/f25HaPPNr5 . It ranks state law related to charter schools from 0 to 4 across a variety of measures, 0 being the lowest score and 4 being the highest. The are 21 ‘essential components’ in total, all of which the NAFPCS believe to be integral for charter school success. States that have the highest total score are deemed to have designed state law to be conducive to charter school success. The 21 essential components include laws related to accountability, teaching, autonomy amongst other factors.

ε - represents the within-study variance

ζ- represents the between study variance.

6.2 Choice of variables

6.2.1 "No-Excuse" dummy variable

As outlined in section 2.5 of this paper, charter schools have autonomy over the choice of curriculum. Charter schools market themselves differently based on the parents they serve (Gulosino and Leibert, 2020). The "No Excuse" model is the most prominent curriculum that focuses on student achievement. Empirical research on the "No Excuses" model tends to find strong positive gains in both ELA and Math results (Angrist, 2013; Dobbie and Fryer, 2011). Given this, it is plausible to assume that papers focusing on this charter type may contribute to heterogeneity in the findings.

In order to incorporate "No Excuses" papers, a "No Excuse" dummy variable has been coded during the literature search. The dummy variable has been coded as followed:

(1) If the paper explicitly references the "No Excuse" model and implies that the paper only focuses on this charter type.
(2) The paper implies the use of all four of the key characteristics of the charter schools: strong disciplinary code, high expectations, data-driven feedback for teachers/students and enhanced instruction time.
(3) Papers that reference some but not all the "No Excuse" characteristics will not be included. Whilst papers that reference "No Excuses" but imply that their data set includes a mix of "No Excuses" and other charter school types, will not be included.

6.2.2 Urban dummy

Geography plays a sizable role in the reported outcomes for charter school achievement. It is often posited that urban schools are better at increasing performance than non-urban schools, referred to as the "urban charter advantage" (Angrist, 2012). Therefore, it is likely that papers focusing on urban areas contribute to the heterogeneity found in the meta-analysis. A dummy variable is included to represent this, 1 if the paper focus strictly on urban charter schools and 0 otherwise.

6.2.3 Grade-level

In keeping with the sub-groups analysis employed in section 5, the grade level has been chosen as the third covariate for the meta-regression. Although this covariate has been dissected to the subgroup analysis, it is worthwhile to put it through a more rigorous statistical test, whilst also controlling for it alongside the ‘No Excuses’ and ‘Urban’ dummy variables. The grade level will take on the form of a categorical variable, representing 1 for Elementary, 2 for Elementary and Middle, 3 for Middle, 4 for pooled results and 5 for High.

6.2.4 Accountability

As outlined in section 2.3 of this paper, accountability can play an important role in student achievement (Hanushek and Raymond, 2005; Rockoff and Turner, 2010). As found in Gleason et. al (2010), charter school performance differs at the state level, and differing levels of accountability in state law may contribute to differences in performance (Hanushek and Raymond, 2005). A proxy for accountability is measured by the NAFPCS’ ‘Model Law’. The level accountability for charter schools is measured through the ‘Model Laws’ “*Performance-based charter contracts required*” metric, which ranks a state from 0-4. A ranking of 0 suggests a very limited accountability for student achievement, whilst a ranking of 4 represents what the NAFPCS deems a high level of accountability for student achievement. The NAFPCS database first published its model law in 2009. For papers in the meta-analysis that predate 2009, the 2009 ranking for accountability will be used. For all papers in the meta-analysis that were published after 2009, the NAFPCS estimate used is based on the year the study was published.

6.2.5 Autonomy

As mentioned across Section 2 of this paper, the amount of autonomy provided to charter schools can be a contributing factor to their success. The level of autonomy is determined by state law, which allows charter schools greater autonomy over budgeting, hiring of staff and general instruction set by management (Cohodes and Parham, 2021). It is therefore plausible that the level of autonomy provided to charter schools can contribute to the heterogeneity in the literature. A proxy for accountability is used from the NAFPCS' model law. The level of accountability is measured through the Model Laws "*Fiscally and Legally Autonomous Schools, with Independent Public Charter School Boards*" metric, which ranks the level of autonomy at the state level from 0 to 4. 0 representing very limited autonomy for public charter schools and 4 representing considerable autonomy. As with the accountability proxy, all papers that predate 2009, the 2009 measurement for autonomy is used. All papers from 2009 onwards will use the measurement for the year the study was published.

6.3 Meta-regression results

Table 3 and 4 provide the breakdown for the results for meta-regressions (3) through (9). In accordance with the literature on the causal effects of Charter Schools, a meta-regression has been run for both ELA and Math results. Table 3 provides the estimated coefficients for Math results, whilst Table 4 provides the meta-regression estimates for ELA results. As both tables depict, the "No Excuses" dummy variable is found to be positive statistically significant in all meta-regressions, indicating that papers focusing strictly on the No Excuse model contribute to the heterogeneity. The results for the Urban dummy are statistically significant in all regressions. As with the No Excuse dummy, the Urban dummy variable has a positive impact on student achievement in both ELA and Maths. The Grade level covariate has a much blunter impact on Math and ELA results. This is particular evident for the ELA meta-regressions, where the 'Grade' covariate has nearly no impact on effect sizes in the literature. The results for the 'Accountability' covariate are interesting, it is found to be both statistically significant and positive across three of the four Math meta-regressions, however it has a rather tame influence on the findings in the ELA meta-regressions. The results are somewhat similar for the 'Autonomy' covariate, which is statistically significant and positive in two out of the four meta-regressions for Math results. In both tables there is a reduced impact of the covariates in the ELA results, which is most stark for the 'Accountability' covariate. This outcome is generally in keeping with the wider literature on charter schools' impact on student performance, where the response in Math results is consistently higher than ELA and is supported by research in development psychology.

Table 3: Meta-regression results for Math

	Regression						
Variables	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
No Excuses	**0.17*** (0.028)**	**0.16*** (0.030)**	**0.17*** (0.030)**	**0.21*** (0.032)**			
Urban	**0.093*** (0.018)**	**0.097*** (0.019)**	**0.089*** (0.020)**		**0.14*** (0.022)**	**0.14*** (0.022)**	**0.13*** (0.023)**
Grade	**-0.013*** (0.007)**					**-0.018*** (0.008)**	**-0.015** (0.009)**
Accountability		**0.027*** (0.013)**		**0.018 (0.015)**	**0.045*** (0.015)**	**0.05*** (0.015)**	
Autonomy			**0.015 (0.012)**	**0.021 (0.014)**	**0.025* (0.014)**		**0.026* (0.014)**
Constant	**0.026 (0.023)**	**-0.07 (0.03)**	**-0.07 (0.04)**	**-0.088 (0.05)**	**-.019 (0.05)**	**-0.05 (0.03)**	**-0.05 (0.06)**
R^2	**60.05**	**57.30**	**56.39**	**44.52**	**41.57**	**45.26**	**40.13**
Observations	**98**	**94**	**94**	**94**	**94**	**94**	**94**

Notes: The above table reports the results of the meta-regression for Math results found in the literature. In the left column we have the list of variables (covariates) included within the meta-regressions. The row at the top provides the separate meta-regressions, (3) through (9), a detailed description of each meta-regression is provided in section 6.1 of this paper. Each meta-regression includes exactly three of the covariates, in keeping with the consensus found in the literature, meta-regressions (3) through (9) provide different combinations of the covariates. Column (3) provides the results for the meta-regression that includes the 'No Excuses', Urban and Grade covariates. Column (4) provides the results for the meta-regression that includes 'No Excuses', Urban and Accountability. Column (5) through (9) read in the same manner as (3) and (4). Each cell provides the coefficient for a given covariate in the respective meta-regression, as well as its standard error in the parentheses below it. The bottom two rows provide the R^2 and the number of observations for each meta-regression.
*** represents significance at the 1% level
** represent significance at the 5% level
*represents significant at the 10% level

Table 4: Meta-regression results for ELA

Regression

Variables	(3)	(4)	(5)	(6)	(7)	(8)	(9)
No Excuses	**0.12*** (0.028)**	**0.12*** (0.029)**	**0.12*** (0.028)**	**0.14*** (0.028)**			
Urban	**0.043*** (0.018)**	**0.043*** (0.018)**	**0.045*** (0.020)**		**0.072*** (0.018)**	**0.075*** (0.021)**	**0.071*** (0.018)**
Grade	**-0.0001 (0.006)**					**-0.005 (0.006)**	**-0.004 (0.006)**
Accountability		**0.0025 (0.012)**		**-0.008 (0.013)**	**0.01 (0.013)**	**0.017 (0.013)**	
Autonomy			**0.012 (0.011)**	**0.014 (0.012)**	**0.021* (0.012)**		**0.021* (0.012)**
Constant	**0.003 (0.023)**	**-0.002 (0.027)**	**-0.039 (0.038)**	**-0.014 (0.04)**	**-0.08 (0.04)**	**-0.05 (0.05)**	**-0.011 (0.04)**
R^2	**26.58**	**26.57**	**29.04**	**24.17**	**15.56**	**15.74**	**12.51**
Observations	**98**	**94**	**94**	**94**	**94**	**94**	**94**

Notes: The above table reports the results of the meta-regression for Math results found in the literature. In the left column we have the list of variables (covariates) included within the meta-regressions. The row at the top provides the separate meta-regressions, (3) through (9), a detailed description of each meta-regression is provided in section 6.1 of this paper. Each meta-regression includes exactly three of the covariates, in keeping with the consensus found in the literature, meta-regressions (3) through (9) provide different combinations of the covariates. Column (3) provides the results for the meta-regression that includes the 'No Excuses', Urban and Grade covariates. Column (4) provides the results for the meta-regression that includes 'No Excuses', Urban and Accountability. Column (5) through (9) read in the same manner as (3) and (4). Each cell provides the coefficient for a given covariate in respective meta-regressions, as well as its standard error in the parentheses below it. The bottom two rows provide the R^2 and the number of observations for each meta-regression.

*** represents significance at the 1% level
** represent significance at the 5% level
*represents significant at the 10% level

6.4 Explaining the results

6.4.1 "No Excuses"

The results of the meta-regression provide external validity to the internal validity found in studies that focus on the 'No Excuse' model. Evidently, papers focusing on the "No Excuse" model contribute to the heterogeneity found in the literature, as in each of the four meta-regressions, (3) through (6), the 'No Excuse' covariate is both statistically significant and positive. Moreover, the size of the coefficients indicate that No Excuse charter schools can lead to strong gains in ELA and Math. The mechanisms behind the No Excuse model success are explained in section 2.5, readers are kindly suggested to revisit this section to familiarise yourself with the No Excuse model.

Dobbie and Fryer (2012) get *"beneath the veil"* of successful charter schools to see what school level factors contribute to student achievement. They find that all principles of the "No Excuse" contribute to its success and provide a quantitative footing to much of the qualitative assessments of successful schools that predated the paper. In 1974, the Office of Education Performance Review in New York, found that academic achievement was driven by principal skills, high expectations for students and classroom instruction. When examining elementary schools in California, Madden et al (1976) found that successful schools provided teacher feedback, tutor their students and monitor student performance, in line with the findings of Brookover and Lezotte (1979) in Michigan. Therefore, the principles of the "No Excuses" model are not new phenomena. However, it is apparent that No Excuse charters are successful in implementing *all* of these principles across *all* of their schools.

6.4.2 Urban

As with the findings for the "No Excuse" covariate, the "Urban" covariate provides external validity to the studies that find an "urban charter advantage" (Angrist, 2012) and explains part of the heterogeneity in the literature. The urban dummy is found to be significant and positive across meta-regressions (3), (4), (5) and (7).

When trying to explain why the “urban charter advantage” exists, it is important to consider the traditional public-school landscape in the United States. Inner-city traditional public schools tend to perform poorly in comparison to rural or suburban schools. This contributes to the “urban charter advantage” in two ways. First, the comparison group, traditional public schools, will tend to perform more poorly in urban areas than non-urban areas. Thus, the σ gains in ELA and Math results found in urban charter schools, may in part be explained by the poor functioning of the competing public schools. Second, it results in different drivers behind charter school demand. Parents in sub-urban or rural areas opt for charter schools that focus on art and progressive forms of education (Langhorne, 2018), perhaps because educational achievement is more easily found in non-urban traditional public schools. Using the same logic, parents in urban areas favour charter models that focus on student achievement (Hastings and Weinstein, 2007), perhaps because it is difficult to come by. Thus, as more urban charters focus on student achievement than non-urban partners, the “urban charter advantage” is a likely outcome.

6.4.3 Grade level

The results found for grade level covariate across ELA meta-regressions (3), (8) and (9) are interesting. Research in development psychology suggests that children develop their reading and writing skill at an earlier age (Pinker, 1994). Fryer (2014) theorises that this is the explanation behind the more muted response in σ for ELA results found in the literature and suggest that it explains why high school improvements are similar to elementary level improvements. The results from the meta-regressions add evidence to this claim, as the coefficient for grade level in the ELA regression suggests that ELA improvement is agnostic to grade level and was not found to be statistically significant. The maths result suggests there is less improvement from charter school intervention as we move up the grade level. Again, this is a plausible finding, given that children are often more receptive to new forms of learning at an earlier age.

6.4.4 Accountability

The meta-regressions for the Math meta-regressions indicate the differing levels of accountability at the state level contribute to the heterogeneity in the literature. Further to that, the results are suggestive that higher levels of accountability lead to greater student improvement in Math. This finding supports the work of (Hanushek and Raymond, 2005), which found that states with greater levels of accountability led to the greatest level of student achievement. More explanation on how accountability can impact student achievement can be found in section 2.3. The results also suggest that accountability has a muted and insignificant impact on ELA results. Again, this finding is in keeping with the wider literature on the impact of charter schools, which generally finds a much weaker response in ELA than Math results. As previously mentioned, it is believed that much of a child's development of reading and writings skills occur early on (Pinker, 1994), perhaps explaining the 'Accountability' covariates limited impact on ELA results.

6.4.5 Autonomy

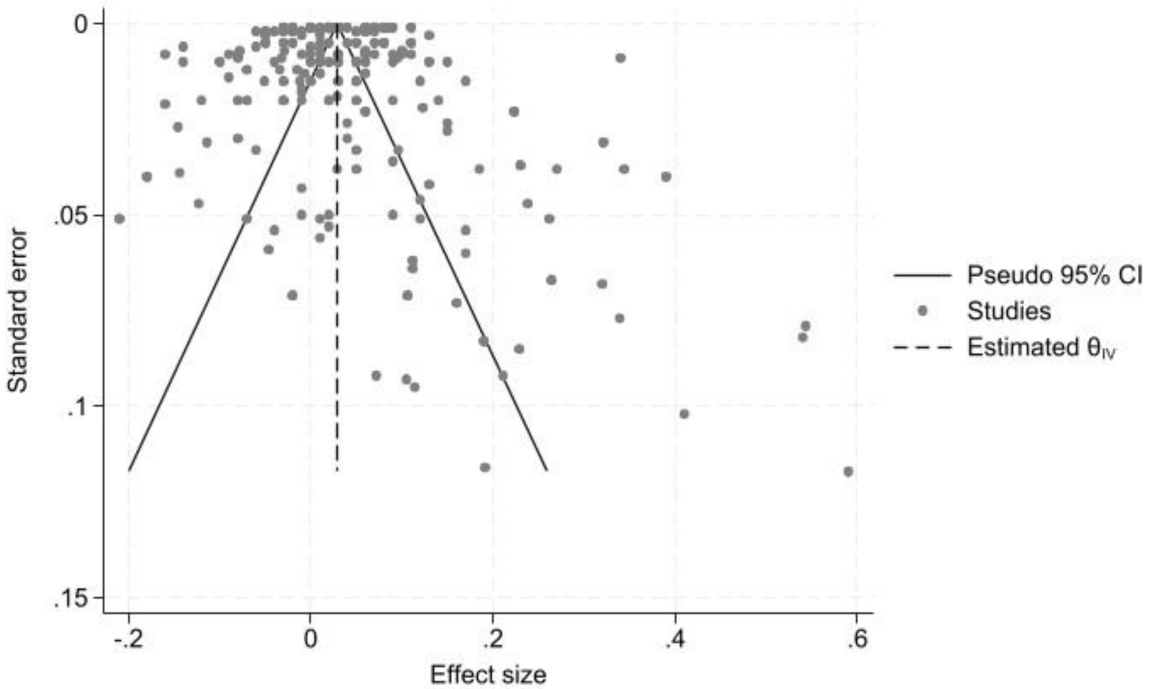
The results for the 'Autonomy' covariate suggest that differing levels of autonomy granted to charter schools contributes to the heterogeneity in the literature. Furthermore, the 'Autonomy' covariate produces positive and statistically significant results for two out of the four math regressions, suggesting it can be a positive driver for student achievement. The mechanisms behind why autonomy can improve student performance is explored throughout section 2, readers are again kindly suggested to read this section. Interestingly, the coefficients for the 'Autonomy' covariate are slightly more muted than the 'Accountability' covariate. This is perhaps 'Accountability' has a direct link to student achievement, as charter schools must meet certain standards for their licence to be renewed. Autonomy, on the other hand, may lead to plethora of outcomes, and provide the opportunity for charters to market themselves differently. As mentioned in prior sections in this paper, not all charters focus directly on student achievement and this in part may explain the slightly reduced impact for the 'Autonomy' covariate in comparison to 'Accountability' covariate. The impact on ELA results is more muted, although the covariate is found to be statistically significant in two out of four meta-regressions.

7. Robustness checks

A long-standing concern in the meta-analysis literature is the presence of publication bias. Publication bias exists when the scientific publication process skews research within a field (Card and Krueger, 1995; Disder and Head, 2008). Meaning that all parties involved, whether that be authors, reviewer or editors, prefer empirical results that fulfil underlying expectations on the subject. Therefore, a publisher's tendency to publish statistically significant findings, as well as a bias towards a certain direction of results, may lead to only a sample of total findings being published (De Long and Jang, 1992).

The most popular method to identify publication bias is to establish the relationship between the effect size and the standard error (Card and Krueger, 1995). In the absence of publication bias, there is no reason to assume a linear relationship between the impact of charter schools and the precision of the estimates. To uncover publication bias in this meta-analysis, a funnel plot has been constructed to provide an illustrative representation of potential bias. Figure 11, the funnel plot, draws on the fundamental idea of publication bias outlined above. If there is completely abject of publication bias, the graph will resemble an inverted funnel, represented by the pseudo 95% confidence interval.

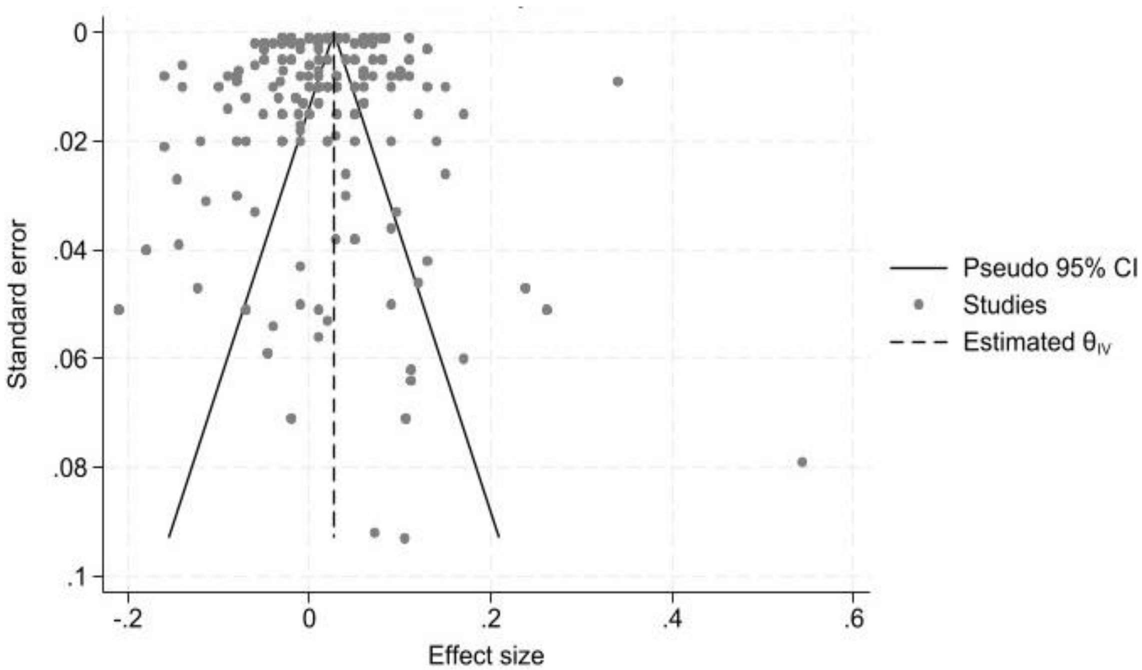
Figure 11: Funnel plot to identify presence of publication bias



Notes: the figure plots the estimates of the effect size of charter school intervention against its corresponding standard error. A funnel plot provides a visual representation of publication bias. If the literature were completely absent of publication bias, the estimates would fall in the symmetrical inverted funnel, represented by the 'Pseudo 95% CI' lines. The X axis plots the effect size and the Y axis is reversed so that the most accurate predictions are placed at the top of the plot.

Evidently, the funnel plot does not present perfect symmetry in the findings. However, this may be due to several reasons that are not directly linked to publication bias (Peter et. al, 2010). Heterogeneity, reporting bias and chance may all contribute to an asymmetric funnel plot (Peter et. al, 2010). To uncover the cause behind the asymmetry found in figure 11, this paper conducts a sensitivity analysis, which removes estimates that focus strictly on the "No Excuses" model.

Figure 12: Funnel plot after the removal of 'No Excuses' papers



Notes: the figure plots the estimates of the effect size of charter school intervention against its corresponding standard error. A funnel plot provides a visual representation of publication bias. If the literature were completely absent of publication bias, the estimates would fall in the symmetrical inverted funnel, represented by the 'Pseudo 95% CI' lines. The X axis plots the effect size, and the Y axis is reversed so that the most accurate predictions are placed at the top of the plot.

Figure 12 provides the funnel plot after the removal of papers that strictly focus on No Excuse charter schools. The sensitivity analysis appears to reduce some of the rightward bias found in figure 11, suggesting that the asymmetry was due to heterogeneity and not publication bias. Figure 12 does provide two extreme outliers on the right-hand side. The second furthest estimate was from Gulosino and Leibert (2020) in an urban estimate on the casual effect of charter schools in California. The farthest right estimate was found by Abdulkadiroğlu et al (2017) in one of the two DA studies. The study focused on Denver charter schools, where 50% of the sample data were No Excuse schools. The sensitivity analysis reinforces the findings of the meta-regression.

8. Conclusion

To conclude, the meta-analysis conducted in this paper adds external validity to the internal validity found across charter school literature. The paper adds to the literature by conducting a meta-regression to disentangle the study level factors that contribute to the heterogeneity in the findings. The overall effect size of the meta-analysis was found be positive and statistically significant in both ELA and Math, whilst seven out of the ten forest plots found positive and significant results in ELA and Math.

As demonstrated throughout this paper, there is a considerable amount of heterogeneity found in the literature. Meta-regressions were conducted to help illuminate which study level factors contribute to the heterogeneity in the studies. The result for the 'Urban' covariate confirms the "urban charter advantage" found in the literature, whilst the results for the 'Grade' covariate confirm findings from development psychologists which suggests that most of a child's development of reading and writing skills occur in their formative years (Pinker, 1994). The meta-regressions also indicate that both a stronger level of accountability and autonomy provided in state law can be positive drivers for student achievement. The result for the "No Excuse" covariate is particularly interesting. Not only does this study-level covariate explain part of the heterogeneity, but it also finds that the "No Excuse" model leads to at least a 0.12σ and 0.17σ gain in ELA and Math results, respectively. To put this into the context, the National Assessment of Education Progress, estimates the student achievement gap between whites and ethnic minorities to be around 0.6-0.8σ, which varies on grade level, race and location. Therefore, the results from the meta-regression suggest that the "No Excuse" charter model can close a considerable amount of the student achievement gap in just three to four years of schooling.

Early evidence suggests that the "No Excuse" model can be both replicable and scalable. In a field experiment, Fryer (2014) trialled the "No Excuses" practices within public schools in Houston. Fryer (2014) found that this led to 0.18σ improvement in Math, whilst the impact on ELA results were modest. In a similar field experiment in the North-East region of Denver, an area that is comprised of a large proportion of ethnic minorities, found that injecting "No Excuse" practices into traditional public schools led to 0.17σ improvement in Math. The results of the Houston and Denver field experiments are markedly similar to the

No Excuses finding in the meta-regression. By looking at a education reform in Boston - which increased the cap on the number of charter schools - Cohodes et. al (2021) estimated how the "No Excuse" model scaled. The majority of schools in the reform were "No Excuse" charters, as policymakers opted for 'proven providers' in charter schools (Cohodes et. al, 2021). The paper found a 0.32σ improvement in Math results and 0.23σ improvement in ELA result, suggesting that good charter school practices can be implemented on scale.

There will inevitably be some obstacles when implementing and scaling the best practices of charter schools. Firstly, the contentiousness of the "No Excuse" model's emphasis on discipline is outlined in section 3.3. This issue is likely to be amplified when instilled in public schools not 'chosen' by parents, and perhaps would be deemed too paternalistic if imposed directly by the government. Therefore, more research into the 'No Excuse' disciplinary code would be beneficial. Other obstacles include financing and human capital. Fryer (2014) found that performance-enhancing schools were associated with marginally higher costs and found it to be an arduous task to find credible principals for the field experiment in Houston, interviewing three hundred to find only nineteen suitable candidates. Finding the correct teaching and principal staff may indeed pose a significant barrier to wider adoption of good charter school practices. Especially when considering that unionisation is rare within the charter school teaching staff, but almost ubiquitous in the traditional public school teaching staff. However, costs should not be viewed as a barrier to wider implementation of good school practices. As although Fryer (2014) finds that No Excuses schools increase costs, the paper also finds a greater return to investment. Furthermore, early work on non-test outcomes of "No Excuse" charters show positive signs, as Dobbie and Fryer (2013) found a reduction in crime and teenage pregnancy amongst "No Excuse" students when compared to traditional public-school peers.

Overall, charter schools can improve the educational achievement of its pupils. This outcome is more likely for children from urban areas, in states that ensure accountability and autonomy, and is most profound for students enrolled in schools that employ a particular set of practices. Regardless of whether these practices become more widely adopted, it is clear that underprivileged children should not be subject to limited opportunities by default and that more can be done to close the student achievement gap.

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