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THE EFFECT OF ADDITIONAL RESOURCES FOR SCHOOLS WITH DISADVANTAGED STUDENTS: EVIDENCE FROM A CONDITIONAL EFFICIENCY MODEL

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Beleidssamenvatting

Sinds 2002 werd in Vlaanderen het Gelijke Onderwijskansen (GOK)-programma geïmplementeerd. Dit GOK-programma voorziet bijkomende lestijden (in het basisonderwijs[1]) of uren-leraar (in het secundair onderwijs) voor scholen met een minimum aandeel leerlingen uit kansengroepen. Deze GOK-uren worden in principe toegekend in cycli van 3 jaar en dienen ingezet te worden op een vooraf bepaald thema.

In dit rapport wordt nagegaan in welke mate scholen in staat zijn om de bijkomende GOK-middelen die ze ontvangen op een efficiënte manier om te zetten in output. De basis van deze analyse is de onderwijsproductiefunctie die beschrijft hoe scholen inputs die ze ontvangen (bv. het urenpakket (inclusief GOK-uren) en de werkingsmiddelen) omzetten in outputs (bv. leerlingen die een A-attest ontvangen of leerlingen die doorstromen naar het hoger onderwijs). Gelet op de aanzienlijke publieke middelen die geïnvesteerd worden in onderwijs is het belangrijk om ernaar te streven dat deze middelen zo efficiënt mogelijk aangewend worden om gewenste output te genereren.

In het kader van een beleidsevaluatie zijn zowel effectiviteit als efficiëntie van belang. In effectiviteitsstudies wordt nagegaan of een bepaald doel bereikt werd (bv. een daling van het zittenblijven), terwijl in efficiëntiestudies geanalyseerd wordt of, gegeven een bepaalde inzet van middelen, de maximale mix van outputs bereikt werd.

In een eerder SONO-rapport (SONO/2017.OL3.1/3) werd de impact van bijkomende GOK-uren gekwantificeerd en werd dus een effectiviteitsbenadering gevolgd. In dit rapport ligt de nadruk op efficiëntie-meting en het kan bijgevolg als complementair beschouwd worden aan de effectiviteitsanalyse.

Voor dit onderzoek werd gebruik gemaakt van bestaande administratieve databanken van het Vlaams Ministerie van Onderwijs en Vorming. Zowel voor basis-als voor secundair onderwijs werden gegevens ter beschikking gesteld op leerlingniveau (bv. GOK-kenmerken, geslacht, nationaliteit, administratieve groep, problematische afwezigheid, schoolse vertraging, behaalde attesten en (eventuele) inschrijving in het hoger onderwijs, …) en op schoolniveau (bv. aandeel GOK-leerlingen, schoolgrootte, lestijden of uren-leraar, GOK/SES-middelen, anciënniteit van leerkrachten en directie, …). Aangezien in de efficiëntiestudie de eenheid van analyse de school is, werden een aantal variabelen die betrekking hebben op leerlingen geaggregeerd op schoolniveau.

Het feit dat de overheid een drempel heeft ingesteld om aanspraak te kunnen maken op GOK-uren (minimum 10% GOK-leerlingen in de eerste graad van het secundair onderwijs en minimum 25% GOK-leerlingen in de tweede en derde graad van het secundair onderwijs) laat toe om een methodologisch innovatieve techniek te ontwikkelen die toelaat verschillen in efficiëntie op een oorzakelijke manier te interpreteren[2]. In eerste instantie zullen we scholen vergelijken die zich net onder of net boven deze

[1] In het basisonderwijs werd het systeem van de GOK-lestijden vanaf het schooljaar 2012-2013 vervangen door een geïntegreerd systeem waarbij de SES-lestijden (die toegekend worden op basis van de socio-economische status van de leerlingen in een school) integraal deel uitmaken van de omkadering.

[2] In het basisonderwijs geldt sinds de invoering van het geïntegreerde omkaderingssysteem in 2012 geen minimumdrempel meer. Bijgevolg is het voor het basisonderwijs niet mogelijk om efficiëntieverschillen tussen scholen oorzakelijk te interpreteren.

drempels bevinden, omdat voor deze scholen de oorzakelijke interpretatie het meest valide is. Aangezien deze drempelwaarden aan de scholen opgelegd worden door externe entiteit (in concreto de Vlaamse overheid), zullen scholen die zich net onder en net boven deze drempel bevinden zeer sterk vergelijkbaar zijn en kunnen gemeten efficiëntie-verschillen tussen scholen onder de drempel (deze scholen ontvangen geen bijkomende middelen en worden beschouwd als 'controlegroep') en scholen boven de drempel (deze scholen ontvangen wel bijkomende middelen) toegewezen worden als het effect van de GOK-middelen op de efficiëntie.

Cruciaal voor dit soort analyses is dat scholen die zich onder en boven de drempel bevinden niet fundamenteel van elkaar verschillen, zo niet is de controlegroep niet voldoende vergelijkbaar met de interventiegroep. Bij de selectie van de bandbreedte rond de drempelwaarden is er dus een afweging: een kleine bandbreedte zorgt voor een grote interne validiteit maar reduceert het aantal observaties en de externe validiteit; terwijl een grote bandbreedte zorgt voor voldoende observaties, maar tegelijk de vergelijkbaarheid en dus de interne validiteit reduceert. Om na te gaan of de resultaten niet sensitief zijn aan de gekozen bandbreedtes, experimenteren we in verdere analyses en robuustheidschecks met de bandbreedte rond deze drempels en zullen we finaal ook de volledige populatie van scholen in de analyses opnemen.

Voor de analyses maken we gebruik van een niet-parametrische 'Free Disposal Hull' (FDH) model, waarbij scholen met elkaar vergeleken worden door middel van een benchmark. Scholen die met gegeven inputs de hoogste outputs behalen, krijgen een efficiëntiescore van 100 procent. Scholen die onder de benchmark scoren, krijgen een lagere score: bv. een school met een score van 90% realiseert met vergelijkbare inputs een output die 90% bedraagt van die van de best presterende gelijkaardige school. Dit betekent dat deze school met dezelfde middelen hogere outputs zou kunnen bereiken, of dezelfde outputs kan bereiken met de inzet van minder middelen. Om verschillen causaal te interpreteren, zullen drie verschillende productiegrenzen (benchmarks) geschat worden: (1) een algemene productiegrens voor alle scholen (binnen de gehanteerde bandbreedte); (2) een productiegrens voor scholen die zich boven de drempelwaarde bevinden (binnen de gehanteerde bandbreedte) en (3) een productiegrens voor scholen die zich onder de drempelwaarde bevinden (binnen de gehanteerde bandbreedte). De efficiëntiescore van een school binnen de groep waartoe ze behoort (GOK-scholen enerzijds en niet-GOK-scholen anderzijds) geeft een indicatie van efficiëntie van de school zelf (ze wordt immers vergeleken met andere scholen binnen dezelfde groep). Het verschil tussen de algemene productiegrens (1) en de productiegrens van GOK-scholen (2) enerzijds en niet-GOK-scholen (3) anderzijds duidt op de efficiëntie van de groep (GOK versus niet-GOK) in zijn geheel en kan geïnterpreteerd worden als programma-efficiëntie.

In een verdere verfijning worden tevens conditionele FDH-modellen geschat, waarbij rekening gehouden wordt met bijkomende schoolkenmerken, leerkrachtenkenmerken en leerlingenkenmerken zodat *de facto* enkel vergelijkbare observaties worden vergeleken.

De extra middelen die de scholen ontvangen die net boven de GOK-drempel vallen, zijn eerder beperkt. De scholen in de tweede en derde graad die zich binnen een beperkte bandbreedte van 6% rond de drempelwaarde bevinden ontvangen gemiddeld 9,81 GOK uren per school, of 0,02 uren per leerling op deze scholen. Voor de eerste graad ontvangen de scholen binnen een bandbreedte van 4% gemiddeld 8,44 GOK-uren, of 0,02 uren per leerling

Uit de resultaten van de niet-conditionele modellen blijkt dat, voor secundaire scholen binnen een beperkte bandbreedte rond de drempelwaarde om GOK-middelen te ontvangen, de algemene efficiëntie hoger is voor scholen uit de controlegroep (dit zijn scholen die geen GOK-middelen ontvangen). Dit verschil wordt voornamelijk veroorzaakt door een verschil in programma-efficiëntie die

voor GOK-scholen lager is dan voor niet-GOK-scholen. Deze bevinding blijft gelden over verschillende alternatieve specificaties (bv. modellen met een alternatieve mix van inputs en outputs, modellen met andere bandbreedtes of aparte modellen voor scholen die een bepaalde mix van onderwijsvormen aanbieden (bv. scholen met minstens een BSO aanbod of scholen met enkel een ASO aanbod)). Omdat de scholen binnen de bandbreedte rond de drempelwaarde om GOK-middelen te ontvangen vergelijkbaar zijn met elkaar, suggereert dit verschil dat scholen die de GOK-middelen ontvangen een lagere efficiëntie hebben.

Ondanks dat de scholen in de bandbreedte vergelijkbaar zijn, blijven er geobserveerde verschillen tussen de scholen die wel en de scholen die niet de GOK-middelen ontvangen. Wanneer in de conditionele modellen meer controlevariabelen worden toegevoegd die voor deze verschillen corrigeren, blijven scholen onder de drempel efficiënter, maar verkleinen de verschillen in algemene efficiëntie tussen scholen onder en boven de drempel. Ook de programma-efficiëntie blijft in de controlegroep consistent hoger, maar het verschil wordt kleiner naarmate meer controlevariabelen worden toegevoegd. Terwijl er voor de tweede en derde graad secundair onderwijs een lagere programma-efficiëntie blijft, observeren we in de eerste graad secundair onderwijs geen verschil meer in de programma-efficiëntie. Dit suggereert voor de eerste graad dat, wanneer we rekening houden met de school-, leraar- en leerlingkenmerken, de GOK-middelen de efficiëntie van de scholen niet beïnvloeden (noch in positieve, noch in negatieve zin). Bijkomende analyses laten toe om de richting van de invloed van contextuele variabelen op de efficiëntie van scholen te bepalen. Typische ASO scholen hebben een positieve invloed op efficiëntie terwijl een BSO aanbod een negatieve invloed heeft op efficiëntie. Een groot verloop van leerlingen heeft eveneens een negatieve invloed, terwijl schoolgrootte een positieve invloed heeft op de efficiëntie.

Bijkomend werden ook voor de conditionele modellen verscheidene alternatieve varianten geschat. Wanneer aparte modellen geschat worden voor scholen die minstens een BSO aanbod hebben, blijkt dat de gemiddelde programma-efficiëntie voor GOK-scholen lager is dan die van scholen die geen GOK-middelen ontvangen en dat de controlescholen gemiddeld beter presteren op de algemene efficiëntie dan de GOK-scholen. Het toevoegen van contextvariabelen, zoals kenmerken van de school, de leerkracht en de leerling vermindert echter aanzienlijk het verschil in de programma-efficiëntiescores, zelfs in die mate dat het verschil in sommige modellen niet langer significant is. Dezelfde conclusie geldt voor een deelsteekproef die beperkt is tot scholen die alleen ASO aanbieden. Aangezien de scholen in het Brussels Hoofdstedelijk Gewest (BHG) recht hebben op gunstigere omkaderingscoëfficiënten, zouden deze scholen potentieel voor een vertekening van de resultaten kunnen zorgen. Daarom hebben we extra robuustheidscontroles uitgevoerd door (1) de steekproef te beperken tot scholen in het BHG en (2) scholen het BHG uit de volledige steekproef weg te laten. De programma-efficiëntie voor behandelde scholen in Brussel is aanzienlijk lager dan voor niet-behandelde scholen, maar het toevoegen van controlevariabelen leidt tot niet-significante verschillen in programma-efficiëntie tussen behandelde en niet-behandelde scholen. De resultaten voor de steekproef zonder scholen uit het BHG laten (zowel bij de onvoorwaardelijke als bij alle voorwaardelijke modellen) zien dat de programma-efficiëntie aanzienlijk lager is voor scholen boven de drempelwaarde.In het lager onderwijs is er geen drempelwaarde voor de SES-middelen, waardoor we bovenstaande techniek niet kunnen toepassen. Voor het lager onderwijs zijn alle analyses gebaseerd op de volledige populatie. Bijgevolg kunnen we de resultaten niet interpreteren als causaal met betrekking tot de bijkomende SES-financiering die scholen ontvangen. De resultaten tonen aan dat de gemiddelde efficiëntiescores voor de modellen zonder controlevariabelen rond de 0,80 liggen. Het toevoegen van contextuele variabelen verhoogt de gemiddelde efficiëntiescore tot ongeveer 0,90. Net als bij de deelanalyses voor het secundair onderwijs werden afzonderlijke analyses uitgevoerd voor scholen in het Brussels Hoofdstedelijk Gewest (BHG) en

voor scholen die niet in het BHG gevestigd zijn. De resultaten voor de Brusselse scholen tonen een gemiddelde efficiëntiescore van ongeveer 0,89 voor de onvoorwaardelijke modellen, tegenover een gemiddelde efficiëntiescore van ongeveer 0,81 voor de steekproef exclusief BHG. Het toevoegen van meer contextuele variabelen leidt tot gemiddelde efficiëntiescores (voor de meest uitgebreide modellen) van bijna 1 voor scholen in Brussel, vergeleken met ongeveer 0,91 voor de steekproef exclusief Brussel. Hogere gemiddelde efficiëntiescores voor een bepaalde deelsteekproef betekenen echter niet noodzakelijk dat de scholen in deze deelsteekproef efficiënter zijn dan de scholen in een andere deelsteekproef: het kan gewoon betekenen dat de scholen in de eerste deelsteekproef homogener zijn (wat individuele efficiëntiescores betreft) dan de scholen in de tweede deelsteekproef. Wat de richting van de invloed van contextuele variabelen op de efficiëntie betreft, blijkt uit de analyses dat de meeste indicatoren die het aandeel van leerlingen met een lage SES capteren, geen significante invloed hebben op de efficiëntie van de school, wat suggereert dat de extra lesuren die bedoeld zijn om leerlingen met een lage SES te bereiken de invloed van deze variabele op de efficiëntiescores van scholen helpen verminderen. Vergelijkbaar met de resultaten van het secundair onderwijs, heeft de omvang van de school een gunstige invloed op de efficiëntie en een groot leerlingenverloop een ongunstige invloed op de efficiëntie. Specifiek voor basisscholen heeft een hoger aandeel leerlingen die in de kleuterschool zijn ingeschreven geweest een positieve invloed op de efficiëntie. Ten slotte spelen, in tegenstelling tot het secundair onderwijs, de kenmerken van de leerkrachten een belangrijke rol. Dit blijkt uit de gunstige (en significante) invloed die de anciënniteit en het diploma van de leerkracht hebben. Vanuit beleidsperspectief suggereren deze bevindingen dat de opleiding en ervaring van leerkrachten belangrijke determinanten zijn voor de efficiëntie van de school.

The effect of additional resources for schools with disadvantaged students: Evidence from a conditional efficiency model[3]

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Abstract:

This paper proposes an innovative approach to evaluate the causal impact of a policy change on efficiency. It combines insights from the econometric impact evaluation techniques and from the standard efficiency analysis. Specifically, we account for endogeneity issues by introducing a quasi-experimental setting within a conditional multi-input multi-output efficiency framework and decompose the overall efficiency between 'group-specific' efficiency (i.e., reflecting internal managerial inefficiency) and 'program' efficiency (i.e., explaining the impact of the policy intervention on performance). This allows us to interpret the efficiency differences in a causal way. We demonstrate the practical usefulness of our methodology through an application to secondary and primary schools in Flanders, Belgium. In particular, exploiting exogenous thresholds, we examine whether additional resources for disadvantaged students impact the efficiency of schools. Our empirical results indicate that additional resources do not causally influence efficiency around the threshold.

JEL-Classification: H52, I22, I24, I28

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1. Introduction

This paper proposes an innovative procedure to capture the causal impact of a policy intervention on efficiency, whenever the treatment status depends on an exogenously set threshold. We combine insights from the policy evaluation literature (Abadie and Cattaneo 2018; Angrist and Pischke 2009) and the efficiency literature (Simar et al. 2016). The suggested approach is novel for the efficiency literature as it distinguishes management practices from program effects. In addition, we move beyond correlational evidence to a causal interpretation of the findings. The approach is innovative for the program evaluation literature as it allows program evaluation in a multi-input and multi-output setting, and, as such, grasp synergies in the input/output mix, rather than considering one output at the time. Moreover, we do not only investigate whether a policy has an impact on the outcome, but we can also explore the mechanisms leading to the observed outcome, namely how the resources allocated for the policy intervention have been used, regardless of whether it is effective or if not even explaining why.

In the application, we examine the efficiency effects of a large-scale (both in number of students and in funds) "Equal Educational Opportunity (EEO) program" in Flanders, Belgium. Particularly, we evaluate the impact of additional funding provided to schools which pass an exogenously determined percentage of disadvantaged students. Similar programs are popular in many countries as socio-economic status has been widely recognized as one of the most important drivers affecting educational outcomes (e.g. Agasisti et al. 2018, Dahl and Lochner 2012, Haveman and Wolfe 1995) and, in turn, labour market outcomes (Grenet 2013, Oosterbeek and Webbink 2007, Pischke and von Wachter 2008, Stephens and Yang 2014). For this reason, "the school's task is - besides increasing opportunity for all, through what it imparts - to reduce the unequalising impact on adult life of differential environments" (Coleman 1975). Accordingly, governments have promoted many programs and policies to reduce the impact of the socio-economic background on educational achievement, including, but not limited to, voucher programs (Muralidharan and Sundararaman 2015), class size reduction (Duflo et al. 2015) and additional funding (Leuven et al. 2007).

As a starting point, we use the educational production function (Levin 1974; Hanushek 1979, 2002), which models the conversion of multidimensional inputs (e.g., school resources, peers, innate ability, motivation) into educational outcomes (e.g., student achievement, attendance rate, job market success). The educational production is deemed to be efficient if the observed outputs are produced using the lowest amount of resources (or alternatively if the observed inputs are transformed into the highest amount of outputs).[5] However, endogeneity issues might arise from various sources when estimating the educational production function (Cazals et al. 2016, Cordero et al. 2015, Santín and Sicilia 2017a, c, Simar et al. 2016) and this occurs quite often in the education sector (Cordero et al. 2015; Mayston 2003). For example, there could be a potential impact of unobservable factors that correlate with the measured variables, such as the innate ability of the student, motivations or other family information that might not be retrieved. There might be problems of self-selection, for example whenever parents can decide which school their kids should be enrolled in or if teachers can choose which school to teach in, confounding the real underlying production process. Another selection problem arises when schools have the ability to select pupils. There also might be reinforcing mechanisms in the allocation of school resources as for example in the allocation of additional funding

[5] For a comprehensive overview of the different levels of analysis, the main inputs/outputs/contextual variables and the methodological approaches considered in the efficiency in education literature, we refer the interested reader to the most recent reviews by Johnes 2015, De Witte and López-Torres 2017, G. Johnes et al. 2017, J. Johnes et al. 2017.

or good teachers, leading to reverse causality (De Witte and López-Torres 2017). In particular, with reference to the debate about the efficiency and effectiveness of school resources on educational outcomes, unsolved endogeneity problems might be a possible explanation of ambiguous findings in the literature (Hanushek 2006, Jackson et al. 2016).

The focus of the efficiency in education studies has not been limited only to overall production frontier estimation, but it has also been extended to program evaluation. Since the seminal paper by Charnes et al. (1981), researchers have tried to disentangle program efficiency from the managerial one, in the attempt to disentangle a component attributable to the context or the program under which a school operates from a component related to its internal managerial characteristics. This decomposition is helpful in distinguishing evidence of good school management practices from bad programs or, *vice versa*, evidence of good programs from a bad school management. However, the endogeneity issues described above might arise in this framework as well, leading to biased program/managerial efficiency estimates and preventing from causal interpretation of the findings.

The remainder of this paper is organized as follows. Section 2 explains the suggested approach to handle endogeneity issues in efficiency program evaluation in three steps, combining econometric policy evaluation techniques and efficiency analysis tools. Section 3 shows the empirical application to an education context: we describe the program under analysis, the variables considered in the analysis and the possible sources of endogeneity. Sections 4-6 present the steps and the way we implement the proposed approach together with the empirical findings for secondary education and Section 7 for primary education. To conclude, Section 8 presents a critical discussion of the main methodological aspects and outlines ways to move forward along the path traced by this paper.

2. Methodology

To capture the causal impact of a policy intervention on efficiency, we combine program evaluation tools from the econometric and the efficiency literature in three steps. First, similar to a regression discontinuity design, we first focus on the treated and control group around an exogenous cut-off to tackle endogeneity in the production frontier. Second, we disentangle the overall efficiency into a *managerial* and a *program* component, as proposed in the program evaluation literature. Because of the quasi-experimental setting defined in the first step, we can give causal interpretation to the estimates obtained in this second step. Third, using a conditional efficiency analysis we explore the role of heterogeneity as potential mechanisms.

Step 1. Tackling the endogeneity issue in frontier estimation

The econometric impact evaluation literature has developed and consolidated a range of techniques that address endogeneity issues, as, e.g., Regression Discontinuity Design (RDD), Difference-in-Differences (DiD) and Instrumental Variables (IV) (Abadie and Cattaneo 2018, Angrist and Pischke 2009). These techniques estimate the causal effect of the policy intervention by comparing a group of treated observations with a control group of untreated observations, which have similar characteristics. The latter group is meant to represent what would have happened if the treated units had not received the treatment, namely the counterfactual, isolating in this way the impact of the intervention (Schlotter et al. 2011).

The approach we propose deals with a policy intervention where the treatment is assigned to observations based on whether a specific covariate c, the "assignment variable", falls below or above a certain cutoff value c_0: this is the quasi-experimental setting handled in the regression discontinuity design (Cattaneo et al. 2015, Lee and Lemieux 2010). Following the RDD standard notation:

$$D_i = \begin{cases} 1 & if\ c_i \geq c_0 \\ 0 & if\ c_i < c_0 \end{cases} \qquad (2.1)$$

where D_i denotes the treatment status of unit i and it is a deterministic and discontinuous function of c_i (Angrist and Pischke 2009): when $D_i = 1$, the unit is subject to the policy intervention and hence it is assigned to the treated group, otherwise to the control group[6].

If the units have no precise control over the assignment variable, "there is a striking consequence: the variation in the treatment in a neighborhood of the threshold is 'as good as randomized'" (Lee and Lemieux 2010, p.293). Therefore, the treated and the untreated units are comparable and, in this perspective, the observations right below the cutoff can be seen as a valid counterfactual for those right above. For this reason, we might want to exclude the influence of observations far from the threshold and thus focus on more similar units. Following the insights of the nonparametric regression discontinuity design, we restrict the attention over a narrow window of observations. The choice of the width of the window is a crucial step and in the RDD literature it is known as a problem of bandwidth selection (for a review, see for example Calonico et al. 2014b, Imbens and Kalyanaraman 2012). The bandwidth should be neither too small nor too big. In the first case there would be too few observations to obtain meaningful estimates; in the second case there would be too many, bringing into the analysis heterogeneity and confounding factors. For the choice of the optimal bandwidth *h*, we follow the idea behind the nonparametric local linear regression method and specifically we adopt the robust data-driven bandwidth selection procedure proposed by Calonico et al. (2014). As a results, we restrict the full sample by considering only observations with $c_i \in [c_0 - h\ , c_0 + h]$, that is within h distance from the cutoff and hence the name *h% discontinuity sample* (Angrist and Lavy 1999, Leuven et al. 2007). The units with $c_i \in [c_0 - h\ , c_0)$ constitute to the control group, while the units with $c_i \in [c_0, c_0 + h]$ the treated group. In the practical implementation, the selection procedure requires the output variable and the assignment variable (also referred to as "running" variable or "forcing" variable in the RDD literature). Given the multi-input multi-output framework of the production frontier estimation, we obtain as many ideal bandwidths as the number of outputs that will be considered in the efficiency analysis, ranging between a lower and upper bound. In the spirit of local linear regression methods, having a range of optimal bandwidths (differently from the RDD applications where one outcome at the time is considered) is not a matter of concern, but rather a tool to check the robustness of the causal estimates (Lee and Lemieux 2010). In addition, the nonparametric CCT procedure gives the smallest bandwidth compared to the ones obtained by using other procedures, therefore even the upper bound should give reliable estimates.

To support the internal validity of the RDD setting, there are several conditions that need to be satisfied (Lee and Lemieux 2010). First and foremost, it is fundamental to check the hypothesis of no precise control over the assignment variable, as units might have incentive in manipulating it to benefit

[6] Specifically, the proposed approach follows the idea behind the sharp RDD (presence of perfect compliance) and accordingly the estimates measure average treatment effects. However, we keep as scope for further research the possibility to extend the approach also in the fuzzy RDD framework (presence of imperfect compliance, i.e. units might not receive the treatment even if they are eligible for it) and interpret accordingly the estimates as local average treatment effects.

of the policy intervention. In the RDD literature the way to rule out sorting around the threshold is mainly twofold. First, baseline covariates should be similar in treated and control groups and have the same distribution so to support randomization around the cutoff. Second, a more formal test is suggested to check the continuity of the assignment variable density function (McCrary 2008). In addition to no manipulation, it is necessary to have a clear discontinuous jump in the probability of treatment at the cutoff point. If these conditions are met and the *h%* discontinuity sample with treated and control units is constructed, we are ready to go to the second step.

Step 2. Decomposing the overall efficiency

Once the endogeneity issue has been solved by focusing on observations just right below and above the cutoff, we can proceed to the second step: the performance evaluation of the units under analysis in a multi-input multi-output framework and its decomposition into a *managerial* and a *program* component.

Let's consider a general production function that converts a vector of inputs $x = (x_1, \dots, x_k) \in \mathbb{R}^{K+}$ into a vector of outputs $y = (y_1, \dots, y_l) \in \mathbb{R}^{L+}$ and that can be presented in the following standard formulation:

$$y = f(x) \qquad (2.2)$$

where *f(.)* is the technology that determines the output production together with the inputs. However, this general production function implicitly neglects potential inefficiencies in the production process (Santín and Sicilia 2017b). Therefore, we can add an efficiency component *u*:

$$y = f(x) \cdot u \qquad (2.3)$$

Specifically, $u = 1$ suggests that the inputs are efficiently managed producing the maximum achievable output given the existing technology. If $u \in (0,1)$, the decision making unit (DMU) is not fully exploiting its capacity and, therefore, the observed level of outputs is determined not only by the used inputs and the available technology, but also by the level of mismanagement *u*. In the production frontier approach, the basic idea is to represent the relationship between inputs and outputs by looking at all the observations under analysis. The "best practice" DMUs constitute the efficiency frontier and envelop all the other DMUs under analysis. Accordingly, the farther from the efficiency frontier, the more inefficient is the unit in the process of transforming inputs into outputs.

Looking at equation (2.3), an increase in the outputs can be obtained by a change in inputs (x), technology $(f(.))$ or efficiency (u). However, there might be spillover effects from one component to another one, so that isolating one effect at the time might be puzzling. Moreover, we do not know *a priori* the direction of the treatment impact on the production activity of the treated units. For example, on the one hand, an increase in the inputs might result in scale economies and let the units achieve some targets otherwise not feasible (therefore producing spillover effects on the production technology or on the internal management efficiency). On the other hand, additional resources might lead to a 'wealth effect', i.e. a larger amount of resources will be more prone to be misused as often observed in the more general public spending framework (Cherchye et al. 2018, D'Inverno et al. 2018). In a multidimensional framework, more inputs might have an impact on one output, but not on others.

The efficiency literature dealing with program evaluation proposes different approaches to evaluate group performance. Since the seminal paper by Charnes et al. (1981) (Grosskopf and Valdmanis 1987, Månsson 1996), researchers have tried to disentangle program efficiency from the managerial

one, in the attempt to distinguish a component attributable to the context or the program under which the DMU operates from a component related to its internal managerial characteristics (for further references, see also Camanho and Dyson 2006, Aparicio et al. 2017, Aparicio and Santin 2017). In the procedure we propose, we adapt the concept of the non-parametric metafrontier approach developed by Rao et al. (2003) and O'Donnell et al. (2008).

Specifically, we consider the treated and the control group determined in step 1 by restricting the focus on units right above and below the exogenous cutoff. We estimate a group-specific local production frontier (TE^k) separately for each group k (the treated and the control one) and an overall production frontier (TE^*) for the *h*% discontinuity sample (where both treated and control units are present). The program efficiency is computed for each unit belonging to either k groups as follows:

$$Program\ efficiency^k = \frac{TE^*}{TE^k} = \frac{Overall\ efficiency}{Managerial\ efficiency^k} \tag{2.4}$$

where $k = \{Treated, Control\}$. The distance of a DMU from its (group-specific) local frontier measures the 'managerial efficiency', that is the level of efficiency associated with the internal within-group management. The distance between the local and the overall frontier captures the 'program efficiency' or, in other words, the level of efficiency linked to the fact that the units belongs or not to the treated group. Accordingly, it can be interpreted as the causal effect of the policy intervention on efficiency. In this way, we are able to distinguish to which extent the overall performance of a DMU is due to its own internal managerial efficiency and to the policy impact.

As for the frontier estimation of the production process, we rely on a nonparametric formulation. Specifically, we consider the robust Free Disposal Hull (FDH) model also known as *order-m* (Deprins and Simar 1984, Cazals et al. 2002, Daraio and Simar 2005) for a number of reasons. First of all, being nonparametric, it avoids imposing any functional form, which is preferable, as we do not a priori observe the exact relationship between inputs and outputs. This avoids specification biases. Moreover, it is consistent with the nonparametric approach proposed in the previous step for the Regression Discontinuity Design. Second, it reduces the impact of atypical observations (outliers or measurement errors). Instead of the full frontier obtained enveloping all the observations, we construct a partial frontier focusing on a subsample of *m* DMUs randomly drawn from the full sample of *n* observations. In this way, the influence of outlying or extreme observations can be mitigated and the estimates are more robust compared to those obtained with the standard FDH methodology. Third, it allows for multiple inputs and outputs simultaneously: there is no need for restrictive choice in inputs and outputs as required in other model specification. It is worth noticing that, by means of effectiveness we would consider one dimension at the time. By efficiency instead we can consider multiple dimensions simultaneously. Fourth, it does not assume any convexity, which otherwise might lead to unfeasible input-output combinations. Fifth, it has interesting asymptotical properties and tests (Kneip et al. 2015, 2016). Following Daraio and Simar (2007a), the input-oriented order-m efficiency estimator ($\hat{\theta}^S_{m,n}$) for an observation *i* is defined in its probability formulation as follows:

$$\hat{\theta}^S_{m,n}(x,y) = \int_0^\infty (1 - \hat{F}_{X|Y,n}(ux|y))^m\, du \tag{2.5}$$

where *s*={*Treated*, *Control*, *Overall h% discontinuity sample}*, n is the size of the sample from which $m < n$ units are drawn, x the inputs and y the outputs. The obtained efficiency score per unit reflects the extent to which the unit succeeds in converting its multiple inputs into multiple outputs. Due to the subsampling, there might arise 'super-efficient' observations: these units are more efficient than the average of *m* units producing at least their level of output and randomly drawn from the full sample of *n* units (Daraio and Simar 2007a).

Step 3. Detecting the environmental variable influence: a Conditional approach

As environmental variables beyond the control of the observations' management might affect not only the distribution of the efficiency scores, but also their attainable set (Cazals et al. 2002, Daraio and Simar 2005, 2007b, De Witte and Kortelainen 2013), as a third step we include heterogeneity in the estimation of the production frontier of step 2. Using a conditional efficiency framework, the efficiency estimates are not only determined by the inputs (*x*) and the outputs (*y*), but also by the environmental variables (*z*) under a non-separable production context (Cazals et al. 2016). Following Daraio and Simar (2007a), the input-oriented conditional order-m efficiency estimator ($\hat{\theta}^{s}_{m,n}$) is defined in its probability formulation as follows:

$$\hat{\theta}^{s}_{m,n}(x,y|z) = \int_0^{\infty} (1 - \hat{F}_{X|Y,Z,n}(ux|y,z))^m \, du \qquad (2.6)$$

where *s*={*Treated*, *Control*, *Overall h% discontinuity sample}*, n is the size of the sample from which $m < n$ units are drawn, x the inputs, y the outputs and z the contextual variables. For this estimation, a nonparametric kernel function and a bandwidth parameter *b* have to be selected using smoothing techniques, properly handling discrete and continuous environmental variables. Due to the subsampling, there might arise 'super-efficient' observations as the evaluated observation is not necessarily part of the reference set.

It should be noticed that this further step is not redundant with respect to the regression discontinuity design approach, but rather complementary as it addresses different aspects. First, as in the spirit of the RDD, the environmental characteristics that are not pre-determinants of the treatment status should not be statistically different across the treated and the control groups, but nonetheless they are included in the regression to provide more accurate estimates (Calonico et al. 2016, Lee and Lemieux 2010). Second, the direct inclusion of the environmental variables handles left heterogeneity across the treated and the control samples (especially for the upper bound of the optimal bandwidth range) if any. Third, we can exploit an additional source of information obtained while performing the conditional analysis. By comparing the conditional and the unconditional efficiency estimates

$$Q_m^{s,z} = \hat{\theta}^{s}_{m,n}(x,y|z) / \hat{\theta}^{s}_{m,n}(x,y) \qquad (2.7)$$

we can causally evaluate the direction of influence of environmental variables on the production process by performing a nonparametric statistical inference (Bădin et al. 2012, Daraio and Simar 2007a p. 115). By definition, the environmental variables are non-discretionary; therefore in principle the DMUs

cannot directly change them as they would. However, knowing the influence of these variables can help the policy makers to enact more targeted interventions and provide further help.

3. Empirical application

This section applies the procedure described in Section 2 to evaluate the causal impact of additional funding for schools with disadvantaged students on school performance. First, we describe the program and the data collected for the analysis. Next, we implement the proposed procedure in the quasi-experimental setting under analysis.

3.1 The "Equal Educational Opportunities" program

Ensuring equal educational opportunities has been a policy priority for the Flemish Community of Belgium over the last decades (OECD, 2017) for various reasons. First, according to the OECD PISA surveys, Flanders is experiencing a high disparity in basic skills and achievement, largely explained by the student socio-economic background (OECD 2013, 2017a). The performance gap for students with a migrant background is the highest in the OECD. Second, this performance gap is exacerbated by the uneven distribution of experienced teachers (Nusche et al. 2015). Third, there is large segregation in schools determined by secondary school track choice. While choice between the tracks is, in theory, up to the students' ability and ambitions, general education is generally perceived as the most prestigious of the tracks and vocational education is perceived as the least prestigious one. In the absence of standardized exams, this creates segregation in schools (De Witte and Hindriks, 2017). Fourth, the school population is increasingly heterogeneous in terms of poverty, language, culture and family structure. Projections suggest that the population growth will be concentrated in disadvantaged groups, mainly consisting of first and second generation migrants. Therefore, the equity challenge is noteworthy and could even worsen in the next years (Council of the European Union, 2017).

The 'Equal Educational Opportunities ("*gelijkeonderwijskansenbeleid*, GOK") program' promoted by the Flemish Ministry of Education started in 2002. The program provides additional funding for primary[7] and secondary schools with a significant share of disadvantaged students. Although there is sufficient leeway in the exact use of the funding, these extra resources can only be used for hiring additional teachers and teacher support (hence, equivalently expressed in teaching hours). The criteria for being considered a "disadvantaged" student slightly changed over the years. Before 2008, the focus was more educational outcome oriented. After 2008, the focus shifted to student background characteristics, so to support mainly low socio-economic students. Specifically, five indicators are considered: (i) the student receives an educational grant (proxy for the family income); (ii) the student's mother does not have a secondary education degree (proxy for parental educational background); (iii) the student lives outside of family; (iv) the parent is part of the travelling population; (v) the student does not speak Dutch (i.e., the native language) at home. A school is eligible for additional teaching hours if a weighted share of students meets at least one of these indicators and it exceeds an exogenously set threshold[8]. For the first stage of secondary education (first two years), the cut-off is set

[7] Starting from the school year 2012-2013, the GOK-program in primary education was replaced by an integrated system in which SES-hours (i.e. teaching hours allocated based on the socio-economic status (SES) of pupils) are an integral part of the funding mechanism.

[8] As from the implementation of the new integrated funding mechanism for primary schools (starting in the school year 2012-2013), there is no exogenously set threshold anymore.

at a minimum share of 10% disadvantaged students. For the second and third stage of secondary education (last four or five years), the cut-off level is at 25%. The difference in the threshold for the first and the second/third stage is due to historical reasons (Nusche et al. 2015). The total amount of additional funding assigned to a school is decided upon every three years and it is based on the amount and type of disadvantaged students per school in the year before the start of the 3-year cycle. Moreover, to avoid fragmentation of resources, eligible schools receive the extra funding only if they generate at least six teaching hours. Further details on Flemish education system and the program are provided in Appendix A.

3.2 Data and variables[9]

The Flemish Ministry of Education provided us with data at pupil and school level. We observe the universe of pupils and schools in secondary education in the Flemish Community of Belgium from the school year 2010/2011 to 2013/2014. At the student level, data contain information on the disadvantaged student indicators, student characteristics (e.g., gender, nationality) and field of study. Moreover, we have information on educational outcomes that cover the short term (problematic absenteeism, grade retention and certificate obtained at the end of the school year) and the long term (enrollment in higher education). At school level, data include information on the percentage of disadvantaged students, school location, educational track (general, technical, vocational or artistic education), school size, whether the school received additional funding in the previous years, amount of operational grants, teacher information (e.g., gender, degree, seniority) and number of teaching hours.

3.2.1 Inputs

School funding resources are mainly allocated across three categories: staffing hours, operating grants and capital (Nusche et al. 2015). In the following, we do not consider capital expenditure given the cross-sectional focus of the analysis. Therefore, our analysis uses two input variables obtained from the administrative data. First, teaching hours per student, which measure the number of total teaching hours, considering both the standard teaching hours and the extra resources for disadvantaged students if any. Second, the operating grants per student, which measure the total budget distributed among schools to cover their expenses. To reduce the variability across the units under analysis, we consider the amount of teaching hours and operating grants per student. Data expressed in ratios are not a matter of concern given the FDH model adopted for the frontier estimation (Olesen et al. 2015, 2017).

3.2.2 Outputs

In the efficiency of education literature, educational outcomes have been measured as student achievement or more generally student engagement, focusing both on short-term and on long-term benefits (De Witte and López-Torres 2017). We consider four different outputs in the attempt to represent all these aspects. First, the s*hare of students with "A certificate"* measures the proportion of students that can progress to the next school year without any restrictions. In the absence of standardized test scores, an 'A certificate' serves as a good proxy for student performance. In particular, at the end of the school year each student receives one of 3 types of certificates, "A", "B" or "C", based

[9] The input, output and contextual variables described here hold for secondary education. In Section 7 we discuss the input, output and contextual variables for primary education.

on the final school exam session. A student obtaining an "A certificate" is allowed to progress to the following year level without restrictions in the program. In the latter two scenarios, the student can progress but only in specific programs or has to take a grade retention. A second output variable consists of the s*hare of students without problems of absenteeism.* This output quantifies the proportion of students that are not problematically absent (that is for more than 30 half school days). It seizes how a school engages students in educational activities, promoting better learning in the short term and lifetime opportunities in the long term.[10] Third, the s*hare of students progressing through school* can be considered as the complement of grade retention (Rosenfeld 2010). Accordingly, this variable measures the proportion of students that progress through school without experiencing grade retention in the second and third stage of secondary education. It should be noted that 24% of the 15-years old in Flanders experienced grade retention, which is double from the OECD average. Finally, the s*hare of students enrolled in higher education* measures the proportion of students that started either an academic or professional bachelor. Therefore, it acknowledges the role of the school in encouraging its students towards higher education and pursuing lifelong opportunities.

Finally, remark that although the *share of students with A certificate* captures how the school promotes the student attainment and the *share of students without problems of absenteeism* captures the student engagement, the *share of students progressing through school* embeds partly both the aspects in a complementary fashion.[11]

3.2.3 Contextual variables

The educational production function might be influenced by characteristics which are not under direct control of the school management, and where we need to control for in the analysis. We identify three groups of contextual variables: school, teacher and student characteristics. Given that the unit of analysis is the school, all variables are measured at school level. Although a school-level analysis is common in efficiency estimation (i.e., it is uncommon to estimate efficiency scores at individual level, see De Witte and Lopez-Torres, 2017), it comes at the cost of losing individual variance at pupil level information. In other words, aggregated pupil level information at school level might hide heterogeneity within the variable. This is not problematic in the current application as we are mainly interested in general patterns at school level.

School characteristics

School track. In second and third grade of secondary education, students can choose among four tracks: general, artistic, technical and vocational secondary education. General education is generally perceived as the most prestigious track, while vocational education is considered as the least prestigious track. This perception creates segregation in student allocation across schools, often observed in differences in the average socio-economic levels. To capture this phenomenon we consider two different variables. One is a dummy variable equal to one if the school offers general secondary education (*School track - General*). A second variable measures the share of students that choose the vocational track (*School track - Vocational*).

[10] https://www.brookings.edu/research/going-to-school-is-optional-schools-need-to-engage-students-to-increase-their-lifetime-opportunities/

[11] Rather low correlation coefficients (0.6359, 0.3932, 0.3784) further prove this statement.

School size. The relevance of school size has been acknowledged in the education economics literature, in particular by exploring the relationship between the school size effects and the possible existence of scale economies. Interestingly, the evidence can be mixed if looking at the student socio-economic characteristics (Leithwood and Jantzi 2009). School principals cannot refuse student enrolments by law (unless the school faces capacity restrictions), consequently, school size is an exogenous variable that is not under the control of the school management, but that still affects the way schools convert school resources into educational outcomes and therefore it is worth controlling for it.

Share of students changing school. The variable measures the share of students that change school and go to a different school in the next year (a school is here defined as a pedagogical unit). This variable captures how many students leave the school or are pushed away from the school they are currently enrolled in, and, as such, it may serve as a proxy for selection in and of schools.

Previously treated school. This variable is a dummy equal to one if the school received additional teaching hours in the previous three-year cycle (started in 2008). In this way, we can handle the influence on the school management of being already a recipient of extra resources. This influence might work in two different directions: either schools experience a learning effect so that they use in a more fruitful way the resources assigned in the current new cycle, or additional resources lead to a worse management because a "wealth effect" occurs.

School type. In the Flemish Community, there are three main educational networks that act as "umbrella organization" for the school governing bodies (Nusche et al. 2015): public education organized by the Flemish Community, public education organized by municipalities or provinces, and private education. Irrespective of the educational network, schools have to reach the same goals such that schools in the different networks mainly differ in the competent government authority and in the way they are managed, that is either publicly or privately.

School with special need students. This variable is a dummy variable equal to one if the school is eligible for additional funding to support integration of special need students (GON).

Teacher characteristics

The role of teacher quality and school principals in the educational process has been increasingly acknowledged (see, e.g., Hanushek and Woessmann 2015, OECD 2017b, De Witte and Van Klaveren 2014, De Witte and Rogge 2011) and, consequently, has to be taken into account. We observe the teacher characteristics in a detailed and rich way.

First, *teacher seniority* measures the teacher experience level in a school. It ranges from 1 to 7, where 1 refers to the least experienced teachers (0-5 years) and 7 to the most experienced ones (>30 years). Second, *teacher diploma* quantifies the share of teachers that have a "proper" diploma to teach the subject they are assigned to ("vereiste bekwaamheidsbewijzen") or one at a similar level ("voldoend geachte bekwaamheidsbewijzen"), as opposed to another type of diploma representing the minimum level required for teaching. Third, s*chool principal seniority* measures the school principal seniority. As for teachers, it ranges from 1 to 7, where 1 refers to the least experienced and 7 to the most experienced school principal. Fourth, *teacher age* ranges from 1 to 8, where 1 refers to the youngest teachers (<30 year old) and 8 to the oldest ones (60+). Sixth, t*eacher full-time* represents the share of teachers that have a full-time contract, as opposed to a part-time contract. Finally, *female teachers* is the share of female teachers working in a school.

Student characteristics

We proxy the student population of a school by including three variables. First, the s*hare of students with grade retention in primary school* measures the share of students that experienced grade retention in primary school. Therefore, this variable can be seen as a proxy for pupil's cognitive skill. Second, the s*hare of special need students in primary school* serves as a proxy for pupil's cognitive skill the school has to deal with. Third, the s*hare of male students* measures the proportion of male students in a school. In the education literature, there is evidence of different performance between male and female students and accordingly we include this characteristic too.

3.3 Sources of endogeneity

We examine how successfully schools use the resources to promote student engagement by distinguishing the schools eligible for additional funding or not. Close to the threshold, the endogeneity, which is arising from different sources, is limited.[12] First, endogeneity might arise from selection bias, both on the student and on the teacher side. As explained in Section 3.2, schools might be segregated due to secondary school track choice: students with low socio-economic status (SES) are more concentrated in vocational schools and the opposite holds for high SES students. At the same time, teachers can choose the school where to teach. Consequently, the better teachers are more likely to select themselves in the better schools and the worse or inexperienced teachers have to choose from the more disadvantaged schools. Second, there is a problem of omitted variables linked to unobserved motivation and ability both on the student and on the teacher side. Third, there might be a problem of measurement errors that need to be handled with particular caution, even more due to the deterministic nature of the frontier estimation method.

4. Results for second and third cycle secondary education

In the following, we detail step by step the way we implemented the novel approach proposed in this paper focusing on the second and third cycle of secondary education.

4.1 Step 1: a Regression Discontinuity Design approach

To evaluate the policy impact on school performance of additional funding provided to schools, we exploit the cutoff exogenously set at 25% share of disadvantaged students in second and third cycle of secondary education. To provide causal interpretation of the efficiency estimates, we focus on observations just above and below the 25% cutoff. We determine the CCT optimal bandwidth by using the 'rdrobust package' in Stata (Calonico et al. 2014a). Specifically, since for the main analysis we consider four outputs, we have four optimal bandwidths ranging between 6% and 8% (for more details see Appendix B.1). Accordingly, we obtain several refined samples, where the 6% discontinuity sample represents the smallest subset and the 8% discontinuity sample the largest. To focus the discussion, we provide critical discussion for the 6% discontinuity sample in the main text, while the results are provided for the 8% discontinuity sample and the full sample in Appendix D.2 and D.3, respectively.

Next, we have to check the validity of the RDD setting put in place. Given that schools above the threshold receive additional resources, there might be manipulation around the threshold. Although

[12] Nevertheless, the results of the full sample (i.e., all schools) show very similar results (presented in Appendix D.3).

this is unlikely due to the use of administrative data to cross-check multiple of the indicators used in determining the percentage of disadvantaged students, we check whether there is sorting around the threshold. As a first indication for manipulation, we test if the baseline characteristics around the threshold are similar. Close to the cutoff, the schools in the control and treatment group should be similar, except for the treatment.[13] Table 1 suggests that the two groups are not statistically different in means for all the control variables we consider, but for few exceptions, mostly related to student characteristics such as share of disadvantage students and share of special needs students in primary school, which will serve as contextual variables in our analysis. Moreover, we observe that below the thresholds the schools tend to be more often general education schools, which were not treated before. Appendix E accounts for similar observed differences between schools by limiting the sample to only general or vocational schools. Table 2 shows that the treated group has, on average, a higher level of inputs, but a lower level of outputs. On the one hand, the difference in inputs and outputs may be a consequence of the different share of general and vocational pupils in the control and treated group as the teacher hours per pupil in general education is between 1.45 and 1.9 versus between 2.45 and 3.8 in vocational. In a similar way, there are differences in the operating grants and the outputs between general and vocational education.[14] On the other hand, this might suggest the presence of inefficiency in the treated group. However, the analysis proposed by this paper helps in measuring the efficiency from an input/output mix perspective, disentangling the source of this inefficiency and detecting the possible mechanisms behind the observed picture.

Table 1. Sample means for control/treated group and population. Control variables.

	Below threshold		*Above threshold*		Full sample		*p*-value
School track – General edu	0.794	(0.407)	0.493	(0.504)	0.640	(0.482)	0.0002
School track - Vocational	0.0982	(0.148)	0.219	(0.177)	0.160	(0.174)	0.0000
School size (log)	6.176	(0.449)	6.186	(0.476)	6.181	(0.461)	0.8916
Share of students changing school	0.0978	(0.0364)	0.0929	(0.0363)	0.0953	(0.0363)	0.4281
Previously treated school	0.221	(0.418)	0.704	(0.460)	0.468	(0.501)	0.0000
School type							0.561
GO	0.191		0.197				
OGO	0.074		0.123				
VGO	0.735		0.676				

[13] Again, for brevity, in this section we report the means for the 6% discontinuity sample. In Appendix, there are the tables listing the means for the 8% discontinuity sample (Appendix D.2) and for the full sample of schools under analysis (Appendix D.3).

[14] In Appendix E.4 and E.5 we analyse the efficiency for vocational schools (BSO) and general education schools (ASO) separately. The analysis suggest robust findings to the main outcomes.

School with special need students	0.441	(0.500)	0.507	(0.504)	0.475	(0.501)	0.4406
Teacher seniority	3.922	(0.348)	3.867	(0.356)	3.894	(0.352)	0.3627
Teacher diploma	0.973	(0.0308)	0.963	(0.0360)	0.968	(0.0338)	0.0879
School principal seniority	5.334	(1.119)	5.432	(1.031)	5.384	(1.072)	0.5905
Teacher age	4.188	(0.316)	4.161	(0.316)	4.174	(0.315)	0.6163
Teacher full-time	0.299	(0.109)	0.312	(0.0983)	0.306	(0.104)	0.4601
Female teachers	0.595	(0.118)	0.571	(0.123)	0.583	(0.121)	0.2318
Share of students with grade retention in primary school	0.0952	(0.0566)	0.148	(0.0654)	0.122	(0.0665)	0.0000
Share of special need students in primary school	0.0141	(0.0238)	0.0318	(0.0334)	0.0232	(0.0303)	0.0005
Share of male students	0.474	(0.161)	0.533	(0.211)	0.504	(0.190)	0.0670
Share of disadvantaged students	0.220	(0.0188)	0.281	(0.0187)	0.251	(0.0357)	0.0000
Observations (school level)	68		71		139		

Note: Results for 6%-discontinuity sample (8% and full sample in Appendix D). Standard deviation in parentheses. *p*-values obtained from t-test to examine whether the control and the treated group variables are statistically different in means.

Table 2. Sample means for control/treated group and population. Input and output variables.

	Below threshold		*Above threshold*		Full sample		*p*-value
Inputs							
Teaching hours per student	2.120	(0.408)	2.391	(0.431)	2.258	(0.440)	0.0002
Operating grants per student	915.5	(82.54)	985.8	(138.2)	951.4	(119.3)	0.0004
Outputs							
Share of students with "A certificate"	65.96	(5.261)	61.88	(6.417)	63.88	(6.206)	0.0001
Share of students without problems of absenteeism	99.68	(0.550)	99.35	(0.584)	99.51	(0.589)	0.0009
Share of students progressing through school	94.53	(2.757)	93.53	(3.431)	94.02	(3.149)	0.0594
Share of students enrolled in higher education	75.46	(15.38)	62.34	(17.37)	68.76	(17.64)	0.0000
Observations (school level)	68		71		139		

Note: Results for 6%-discontinuity sample (8% and full sample in Appendix D). Standard deviation in parentheses. *p*-values obtained from t-test to examine whether the control and the treated group variables are statistically different in means.

As a more formal test for manipulation, we run a McCrary manipulation test (McCrary 2008) using a Local-Polynomial Density Estimation as proposed by Cattaneo et al. (2018) and implemented in the 'rddensity' command in Stata. Also, in this case, the results in Table 3 do not point to any manipulation around the threshold. In addition, we check graphically in Figure 1 the frequency distributions of the schools with respect to the assignment variable (the share of disadvantaged students) for different ranges and there is no evidence of any sorting around the threshold.

Table 3. Manipulation test for 6% discontinuity sample. Threshold at 25% share of disadvantaged students

	Bandwidths		Number of schools		Test	
	Below	Above	# Below	# Above	T	*p*-value
$h_- = h_+$	0.06	0.06	68	71	0.3252	0.7450
Observations in the full sample			236	406		

Note: Results for 6%-discontinuity sample (8% and full sample in Appendix B.3) obtained using the 'rddensity package' in Stata (Cattaneo et al. 2018) and specifying the 6% bandwidth at both sides of the cutoff.

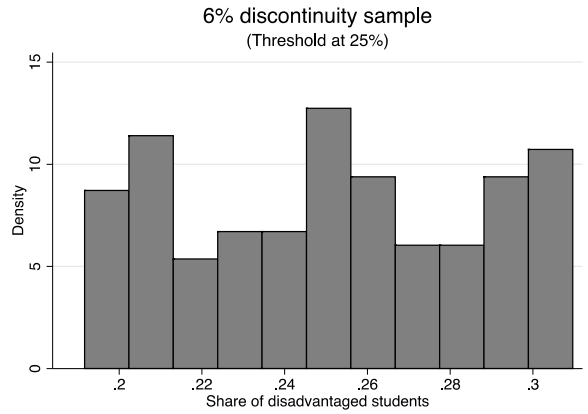
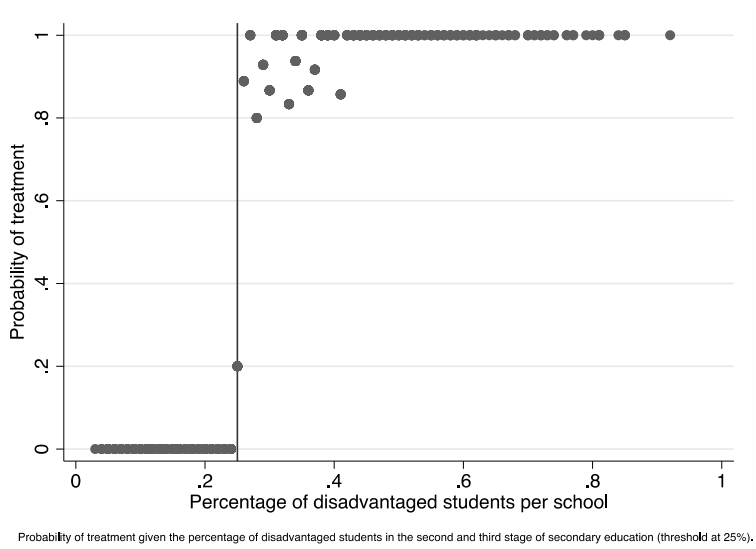


Figure 1. Frequency distribution of the schools with respect to the share of disadvantaged students for the 6% discontinuity sample

In addition, we have to check for the presence of discontinuity in the probability of treatment. Figure 2 shows the probability of treatment when the cutoff is exogenously set at 25% of disadvantaged students in a school and displays a discontinuous jump at the cutoff. The jump in the probability of treatment at the cutoff is not sharp from 0 to 1 as would be expected in a sharp RDD setting (Lee and Lemieux 2010). We are aware of the limits that this might bring into our empirical application, but we believe also that this is not a matter of concern for two main reasons. First of all, the imperfect compliance we observe in this case is due to the additional requirement of generating a minimum of 6 hours and we can reasonably rule out the case of imperfect take-up. Moreover, we performed as a robustness check the analysis with and without the units that are eligible but not receiving the treatment and the results are

consistent (see Section 5.1). Therefore, we are confident that the quasi-experimental data at hand are able to show the potential of the tool proposed in this paper and to provide sound policy recommendations. Anyway, we keep how to deal with imperfect compliance as scope for future research.



Probability of treatment given the percentage of disadvantaged students in the second and third stage of secondary education (threshold at 25%).

Figure 2. Discontinuity in the probability of treatment

4.2 Step 2: a Metafrontier approach

In step 2, for the groups of schools distinguished in step 1, we estimate the educational production frontier using an input-oriented robust FDH model. Practically, we compute the efficiency scores for each school under analysis following equation (2.5). As for the choice of *m*, a sensitivity analysis shows that *m=40* is warranted, even across different discontinuity samples (see plots in Appendix C). We recall that, from an economic perspective, the value *m* can be interpreted as the number of (randomly drawn) potential competing schools producing at least the same level of output as the unit under observation (Daraio and Simar 2007a). First, we estimate the pooled frontier for the whole discontinuity sample. The efficiency score indicates the overall level of efficiency of the school under analysis. Then, we estimate group-specific frontiers, separately for the treated and the control group so to disentangle the overall efficiency into a component related to managerial efficiency and another to program efficiency. The obtained efficiency scores for the group-specific frontiers measure the internal managerial efficiency level of the schools. Residually, we compute the level of program efficiency, as explained in section 2 - Step 2.

Table 4 shows the average scores of the overall, managerial and program efficiency for the 6% discontinuity sample (results for 8% and full sample are similar and presented in Appendix D.2 and Appendix D.3, respectively), without controlling for the operational environment (we do so in the next subsection). We interpret the complement to 1 of the average overall efficiency and managerial efficiency as the detected level of inefficiency. The average overall efficiency is 5 percentage points higher for control schools, but the average school-specific efficiency is about 2 percentage points higher for treated schools. This suggests that treated schools have a more homogenous production technology (i.e., there efficiency scores are closer to each other). However, the overall efficiency level is lower among the treated schools pointing at the presence of a higher waste of resources, that is almost 20% (obtained as 1-0.803) versus 14% (obtained as 1-0.855), and this can be explained by the program

efficiency component.[15] A program efficiency score for the treated schools lower than one denotes that the TREATED-specific frontier is further from the overall frontier compared to the CONTROL-specific frontier. This suggests that treated schools do not successfully convert more resources into more outputs around the threshold or, in other words, that schools could have achieved the same outputs even with a lower amount of resources as observed for similar but untreated schools.

Thanks to the regression discontinuity setting, we can go beyond the correlation interpretation of the findings and provide instead causal inference: around the threshold the extra resources allocated because of the policy intervention do not promote a better overall school performance. The program efficiency of the untreated schools amounts to 1.002, suggesting that the untreated schools are mainly constituting the metafrontier.[16] To be noticed, we look at the average program efficiency as local average treatment effect, given the imperfect compliance of the current application. More in general, in case of perfect compliance we can interpret the average program efficiency scores as average treatment effects, consistently with the sharp Regression Discontinuity Designs (Lee and Lemieux 2010).

Table 4. Efficiency scores mean (Standard deviation in parentheses).

	Below threshold		*Above threshold*		*p*-value
Unconditional					
Overall efficiency	0.855	(0.0837)	0.803	(0.0996)	0.0009
School efficiency	0.854	(0.0848)	0.879	(0.115)	0.1464
Program efficiency	1.002	(0.00292)	0.916	(0.0560)	0.0000
Observations	68		71		

Note: Results for 6%-discontinuity sample (8% and full sample in Appendix D). Standard deviation in parentheses. *p*-values obtained from t-test to examine whether the control and the treated group efficiency scores are statistically different in means.

4.3 Step 3: a Conditional approach

The efficiency in education literature has increasingly acknowledged a prominent role of environmental variables in the educational production process estimation (Brennan et al. 2014, Cherchye et al. 2010, Cordero et al. 2017, Johnes 2015). These variables have been often included in a two-stage procedure that implicitly assumes a "separability condition" (Daraio and Simar 2007b), which seems an unrealistic assumption in educational applications (e.g., if schools with more low SES students receive more resources, the separability condition is violated as SES directly affects the educational production process). For this reason, we opt for a non-separable production context. Accordingly, we estimate a robust conditional model directly including the contextual variables in the frontier specification.

Table 5 shows the results for the 6% discontinuity sample (results for the 8% discontinuity sample and for the full sample are provided respectively in Appendix D.2 and D.3). In line with the insights provided by the regression discontinuity design, adding the contextual variables in the frontier

[15] It should be noted that the results for general and vocational schools only suggest similar findings (see Appendix E.4 and E.5).

[16] Recall that efficiency scores > 1 point to 'super-efficient' observations, which is due to the resampling technique discussed in Section 2. A score of 1.002 can be interpreted as the schools are performing 0.2% better than expected.

estimation does not change the main findings outlined in step 2 (even if the conditional estimates are higher than the unconditional ones): this holds for the discontinuity samples obtained considering the range of optimal bandwidths computed in step 1. As in the unconditional efficiency estimates, program efficiency scores are systematically lower for treated schools rather than for the control ones.

Nevertheless, by systematically adding control variables to the analysis, the results in Table 5 suggest that including school characteristics influences the obtained efficiency scores most. For example, in model specification 3 (school characteristics) the average difference in program efficiency between the control and treated groups almost vanishes to as little as 3.7 percentage points, although the variation in the program efficiency scores remains larger in the treated schools. In the most elaborated model specification 10 (i.e. School & Teacher & Student characteristics), although the variation in the program efficiency is larger for the treated schools, the average difference in program efficiency between the control and treated group drops to 0.3 percentage points. This suggests that the policy did not improve the efficiency of the treated schools, but did not harm them as well.

Table 5. Efficiency scores mean (Standard deviation in parentheses). 6% discontinuity sample.

	Below threshold		*Above threshold*		*p*-value of difference in efficiency score
Conditional 1 (School characteristics)					
Overall efficiency	0.902	(0.0886)	0.837	(0.108)	0.0002
School efficiency	0.899	(0.0834)	0.914	(0.107)	0.3466
Program efficiency	1.003	(0.0272)	0.918	(0.0736)	0.0000
Conditional 2 (School characteristics)					
Overall efficiency	0.909	(0.0770)	0.857	(0.0990)	0.0007
School efficiency	0.908	(0.0736)	0.930	(0.0830)	0.1070
Program efficiency	1.001	(0.0201)	0.922	(0.0651)	0.0000
Conditional 3 (School characteristics)					
Overall efficiency	0.940	(0.0775)	0.933	(0.0875)	0.6093
School efficiency	0.932	(0.0750)	0.961	(0.0781)	0.0294
Program efficiency	1.009	(0.0209)	0.972	(0.0592)	0.0000
Conditional 4 (School characteristics)					
Overall efficiency	0.945	(0.0729)	0.940	(0.0836)	0.6932
School efficiency	0.936	(0.0720)	0.967	(0.0720)	0.0124
Program efficiency	1.010	(0.0227)	0.973	(0.0530)	0.0000
Conditional 5 (Teacher characteristics)					
Overall efficiency	0.930	(0.0835)	0.889	(0.115)	0.0170
School efficiency	0.906	(0.0893)	0.907	(0.111)	0.9863

Program efficiency	1.029	(0.0560)	0.985	(0.103)	0.0022
Conditional 6 (Teacher characteristics)					
Overall efficiency	0.964	(0.0607)	0.929	(0.0935)	0.0098
School efficiency	0.946	(0.0693)	0.948	(0.0812)	0.9162
Program efficiency	1.020	(0.0418)	0.981	(0.0671)	0.0001
Conditional 7 (Student characteristics)					
Overall efficiency	0.918	(0.0787)	0.914	(0.0924)	0.7784
School efficiency	0.928	(0.0773)	0.951	(0.0787)	0.0852
Program efficiency	0.990	(0.0393)	0.962	(0.0611)	0.0014
Conditional 8 (School & Teacher characteristics)					
Overall efficiency	0.950	(0.0697)	0.896	(0.107)	0.0006
School efficiency	0.944	(0.0731)	0.932	(0.0967)	0.4172
Program efficiency	1.007	(0.0372)	0.964	(0.101)	0.0012
Conditional 9 (School & Teacher characteristics)					
Overall efficiency	0.987	(0.0243)	0.962	(0.0541)	0.0008
School efficiency	0.986	(0.0261)	0.985	(0.0334)	0.7491
Program efficiency	1.001	(0.0135)	0.977	(0.0407)	0.0000
Conditional 10 (School & Teacher & Student characteristics)					
Overall efficiency	0.996	(0.0109)	0.995	(0.0115)	0.6751
School efficiency	0.995	(0.0147)	0.997	(0.00871)	0.2285
Program efficiency	1.001	(0.00603)	0.998	(0.00802)	0.0065
Observations (school level)	68		71		

Note: Results for 6%-discontinuity sample (8% and full sample in Appendix D). Standard deviation in parentheses. *p*-values obtained from t-test to examine whether the control and the treated group efficiency scores are statistically different in means.

Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: School track (Vocational), School size, % of students changing school, Previously treated school

Conditional 4: School track (Vocational), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 5: Teacher seniority, Teacher diploma, School principal seniority

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 7: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 8: School track (General), School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 9: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 10: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

So far, the evidence seems to suggest that treated schools do not successfully convert the additional resources in better performance around the threshold, unless school and pupil characteristics are accounted for. Interestingly, results are confirmed also for the other samples. In model 3, model 4, model 7 and model 10 the overall efficiency below the threshold does not significantly differ from the overall efficiency above the threshold (the same finding holds for the models in Appendix D.2 where an 8% bandwidth was used). However, for the full sample (see Appendix D.3), in model 3, model 4, model 7 and model 10 the overall efficiency of the treated schools is significantly higher than the overall efficiency of the control group (in these models both school efficiency and program efficiency is higher in treated schools compared to schools in the control group). Program efficiency scores of the treated schools are close to 1 whenever student-related characteristics are included in the frontier estimation.

As the variation in the program efficiency scores is larger for the treated schools, it is worth to explore the distribution of the program efficiency scores across the two groups with respect to the assignment variable, that is the share of disadvantaged students in a school. We report the plots for the 6%, the 8% discontinuity sample and the full sample for second and third cycle of secondary education in Appendix D.4. For the 6% and the 8% discontinuity sample, we can observe that the program efficiency scores of the treated schools are systematically lower than the ones of the control schools, regardless of the conditional model specification. However, we observe that this is not the case for the full sample (although, as argued before, the full sample has serious issues in terms of comparability): the further the schools from the cutoff, the higher the program efficiency scores of the treated schools whenever students' characteristics are taken into account. This provides interesting insights as concerns the cutoff and the intensity of the treatment: resources allocated where there is a higher share of disadvantaged students and a greater amount of resources seem to lead to the desired policy outcome.

Statistical inference

A further analysis that we can perform thanks to the conditional analysis consists of analyzing the statistical inference by comparing conditional and unconditional estimates along the contextual variables of interest by means of a nonparametric regression and considering 2000 bootstrap samples. We can explore the direction of the influence of these variables with respect to the efficiency assessment. Table 6 and 7 (and Appendix D.5 for the 8% bandwidth) summarize the main findings obtained for the different conditional models considered above, listing the median influence of the contextual variables and the p-values for the significance tests (Li and Racine 2007). Graphically, the smoothed regression line can be interpreted as the marginal effect of the contextual variable under focus on the attainable set. For a more intuitive interpretation of the findings, we consider the ratio of unconditional over conditional estimates: if the smoothed nonparametric regression is increasing, then the variable is favourable to the efficiency, otherwise the opposite holds (De Witte and Schiltz 2018).

The model specifications that include school characteristics reveal that secondary schools providing general education (ASO) have a favourable influence on the efficiency, while the opposite holds for vocational school (BSO). This is not surprising as more disadvantaged students will be concentrated in vocational schools, creating a more problematic context where to promote school engagement compared to the other schools, and as vocational schools receive more inputs. In line with this evidence, the share of students that change school in the next year plays an unfavourable influence on the education production as they are the most problematic ones and for this reason somehow pushed away. As revealed from the nonparametric regression plot, the VGO (*Vrij gesubsidieerd*

onderwijs – Grant-aided Private Education) schools have a favourable influence and the opposite holds for the schools which had received additional resources in the previous three-year cycle, denoting a lack of learning effect in the management of these extra resources. Moreover, the favourable influence that emerges for the school size points at the presence of scale economies in the educational production, or, alternatively, it might capture the decreasing input coefficients of the financing mechanism. As concerns for the teacher characteristics, seniority plays a favourable (but insignificant) influence on efficiency both from the teacher and the school principal side. The same applies when teachers have a diploma specifically related with the topic they teach: reasonably, this favors the education delivery. Having a full time contract and the teacher age instead play an unfavourable role. The significant role of teacher characteristics might be insightful from a policy perspective as it shows the importance of teacher training and teacher experience. All student characteristics in the analysis play an unfavourable (but insignificant) influence: it is more likely that schools where students experienced grade retention in primary education or students in special need schools face more problematic students and, therefore, face an unfavourable environment for the education production. As for the variables measuring the share of males in class, the evidence is consistent with the literature, as there is evidence that females outperform male student quite often (Cipollone and Rosolia 2007).

Table 6. Direction of the influence of the contextual variables. 6% discontinuity sample

	Model 1			Model 2			Model 3			Model 4		
	Influence	*p*-value		Influence	*p*-value		Influence	*p*-value		Influence	*p*-value	
School characteristics												
ASO	Favorable	0.035	**	Favorable	0.2605							
BSO							Unfavorable	0.000	***	Unfavorable	0.567	
School size	Favorable	0.158		Favorable	0.134		Favorable	0.0145		Favorable	0.040	**
% Change school	Unfavorable	0.001	***	Unfavorable	0.0035	***	Unfavorable	0.0135	**	Favorable	0.086	
Previously treated	Unfavorable	0.139		Unfavorable	0.2315		Unfavorable	0.6775		Unfavorable	0.058	*
Net (GO, OGO, VGO)				Favorable	0.093	*				Favorable	0.3145	
GON school				Favorable	0.193					Unfavorable	0.134	

* p < 0.10, ** p < 0.05, *** p < 0.01

Note: Results for 6%-discontinuity sample (8% and full sample in Appendix D). Standard deviation in parentheses.

Table 7. Direction of the influence of the contextual variables (cont'd). 6% discontinuity sample

	Model 6			Model 7			Model 5			Model 8		
	Influence	*p*-value		Influence	*p*-value		Influence	*p*-value		Influence	*p*-value	
School characteristics												
ASO										Favorable	0.0065	***
BSO												
School size										Favorable	0.092	*
% Change school										Unfavorable	0.0015	***
Previously treated										Favorable	0.136	

Net (GO, OGO, VGO)										
GON school										
Teacher characteristics										
Teacher seniority	Favorable	0.1205	Favorable	0.1745				Favorable	0.1255	
Teacher diploma	Favorable	0.1825	Favorable	0.2125				Favorable	0.0085	***
Teacher age	Unfavorable	0.2155	Unfavorable	0.592						
School principal seniority			Favorable	0.1035						
Teacher contract			Unfavorable	0.0025	***					
% female teachers			Favorable	0.0055	***					
Student characteristics										
Primary retention						Unfavorable	0.9355			
Special students in primary						Unfavorable	0.1825			
% Man						Unfavorable	0.5795			

* p < 0.10, ** p < 0.05, *** p < 0.01

Note: Results for 6%-discontinuity sample (8% and full sample in Appendix D). Standard deviation in parentheses.

5. Robustness checks for second and third cycle secondary education

To test the robustness of the results, we perform several analyses on subsamples. By using the subsamples, we explicitly compare 'like with likes'. For instance, only vocational schools are compared at both sides of the exogenously set threshold. Moreover, to test the sensitivity of the results with respect to the selected inputs and outputs, we run auxiliary model specifications with alternative inputs and outputs. Finally, to be sure that our results are not driven by the chosen frontier method, we also use a semi-parametric stochastic frontier model as proposed by Kumbhakar et al. 2014 to disentangle the school inefficiency into four components: time-varying inefficiency, persistent inefficiency, fixed effects and overall inefficiency. Also in this approach we avoid assuming the "separability condition", as we directly include in the model the environmental variables *z* in one stage. Moreover, we exploit the time dimension, which is more demanding from a computational point of view in the conditional analysis. This section summarizes the findings, while the accompanying tables are presented in the Appendix E.

5.1 Robustness tests excluding some observations or with different inputs and outputs

First, to account for the presence of imperfect compliance we run the main analysis - 2 inputs and 4 outputs - excluding the eligible but not treated schools. Second, we perform an analysis with 2 inputs and 3 outputs, namely without the *share of student enrolled in bachelor*: bachelor enrolment might be unbalanced across the different school tracks and especially vocational schools might be penalized. Third, we run an analysis with 1 input and 3 outputs, namely without *operating grants per student* and without the *share of student enrolled in bachelor*: in this case we exclude the operating grants as they might be imprecisely imputed per student. The results of this analysis are listed in Appendix E.1, Appendix E.2 and Appendix E.3, respectively.

The results confirm the evidence described in Section 4: on average, program efficiency scores are lower for treated schools and there is a higher average overall efficiency among control schools, pointing at the fact that schools do not successfully convert more resources in more outputs, even when we exclude the eligible schools but not treated and when we reduce the number of inputs and outputs. Controlling for the school and pupil characteristics significantly reduces the gap in the program

efficiency scores. This suggests, again, that the policy did not improve the efficiency of the treated schools, but did not harm them as well. The analyses with a different mix of inputs and outputs also confirm the results presented in section 4: including school characteristics (in conditional model 3 and model 4), student characteristics (in conditional model 7) and school, teacher and student characteristics (in conditional model 10) leads to overall efficiency scores that do not statistically differ between schools below and above the threshold in the models with a 6% and 8% bandwidth.

5.2 Robustness tests on subsamples

A second series of robustness tests examines the sensitivity of the results with respect to the underlying (un)observed heterogeneity. As schools at both sides of the exogenously set threshold might have different characteristics which remain unobserved to the researcher, or as the treatment might have heterogeneous effects in different types of schools, we limit the sample to only vocational or only general education schools. The results of this analysis are provided in Appendix E.4 and Appendix E.5, respectively. Moreover, we perform separately two analyses, distinguishing whether the schools belong to the Brussels–Capital Region or not. The results are listed in Appendix E.6.

The results for the separate analyses for schools organizing at least vocational education (see Appendix E.4) indicate that average program efficiency scores of the treated schools are lower than one and that control schools perform on average better than the treated ones. However, controlling for the school, teacher and pupil characteristics significantly reduces the gap in the program efficiency scores, even to the extent that the difference is no longer significant in some models. The same conclusion holds for schools providing only general education (ASO). The results in Appendix E.5 indicate that, for the unconditional model and models with only school covariates included, average program efficiency is lower for schools above the threshold, compared to schools below the threshold. If more covariates are added the difference often becomes insignificant. This suggests, again, that the policy did not improve the efficiency of the treated schools, but did not harm them as well.

Since schools located in the Brussels-Capital Region receive additional inputs (i.e. they have a more favorable student-staff ratio), these schools may be a source of potential bias of the results. Therefore, we performed additional robustness checks by (1) restricting the sample to schools located in the Brussels-Capital Region and (2) by omitting these schools from the full sample. The results of these analyses are presented in Appendix E.6. Given the relatively small number of schools in the Brussels-Capital Region, it is impossible to restrict the estimates to a (small) bandwidth, hence we need to use the entire population of schools (i.e. 10 schools below the threshold and 18 schools above the threshold), reducing the comparability of the treated and the control group. In the unconditional model, the program efficiency for treated schools is significantly lower than for non-treated schools. Adding control variables leads to insignificant differences in program efficiency between treated and non-treated schools (except for conditional model 3 where the program efficiency for treated schools is significantly lower than for non-treated schools). The results of the (6% and 8% discontinuity sample) models excluding schools located in the Brussels-Capital Region, show (for the unconditional as well as all conditional models) that program efficiency is significantly lower for schools above the threshold. Excluding schools from the Brussels-Capital Region seems to strengthen the finding that average program efficiency is lower for treated schools. In line with the results of the main analysis (consisting of all schools), mean school efficiency scores of treated schools tend to be higher than school efficiency scores of non-treated schools, however in most models this difference is not significant.

5.3 Alternative estimation technique with panel data

The underlying model to estimate the efficiency scores is fully non-parametric, which indicates that there are no *a priori* assumptions made on the production frontier. In other words, as we do not assume a particular functional form of the production frontier, we can avoid specification biases. Unfortunately, the applied non-parametric efficiency model cannot properly handle panel data. Moreover, to test whether alternative model specifications deliver the same results, we analyse the robustness of the earlier estimations by using an alternative estimation technique. In particular, we apply an advanced stochastic frontier model (SFA), which was originally developed by Aigner et al. (1977) and Meeusen and Van Den Broeck (1977). The main difference with the non-parametric efficiency model used before is that, similar to traditional regression models, we now assume a particular functional form of the production frontier and that we assume for each school *i* an error term ϵ_i. In a stochastic frontier model, the error term is decomposed into random noise v and an inefficiency component u_i: $\epsilon_i = v_i - u_i$. As a functional form, we make use of a Fourier function, which is a flexible specification (see Appendix E.7 for details).

Given that we have information of schools from 2010/2011 to 2013/2014, we can apply a more advanced and recent SFA panel data model. The model, developed by Kumbhakar et al. (2015), exploits the panel structure of the data by including school random effects. In addition, we distinguish between time-varying inefficiency and time-invariant inefficiency. This captures the fact that schools may eliminate certain sources of their short-run inefficiency over time, while other sources may have a more permanent nature. In fact, we decomposed the original error term into four components: time-varying inefficiency, time-invariant inefficiency, random effects and symmetric random noise. The model, as also discussed by Kumbhakar et al. (2014), is represented by the following set of equations:

$$y_{it} = f_{it}(x_{it}, z_{it}) + \varepsilon_{it} \quad (5.a)$$

$$\varepsilon_{it} = v_{it} - u_{it} + \alpha_i + E(u_{it}) + \alpha_0^* \quad (5.b)$$

$$\alpha_i = \mu_i - \eta_i + E(\eta_i) \quad (5.c)$$

$$\alpha_0^* = \alpha_0 - E(\eta_i) - E(u_{it}) \quad (5.d)$$

$$v_{it} \sim i.i.d.N(0, \sigma_v^2) \quad (5.e)$$

$$u_{it} \sim i.i.d.N^+(0, \sigma_u^2) \quad (5.f)$$

$$\mu_i \sim i.i.d.N(0, \sigma_\mu^2) \quad (5.g)$$

$$\eta_i \sim i.i.d.N^+(0, \sigma_\eta^2) \quad (5.h)$$

In equations (5.b), (5.c) and (5.d), η_i represents time-invariant (or persistent) inefficiency, u_{it} denotes the time-varying (or short-run) inefficiency, μ_i captures school random effects and v_{it} is a stochastic component. This model is estimated in four steps. First, equation (5.a) is estimated using standard fixed effects estimation. Second, time-varying inefficiency u_{it} is obtained. Third, persistent inefficiency η_i is estimated (Kumbhakar et al., 2014). Lastly, overall inefficiency is obtained by - (1 - u_{it}) * (1 - η_i) + 1. This model specification is our preferred one as it does best in estimating inefficiency. Nonetheless, the important drawbacks of this model are that it is heavily parametric (to decompose the error term in various bits).

The results of the alternative model estimation are presented in Appendix E.7. They confirm the earlier findings in that the treated GOK schools are less efficient than similar schools close to the threshold.

5.4 Conclusion of the robustness tests

Overall, results seem to be very robust. This gives us confidence that schools receiving additional resources and located just above the threshold do not successfully convert them into more output. Nevertheless, accounting for the school and pupil characteristics, the difference in program efficiency is largely disappeared. Moreover, analyzing the results for schools far from the cutoff set at 25%, we observe that these additional resources can play a role, either because the treatment intensity is higher or because resources are allocated in more problematic contexts.

6. Results for the first grade of secondary education

So far, we have focused our analysis on the second and third stage of secondary education, whose threshold for treatment eligibility is at 25% of disadvantaged students. The main reasoning for this choice is that the causal impact of the program should be more evident considering a higher threshold rather than a lower one (10% in the first stage of secondary school). Moreover, at a threshold of 10% it would be more likely to have non-compliers (eligible but not treated) due to the second eligibility criteria: even if the observed share of disadvantaged students might be above the set threshold for determining treatment eligibility, it might not be enough to generate a minimum of 6 hours and therefore to receive additional funding.

6.1 Variable sample means for control/treated group and population

6.1.1 Input and output variables

This section focusses on the effect of the additional resources in the first stage of secondary education. In this section, we do not consider the *Share of students enrolled in higher education*, given that the first stage covers the first two years of secondary education and therefore it might not produce direct consequences on students' decision to continue their studies. So, we consider two inputs (*Teaching hours per student*, *Operating grants per student*) and three outputs (*Share of students with A certificate*, *Share of students without problems of absenteeism*, *Share of students progressing though school*). Given the lower threshold and the chosen outputs, the optimal bandwidth has been estimated again and ranges between 4% and 6%. In the 4% discontinuity sample there are 42 schools below the threshold and 38 above. In the 6% discontinuity sample there are 52 schools below the threshold and 64 above. In the full sample there are 54 schools below the threshold and 595 above. The results for the 6% discontinuity sample and the full sample are provided in Appendix F. Overall, these larger samples show very similar results to the smaller 4% discontinuity sample. As the latter has a higher interval validity, we focus on these outcomes.

Differently from the analysis for the second and third grade of secondary education, in this case the sample means show that treated schools have not only a higher level of inputs, but also a higher level of outputs, even if the means are not statistically different. Therefore, a program evaluation analysis can be useful to explore the mechanisms behind this evidence or, in other words, to understand whether this is due to the school management or to the treatment.

Table 8. Sample means for control/treated group and population. Input and output variables. 4% discontinuity sample. First grade of secondary education

	Below threshold		*Above threshold*		Full sample		*p*-value
Inputs							
Teaching hours per student	1.751	(0.176)	1.768	(0.199)	1.759	(0.186)	0.6915
Operating grants per student	822.8	(79.68)	825.6	(81.38)	824.1	(79.99)	0.8762
Outputs							
Share of students with "A certificate"	91.53	(4.423)	92.42	(3.550)	91.95	(4.032)	0.3302
Share of students without problems of absenteeism	99.98	(0.119)	99.98	(0.102)	99.98	(0.110)	0.8381
Share of students progressing through school	98.87	(1.111)	98.89	(1.252)	98.88	(1.173)	0.9383
Observations (school level)	42		38		80		

Note: Statistics for 4%-discontinuity sample (6% and full sample in Appendix F). Standard deviation in parentheses. *p*-values obtained from t-test to examine whether the control and the treated group variables are statistically different in means.

6.1.2 Control variables

Table 9. Sample means for control/treated group and population. Control variables. 4% discontinuity sample. First grade of secondary education

	Below threshold		*Above threshold*		Full sample		*p*-value diff.
School size (log)	6.035	(0.783)	5.929	(0.666)	5.985	(0.727)	0.2960
Share of students changing school	0.233	(0.161)	0.165	(0.141)	0.201	(0.155)	0.6133
Previously treated school	0.0952	(0.297)	0.500	(0.507)	0.287	(0.455)	**0.0000**
School type							0.290
GO	0.000		0.000				
OGO	0.000		0.026				
VGO	1.000		0.974				
School with special need students	0.214	(0.415)	0.263	(0.446)	0.237	(0.428)	0.6133
Teacher seniority	3.934	(0.356)	3.980	(0.290)	3.956	(0.325)	0.5239,
Teacher diploma	0.981	(0.0275)	0.981	(0.0268)	0.981	(0.0270)	0.9954
School principal seniority	5.810	(1.220)	5.899	(0.925)	5.852	(1.084)	0.7144
Teacher age	4.066	(0.333)	4.074	(0.279)	4.070	(0.307)	0.9141

Teacher full-time	0.178	(0.152)	0.205	(0.177)	0.191	(0.164)	0.4660
Female teachers	0.597	(0.121)	0.623	(0.0991)	0.609	(0.111)	0.3004
Share of students with grade retention in primary school	0.0326	(0.0209)	0.0441	(0.0301)	0.0381	(0.0262)	**0.0493**
Share of special need students in primary school	0.000497	(0.00259)	0.00116	(0.00454)	0.000810	(0.00364)	0.4227
Share of male students	0.487	(0.116)	0.462	(0.0942)	0.475	(0.107)	0.3033
Share of disadvantaged students	0.0802	(0.0118)	0.119	(0.0110)	0.0988	(0.0227)	**0.0000**
Observations (school level)	42		38		80		

Note: Statistics for 4%-discontinuity sample (6% and full sample in Appendix F). Standard deviation in parentheses. *p*-values obtained from t-test to examine whether the control and the treated group variables are statistically different in means.

6.2 Validity check of the RDD setting for first grade of secondary education

Before showing the results, in the following the conditions that need to be met for a reliable RDD setting are listed. To rule out any sorting around the threshold, as in the application for second and third cycle, we first check that the baseline characteristics of the control and the treated group are similar. Table 9 confirms this requirement as we observe little statistically significant differences between treated and control group characteristics. Then, we check the manipulation by looking at the frequency distribution of the schools with respect of the assignment variable, that is the share of disadvantaged students, and again we do not observe any manipulation.

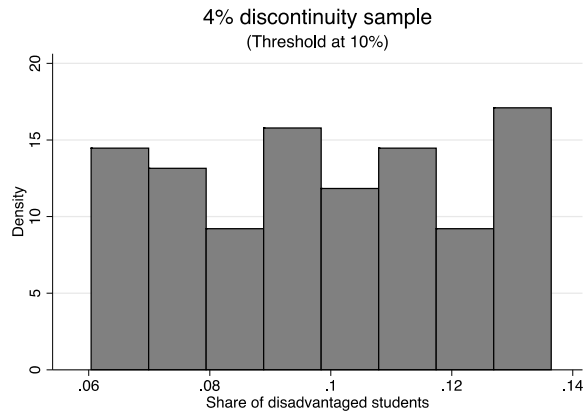


Figure 3. Frequency distribution of the schools with respect to the share of disadvantaged students for the 4% discontinuity sample

Furthermore, we check for a discontinuous jump in the probability of treatment at the 10% cutoff. Figure 4 indicates a clear jump around the threshold, although not as outspoken as in the second and third cycle. This might be due to the second eligibility criteria.

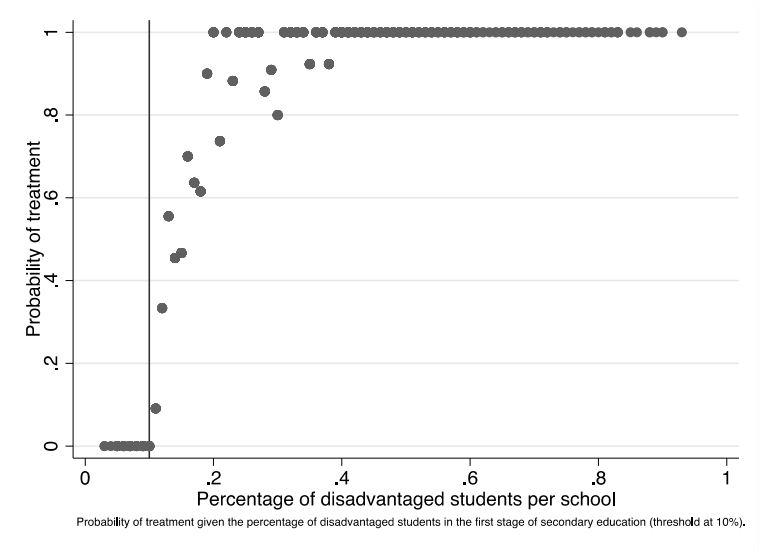


Figure 4. Discontinuity in the probability of treatment

6.3 Descriptive statistics of the efficiency scores

The efficiency scores are provided in Table 10. This initial analysis of the first grade seems to point at the fact that in this case the situation is reversed with respect to the one emerging in the second and third cycle: the calculated average program efficiencies are often higher for schools above the threshold. However, we have to take in mind that in this case there might be many more eligible but not treated schools, given that the cutoff is lower but the rule of the 6 minimum hours is still binding. Similar to the second and third cycle, once we include the school, teacher and pupil characteristics, the program efficiency scores are very similar. The results for the 4% discontinuity sample (presented in Table 10) and for the 6% discontinuity sample (presented in Appendix F.2) are comparable.

Table 10. Efficiency scores mean (Standard deviation in parentheses). 4% discontinuity sample.

	Below threshold		*Above threshold*		*p*-value of difference below and above
Unconditional					
Overall efficiency	0.808	(0.108)	0.789	(0.0889)	0.4107
School efficiency	0.902	(0.0813)	0.768	(0.125)	**0.0000**
Program efficiency	0.896	(0.0824)	1.036	(0.0671)	**0.0000**
Conditional 1 (School characteristics)					
Overall efficiency	0.936	(0.0791)	0.941	(0.0742)	0.7555
School efficiency	0.960	(0.0583)	0.942	(0.0932)	0.3223
Program efficiency	0.975	(0.0551)	1.004	(0.0819)	0.0665
Conditional 2 (School characteristics)					

Overall efficiency	0.942	(0.0673)	0.946	(0.0721)	0.8169
School efficiency	0.941	(0.0673)	0.945	(0.0920)	0.8187
Program efficiency	1.003	(0.0648)	1.006	(0.0828)	0.8670
Conditional 3 (Teacher characteristics)					
Overall efficiency	0.936	(0.0866)	0.934	(0.0849)	0.8862
School efficiency	0.949	(0.0659)	0.936	(0.0837)	0.4240
Program efficiency	0.986	(0.0561)	1.004	(0.115)	0.3822
Conditional 4 (Teacher characteristics)					
Overall efficiency	0.966	(0.0478)	0.944	(0.0691)	0.0992
School efficiency	0.969	(0.0490)	0.962	(0.0669)	0.6174
Program efficiency	0.999	(0.0540)	0.982	(0.0430)	0.1288
Conditional 5 (Student characteristics)					
Overall efficiency	0.832	(0.121)	0.811	(0.109)	0.4337
School efficiency	0.923	(0.0697)	0.806	(0.140)	**0.0000**
Program efficiency	0.898	(0.0921)	1.016	(0.0885)	**0.0000**
Conditional 6 (School & Teacher characteristics)					
Overall efficiency	0.953	(0.0529)	0.948	(0.0812)	0.7599
School efficiency	0.953	(0.0518)	0.951	(0.0856)	0.9109
Program efficiency	1.001	(0.0511)	0.997	(0.0252)	0.7140
Conditional 7 (School & Teacher characteristics)					
Overall efficiency	0.985	(0.0236)	0.974	(0.0501)	0.2163
School efficiency	0.989	(0.0220)	0.986	(0.0334)	0.5480
Program efficiency	0.996	(0.0257)	0.988	(0.0344)	0.2669
Conditional 8 (School & Teacher & Student characteristics)					
Overall efficiency	0.986	(0.0277)	0.984	(0.0422)	0.8217
School efficiency	0.993	(0.0181)	0.988	(0.0341)	0.4334
Program efficiency	0.993	(0.0242)	0.996	(0.0270)	0.6141
Observations (school level)	42		38		

Note: Results for 4%-discontinuity sample (6% and full sample in Appendix F). Standard deviation in parentheses. *p*-values obtained from t-test to examine whether the control and the treated group efficiency scores are statistically different in means.

m=40, 2 inputs (teaching hours per student, operating grants per student) and 3 outputs (Share of students with "A certificate", Share of students without problems of absenteeism, Share of students progressing through school)

Conditional 1: School size, % of students changing school, Previously treated school

Conditional 2: School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: Teacher seniority, Teacher diploma, School principal seniority

Conditional 4: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 5: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 6: School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 7: School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 8: School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

6.3 Descriptive statistics of the efficiency scores (excluding eligible but not treated schools)

In the following, we present the results of the efficiency analysis where we exclude from the sample the schools that are eligible but not treated because unable to generate a minimum of six teaching hours (for further explanation, see also Appendix A). Nevertheless, we consider the same optimal bandwidth range, between 4% and 6%.

For the following estimation, we consider two inputs (*Teaching hours per student*, *Operating grants per student*), three outputs (*Share of students with A certificate*, *Share of students without problems of absenteeism*, *Share of students progressing though school*), three groups of contextual variables (School, Teacher and Student characteristics) and *m* is set to 40. In the 4% discontinuity sample there are 42 schools below the threshold and 9 above. In the 6% discontinuity sample there are 52 schools below the threshold and 21 above. In the full sample there are 54 schools below the threshold and 522 above. The results of the 6% discontinuity sample and the full sample, which are very similar, are provided in Appendix F.3.

The results are presented in Table 11. In this case, average program efficiency scores of treated schools are lower than one. This might suggest that when we focus only on treated schools (excluding those that are eligible but not treated) schools do not successfully convert more resources into more outcomes also at first cycle level. On the other hand, we observe again that the difference between the treated and untreated schools reduces and almost vanishes if we account for the school, teacher and pupil characteristics. This finding suggests that the intervention did not change the efficiency of the first cycle in schools, nor in a favorable or unfavorable way. The results for the 6% discontinuity sample (presented in Appendix F.3) are similar to the ones discussed in this paragraph (and presented in Table 11).

Table 11. Efficiency scores mean (Standard deviation in parentheses). 4% discontinuity sample, excluding eligible but not treated schools

	Below threshold		*Above threshold*		*p*-value
Unconditional					
Overall efficiency	0.904	(0.0814)	0.901	(0.0602)	0.9248
School efficiency	0.902	(0.0813)	0.949	(0.0641)	0.1052
Program efficiency	1.002	(0.00323)	0.949	(0.0237)	**0.0000**
Conditional 1 (School characteristics)					
Overall efficiency	0.958	(0.0616)	0.967	(0.0435)	0.6938
School efficiency	0.960	(0.0583)	0.988	(0.0275)	0.1625

Program efficiency	0.998	(0.00578)	0.978	(0.0275)	**0.0001**
Conditional 2 (School characteristics)					
Overall efficiency	0.960	(0.0581)	0.967	(0.0433)	0.7237
School efficiency	0.941	(0.0673)	0.988	(0.0229)	0.0455
Program efficiency	1.022	(0.0474)	0.978	(0.0270)	**0.0114**
Conditional 3 (Teacher characteristics)					
Overall efficiency	0.949	(0.0671)	0.935	(0.0716)	0.5857
School efficiency	0.949	(0.0659)	0.981	(0.0232)	0.1553
Program efficiency	0.999	(0.00608)	0.952	(0.0520)	**0.0000**
Conditional 4 (Teacher characteristics)					
Overall efficiency	0.973	(0.0491)	0.975	(0.0382)	0.9253
School efficiency	0.969	(0.0490)	0.989	(0.0183)	0.2392
Program efficiency	1.005	(0.0386)	0.986	(0.0244)	0.1545
Conditional 5 (Student characteristics)					
Overall efficiency	0.916	(0.0697)	0.950	(0.0467)	0.1703
School efficiency	0.923	(0.0697)	0.960	(0.0514)	0.1456
Program efficiency	0.992	(0.0300)	0.992	(0.0617)	0.9517
Conditional 6 (School & Teacher characteristics)					
Overall efficiency	0.954	(0.0517)	0.959	(0.0529)	0.7963
School efficiency	0.953	(0.0518)	0.988	(0.0181)	0.0552
Program efficiency	1.001	(0.0111)	0.970	(0.0435)	**0.0002**
Conditional 7 (School & Teacher characteristics)					
Overall efficiency	0.988	(0.0239)	0.994	(0.00972)	0.4323
School efficiency	0.989	(0.0220)	0.998	(0.00567)	0.2474
Program efficiency	0.998	(0.00970)	0.996	(0.0106)	0.5434
Conditional 8 (School & Teacher & Student characteristics)					
Overall efficiency	0.992	(0.0206)	1.000	(0.000245)	0.2417
School efficiency	0.993	(0.0181)	0.999	(0.00175)	0.2959
Program efficiency	0.999	(0.00651)	1.000	(0.00181)	0.4123
Observations (school level)	42		9		

Note: Results for 4%-discontinuity sample (6% and full sample in Appendix F). Standard deviation in parentheses. *p*-values obtained from t-test to examine whether the control and the treated group efficiency scores are statistically different in means.

m=40, 2 inputs (teaching hours per student, operating grants per student) and 3 outputs (Share of students with "A certificate", Share of students without problems of absenteeism, Share of students progressing through school)

Conditional 1: School size, % of students changing school, Previously treated school

Conditional 2: School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: Teacher seniority, Teacher diploma, School principal seniority

Conditional 4: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 5: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 6: School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 7: School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 8: School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

7. Results for primary education

To perform an efficiency analysis at primary education level, we rely on the unconditional and conditional analysis explained in the methodological section. However, for this application we do not focus on a discontinuity sample, but rather we focus on the full sample. Differently from secondary education funding, since 2012 there is no exogenous threshold we can use to observe a specific group of schools receiving additional funding (so-called 'SES-funding'). The decree of July 6 2012 introduced a new system in the Flemish Community to allocate additional funding in pre-primary and primary education (Flemish Ministry of Education and Training, 2015). In the previous system, the school needed to have a minimum of 10% disadvantaged students and to be able to generate a minimum of 6 extra teaching hours (computed by using a funding formula) in order to get additional funding for staff. This exogenous threshold was earlier exploited by Ooghe (2011). From the 2012/13 school year, every low socio-economic status pupil is accounted for in the new financing mechanism. To observe differences across years, and potential learning effects of the new funding system, we analyse the full sample separately for the school year 2012/13 and in school year 2013/14. Nevertheless, due to the lack of an exogenous threshold, and in contrast to before, we caution that the efficiency estimates cannot be interpreted in a causal way, but just from a correlation perspective.

7.1 Input/output/contextual variables

All variables are measured at school level, which is common in efficiency analysis (see review of De Witte and Lopez-Torres, 2017). It should be noted that aggregating the individual level data at school level, comes at the cost of losing individual variance at pupil level information. In other words, aggregated pupil level information at school level might hide heterogeneity within the variable. This is not problematic in the current application as we are mainly interested in general patterns at school level.

7.1.1 Inputs

For the analysis for primary education, we partly consider some variables that have been already used for secondary education analysis and we define new variables specifically related to the primary education context. In the following, we list the inputs and the outputs involved in the educational production, together with the environmental variables that might affect the process but that are not under the direct control of the school management. As for secondary education, we consider *teaching hours per student*. However, for primary education this variable measures the number of total teaching hours considering both the standard teaching hours and the `SES' teaching hours, calculated based on three socio-economic status indicators: mother's education, entitlement for a study grant and language spoken at home (Nusche et al. 2015). Note that in the Flemish education system elementary education

(basisonderwijs) comprises both pre-school education (kleuteronderwijs) and primary education (lager onderwijs). Although resources are typically provided for the elementary school (basisonderwijs), the analysis below includes only the resources for primary education (lager onderwijs).

7.1.2 Outputs

For primary education, we consider six output measures. The first output variable is the *share of students without problems of absenteeism*: this variable is calculated as the proportion of students that is not problematically absent (i.e. for more than 30 half school days). Second, the *share of students progressing through school* is used. This variable can be considered as the complement of grade retention (Rosenfeld 2010). Accordingly, this variable measures the proportion of students that progress through school without experiencing grade retention in primary education. The next four variables measure to which extent primary schools are able to promote school engagement and further education, looking at the share of students that enroll in A-stream (as opposed to B-stream, considered as a bridging class between primary and secondary education) or do not have problem of grade retention in the first years of secondary education. Specifically, *share of students in A-stream (I year)* measures the share of students that enroll in A-stream in the first year; *Share of students in A-stream (I year) - no retention* restricts the focus on students that enroll in A-stream in the first year and do not repeat the year. *Share of students in A-stream (I-II year)* measures the share of students that enroll in the next two years in A-stream and *share of students progressing in secondary school (I-II-III year)* measures the percentage of students which do not experience grade retention in the next three years since their enrolment in secondary education (we do not include the last three years of secondary education as reasonably they shouldn't be affected by primary education influence anymore).

Table 12. Descriptive statistics for primary schools. Input and output variables. 2012.

	mean	sd	min	max
Input				
Teaching hours per student	1.43	0.17	1.10	2.75
Output				
Share of students without problems of absenteeism	1.00	0.01	0.89	1.00
Share of students progressing in primary school	0.80	0.05	0.52	0.95
Share of students in A-stream (I year)	0.87	0.11	0.03	0.99
Share of students in A-stream (I year) - no retention	0.84	0.15	0.02	0.99
Share of students in A-stream (I-II year)	0.81	0.14	0.02	0.99
Share of students progressing in secondary school (I-II-III year)	0.96	0.07	0.33	1.00
Observations (school level)	2094			

Table 13. Descriptive statistics for primary schools. Input and output variables. 2013.

	mean	sd	min	max

Inputs				
Teaching hours per student	1.42	0.19	1.06	3.76
Outputs				
Share of students without problems of absenteeism	1.00	0.00	1.00	1.00
Share of students progressing in primary school	0.81	0.05	0.29	0.94
Share of students in A-stream (I year)	0.86	0.16	0.03	0.99
Share of students in A-stream (I year) - no retention	0.74	0.30	0.02	0.99
Share of students in A-stream (I-II year)	0.76	0.24	0.02	0.99
Share of students progressing in secondary school (I-II-III year)	1.00	0.00	1.00	1.00
Observations (school level)	2094			

7.1.3 Contextual variables

School characteristics

School size. The relevance of school size has been acknowledged in the education economics literature, in particular by exploring the relationship between the school size effects and the possible existence of scale economies. Interestingly, the evidence can be mixed if looking at the student socio-economic characteristics (Leithwood and Jantzi 2009). School principals cannot refuse student enrolments by law (unless the school faces capacity restrictions), consequently, school size is an exogenous variable that is not under the control of the school management, but that still affects the way schools convert school resources into educational outcomes and therefore it is worth controlling for it.

Share of students changing school. The variable measures the share of students that change school and go to a different school in the next year (a school is here defined as a pedagogical unit). This variable captures how many students leave the school or are pushed away from the school they are currently enrolled in, and, as such, it may serve as a proxy for selection in and of schools.

School type. In the Flemish Community, there are three main educational networks that act as "umbrella organization" for the school governing bodies (Nusche et al. 2015): public education organized by the Flemish Community, public education organized by municipalities or provinces, and private education. Irrespective of the educational network, schools have to reach the same goals such that schools in the different networks mainly differ in the competent government authority and in the way they are managed, that is either publicly or privately.

Teacher characteristics

The role of teacher quality and school principals in the educational process has been increasingly acknowledged (see, e.g., Hanushek and Woessmann 2015, OECD 2017b, De Witte and Van Klaveren 2014, De Witte and Rogge 2011) and, consequently, has to be taken into account. We observe the teacher characteristics in a detailed and rich way.

First, *teacher seniority* measures the teacher experience level in a school. It ranges from 1 to 7, where 1 refers to the least experienced teachers (0-5 years) and 7 to the most experienced ones (>30 years). Second, *teacher diploma* quantifies the share of teachers that have a "proper" diploma to teach the subject they are assigned to ("vereiste bekwaamheidsbewijzen") or one at a similar level ("voldoend

geachte bekwaamheidsbewijzen"), as opposed to another type of diploma representing the minimum level required for teaching. Third, s*chool principal seniority* measures the school principal seniority. As for teachers, it ranges from 1 to 7, where 1 refers to the least experienced and 7 to the most experienced school principal. Fourth, *teacher age* ranges from 1 to 8, where 1 refers to the youngest teachers (<30 year old) and 8 to the oldest ones (60+). Sixth, t*eacher full-time* represents the share of teachers that have a full-time contract, as opposed to a part-time contract. Finally, *female teachers* is the share of female teachers working in a school.

Student characteristics

As a proxy of the quality of the students attending the schools under analysis, *Share of students in kindergarten* measures the share of students that have ever been enrolled in kindergarten and *Share of students in kindergarten (3 years or more)* measures the share of students that have been enrolled at least three years in kindergarten. This variable is included as pupils who have spent a longer period in kindergarten have other observed (e.g., higher SES students) and unobserved characteristics (e.g., they are more familiar with the schooling system; background of the parents). In addition, *Share of special need students in kindergarten* considers whether the students that have attended the kindergarten were also special need students.

Second, the *share of special need students in primary school* measures whether the students we observe in standard curriculum of primary education have ever attended special need primary schools before.

Third, the s*hare of male students.* measures the proportion of male students in a school. The following variables capture the criteria according to which a student is deemed to be "disadvantaged" and therefore counted as such in the SES-funding. *Share of disadvantaged students* measures the share of students defined as disadvantaged if he/she meets one of these criteria following Nusche et al. 2015: low cultural background (*Share of SES students - mother's education*), low financial capacity (*Share of SES students – allowance),* low linguistic and cultural capital *(Share of SES students - no Dutch)* and low social capital (*Share of SES students – alone).*

Table 14. Descriptive statistics for primary schools. Control variables. 2012.

	mean	sd	min	max
School size (log)	5.10	0.47	3.09	6.47
Share of students changing school	0.05	0.05	0.00	0.20
School type				
GO	16.28%			
OGO	22.21%			
VGO	61.51%			
Teacher seniority	3.98	0.70	1.42	6.60
Teacher diploma	0.98	0.05	0.67	1.00
School principal seniority	5.50	1.33	1.00	7.00

Teacher age	4.00	0.66	1.83	6.29
Teacher full-time	0.55	0.15	0.00	0.95
Female teachers	0.78	0.12	0.19	1.00
Share of special need students in kindergarten	0.00	0.00	0.00	0.03
Share of special need students in primary school	0.02	0.02	0.00	0.15
Share of students in kindergarten	0.97	0.04	0.52	1.00
Share of students in kindergarten (3 years or more)	0.94	0.07	0.35	1.00
Share of male students	0.50	0.05	0.00	1.00
Share of disadvantaged students	0.39	0.23	0.03	1.00
Share of SES students - allowance	0.24	0.16	0.00	0.82
Share of SES students - no Dutch	0.17	0.22	0.00	0.99
Share of SES students - mother's education	0.20	0.17	0.00	0.89
Share of SES students - alone	0.00	0.02	0.00	0.76
Observations (school level)	2094			

Table 15. Descriptive statistics for primary schools. Control variables. 2013.

	mean	sd	min	max
School size (log)	5.12	0.47	2.89	6.50
Share of students changing school	0.05	0.05	0.00	0.20
School type				
GO	16.38%			
OGO	22.11%			
VGO	61.51%			
Teacher seniority	3.98	0.70	1.42	6.60
Teacher diploma	0.98	0.05	0.67	1.00
School principal seniority	5.50	1.33	1.00	7.00
Teacher age	4.00	0.66	1.83	6.29
Teacher full-time	0.55	0.15	0.00	0.95
Female teachers	0.78	0.12	0.19	1.00
Share of special need students in kindergarten	0.00	0.00	0.00	0.03

Share of special need students in primary school	0.02	0.02	0.00	0.12
Share of students in kindergarten	0.97	0.04	0.53	1.00
Share of students in kindergarten (3 years or more)	0.94	0.07	0.29	1.00
Share of male students	0.50	0.05	0.00	1.00
Share of disadvantaged students	0.39	0.24	0.03	1.00
Share of SES students - allowance	0.23	0.16	0.00	0.83
Share of SES students - no Dutch	0.18	0.22	0.00	1.00
Share of SES students - mother's education	0.20	0.17	0.00	0.90
Share of SES students - alone	0.00	0.02	0.00	0.69
Observations (school level)	2094			

7.2 Descriptive statistics of the efficiency scores

In the following we present the results for the efficiency analysis related to primary education. In particular, we provide efficiency scores computed using just one input (the *teaching hours per student*) and three outputs (the *Share of students progressing in primary school*, the *Share of students in A-stream (I year)* and the *Share of students progressing in secondary school (I-II-III year)*). We did not include the *Share of students without problems of absenteeism* because it has too low variation to be meaningful in the analysis (the same applies for *Share of special need students in kindergarten* and *Share of SES students – alone*, referring to the contextual variables). Moreover, we do not include as input the *Operating grants per student* since they might be imprecisely imputed per school/per student and nevertheless the analysis on secondary education shows that including this variable does not change the findings. The results are robust also when including *Share of students in A-stream (I year) - no retention* and *Share of students in A-stream (I-II year)*.

Section 7.2.1 and 7.2.2 report the efficiency scores obtained by estimating the educational production frontier for 2084 primary schools in 2012 and 2013 respectively, using an input-oriented robust FDH model: as for the choice of *m*, a sensitivity analysis shows that *m=530* is warranted. In addition, several groups of contextual variables have been included directly in the production frontier, by using a conditional robust FDH model. The average efficiency score obtained for the unconditional analysis is both for 2012 and 2013 around 0.80, pointing at the fact that on average schools might reduce their input by 20% and still produce the same level of outputs. By construction, the conditional estimates are higher. However, even in the most complex model specification 10, and, therefore, even when many contextual dimensions are considered at once, there is room to improve the school performance by reducing up to 10% the input.

Appendix G lists the results of the analysis performed distinguishing whether the schools belong to the in the Brussels–Capital Region or not. The results for schools located in the Brussels-Capital Region (n=108) show average efficiency scores of approximately 0.89 for the unconditional models, which is higher than an average efficiency score of approximately 0.81 for the sample excluding Brussels (n=1986) and higher than average scores for the full sample (presented in Table 16 and Table 17). Adding more contextual variables leads to average efficiency scores (for the most elaborate models) close to 1 for schools in Brussels, compared to approximately 0.91 for the sample excluding Brussels and

approximately 0.92 for the full sample of schools. However, one should be careful comparing average efficiency scores across different subsamples. Higher average efficiency scores for a particular subsample does not necessary imply that schools in this subsample are more efficient than schools in another subsample: it may just mean that schools in the former subsample are more homogeneous (regarding individual efficiency scores) than in the latter subsample.

7.2.1 Descriptive statistics of the efficiency scores for the full sample. 2012

Table 16. Descriptive statistics of the overall efficiency scores. Primary education, 2012

Model specification	mean	sd	min	max
Unconditional	0.8075	0.0952	0.4060	1.0120
Conditional 1 (School characteristics)	0.8859	0.0941	0.4898	1.0000
Conditional 2 (Student characteristics)	0.8810	0.0816	0.5363	1.0000
Conditional 3 (Student characteristics)	0.8967	0.0801	0.5394	1.0000
Conditional 4 (Student characteristics)	0.8391	0.0938	0.4558	1.0000
Conditional 4 bis (Student characteristics)	0.8459	0.0906	0.4805	1.0000
Conditional 5 (Teacher characteristics)	0.8703	0.1033	0.4288	1.0001
Conditional 6 (Teacher characteristics)	0.8937	0.0993	0.4539	1.0000
Conditional 7 (School & Teacher characteristics)	0.8905	0.0954	0.5042	1.0000
Conditional 8 (School & Teacher characteristics)	0.9161	0.0884	0.5819	1.0000
Conditional 9 (School & Teacher & Student characteristics)	0.9119	0.0870	0.5688	1.0000
Observations (school level)	2094			

Conditional 1: School type, School size, % of students changing school

Conditional 2: % of disadvantaged students

Conditional 3: % SES – allowance, % SES students - no Dutch, % SES students - mother's education

Conditional 4: % students with special needs in primary school, % of students in kindergarten, % male students

Conditional 4 bis: % students with special needs in primary school, % of students in kindergarten (3 years or more), % male students

Conditional 5: Teacher seniority, Teacher diploma, School principal seniority

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 7: School type, School size, % of students changing school, Teacher seniority, Teacher diploma, School principal seniority

Conditional 8: School type, School size, % of students changing school, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 9: School type, School size, % of students changing school, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with special needs in primary school, % male students

7.2.2 Descriptive statistics of the efficiency scores for the full sample. 2013

Table 17. Descriptive statistics of the overall efficiency scores. Primary education, 2013

Model specification	mean	sd	min	max
Unconditional	0.7998	0.0967	0.2924	1.0094
Conditional 1 (School characteristics)	0.8665	0.0941	0.5174	1.0000
Conditional 2 (Student characteristics)	0.8666	0.0759	0.3783	1.0000
Conditional 3 (Student characteristics)	0.8802	0.0793	0.5007	1.0000
Conditional 4 (Student characteristics)	0.8395	0.0923	0.3847	1.0000
Conditional 4 bis (Student characteristics)	0.8421	0.0888	0.4484	1.0000
Conditional 5 (Teacher characteristics)	0.8530	0.1049	0.3049	1.0000
Conditional 6 (Teacher characteristics)	0.8757	0.1035	0.3110	1.0000
Conditional 7 (School & Teacher characteristics)	0.8730	0.0984	0.5330	1.0000
Conditional 8 (School & Teacher characteristics)	0.9012	0.0945	0.5374	1.0000
Conditional 9 (School & Teacher & Student characteristics)	0.8969	0.0930	0.5535	1.0000
Observations (school level)	2094			

Conditional 1: School type, School size, % of students changing school

Conditional 2: % of disadvantaged students

Conditional 3: % SES – allowance, % SES students - no Dutch, % SES students - mother's education

Conditional 4: % students with special needs in primary school, % of students in kindergarten, % male students

Conditional 4 bis: % students with special needs in primary school, % of students in kindergarten (3 years or more), % male students

Conditional 5: Teacher seniority, Teacher diploma, School principal seniority

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 7: School type, School size, % of students changing school, Teacher seniority, Teacher diploma, School principal seniority

Conditional 8: School type, School size, % of students changing school, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 9: School type, School size, % of students changing school, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with special needs in primary school, % male students

7.3 Direction of the influence of the contextual variables on the educational production

Table 18 and Table 19 list the findings for the statistical inference and, more specifically, the median influence of these variables on efficiency. We present also few smoothed regression plots to give a graphical intuition of the direction of influence on the efficiency. We recall that graphically, the smoothed regression line can be interpreted as the marginal effect of the contextual variable under focus on the attainable set. We consider the ratio of unconditional over conditional estimates to give more intuitive understanding: if the smoothed nonparametric regression is increasing, then the variable is favourable to the efficiency, otherwise the opposite holds (De Witte and Schiltz 2018).

Interestingly, the contextual variables that have been considered already in the analysis for secondary education show the same direction of the influence on efficiency. This yields confidence to

our earlier results. It is important to note that the direction of the influence of socio-economic characteristics might give insights on the `SES'-teaching hours assigned based on these characteristics. We can observe that the share of low socio-economic status students has an unfavourable influence on the efficiency and the same applies for the other related SES variables. However, this influence is almost always not significant, suggesting that the share of low SES-students does not have an influence on the school efficiency. This suggests that the additional teaching hours meant to target low `SES' students help to reduce the influence of this variable on the efficiency scores of schools.

In addition, the results in Table 18 and 19 indicate that larger schools have a significant positive influence on the efficiency estimates. This might suggest the presence of scale economies in the use of the SES-resources. A higher share of pupils changing school seems to have an unfavourable influence on efficiency. As far as the separate student characteristics concern, we observe that for 2012 the allowances and students who do not speak the native language Dutch at home have no significant influence on the efficiency. This contrasts to the percentage of students who have a mother with a low educational background, as this variable still has a significant unfavorable influence on the efficiency scores. In 2013, none of these student characteristics has a significant influence on efficiency scores. Next, we observe that schools with more students from special needs tend to have an unfavorable influence on the school efficiency, while the opposite holds for pupils who have been enrolled (more than 3 years) in kindergarten. From a policy perspective, this finding suggests that initiatives to stimulate kindergarten attendance have also long run effects (which is also confirmed in work by Noble Prize winner Heckmann).

Also teacher characteristics play an important role. This is indicated by the favorable influence that teacher seniority and diploma plays. From a policy perspective, this finding suggest that teacher training and experience are important determinants in school efficiency. For the experience of the school principal, we observe mixed evidence.

The results for the 2012 analysis differ only marginally from the results for the 2013 analysis. The only exception are the student characteristics, which are all insignificant in the 2013 analysis.

Table 18. Statistical inference results for 2012

	Model 1			Model 2			Model 3			Model 4			Model 4 bis		
	Influence	*p*-value		Influence	*p*-value		Influence	*p*-value		Influence	*p*-value		Influence	*p*-value	
School characteristics															
Net (GO, OGO, VGO)	Unfavorable	0.000	***												
School size	Favourable	0.000	***												
% Change school	Unfavourable	0.544													
Student characteristics															
% SES students				Unfavourable	0.807										
% SES - allowance							Unfavourable	0.954							
% SES students - no Dutch							Unfavourable	0.590							
% SES students - mother's education							Unfavourable	0.000	***						

Special students in primary						Unfavourable	0.000	***	Unfavourable	0.000	***
Kindergarten						Favourable	0.000	***			
Kindergarten (3 years or more)									Favourable	0.000	***
% Man						Favourable	0.001	***	Favourable	0.001	***

* p < 0.10, ** p < 0.05, *** p < 0.01

	Model 5			Model 6			Model 8			Model 9		
	Influence	*p*-value		Influence	*p*-value		Influence	*p*-value		Influence	*p*-value	
School characteristics												
Net (GO, OGO, VGO)							Favourable	0.000	***	Favourable	0.000	***
School size							Favourable	0.000	***	Favourable	0.999	
% Change school							Unfavourable	0.000	***	Unfavourable	0.180	
Student characteristics												
Special students in primary										Unfavourable	0.227	
% Man										Favourable	0.000	***
Teacher characteristics												
Teacher seniority	Unfavourable	1.000		Favourable	1.000		Favourable	0.020	**	Favourable	0.995	
Teacher diploma	Favourable	0.000	***	Favourable	1.000		Favourable	0.000	***	Favourable	0.000	***
School principal seniority	Unfavourable	0.027	**	Unfavourable	1.000		Favourable	0.000	***	Favourable	0.004	***
Teacher age				Favourable	1.000		Unfavourable	1.000		Unfavourable	0.049	**
Teacher contract				Favourable	1.000		Favourable	0.000	***	Favourable	0.015	**
% female teachers				Unfavourable	1.000		Favourable	0.0055	***	Favourable	0.999	

* p < 0.10, ** p < 0.05, *** p < 0.01

Table 19. Statistical inference results for 2013

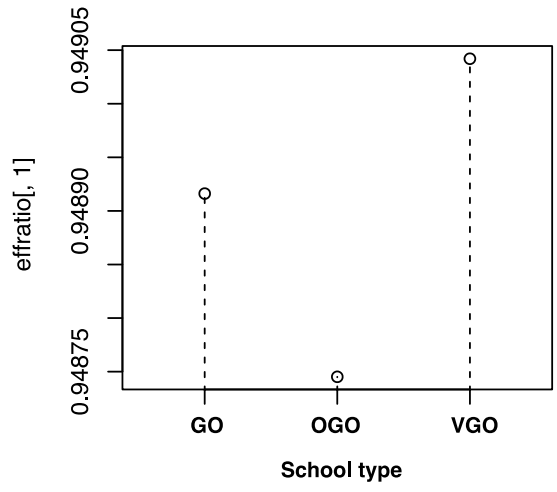
	Model 1			Model 2		Model 3		Model 4		Model 4 bis	
	Influence	*p*-value		Influence	*p*-value	Influence	*p*-value	Influence	*p*-value	Influence	*p*-value
School characteristics											
Net (GO, OGO, VGO)	Favourable	0.0665	*								
School size	Favourable	0.008	***								
% Change school	Unfavourable	0.000	***								
Student characteristics											
% SES students				Unfavourable	0.324						
% SES - allowance						Unfavourable	1.000				
% SES students - no Dutch						Unfavourable	1.000				
% SES students - mother's education						Unfavourable	1.000				

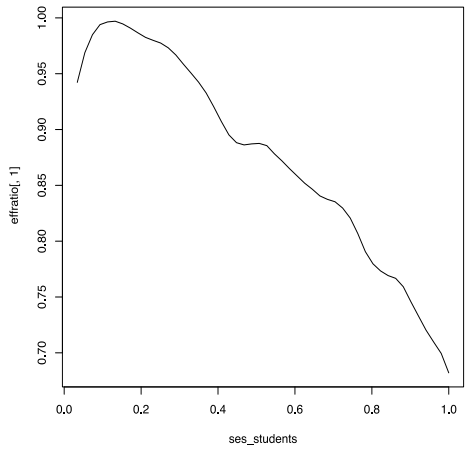
Special students in primary					Unfavourable	0.000	***	Unfavourable	0.000	***
Kindergarten					Favourable	0.000	***			
Kindergarten (3 years or more)								Favourable	0.0125	**
% Man					Unfavourable	0.096	*	Unfavourable	0.018	**

* p < 0.10, ** p < 0.05, *** p < 0.01

	Model 5		Model 6		Model 8			Model 9		
	Influence	*p*-value	Influence	*p*-value	Influence	*p*-value		Influence	*p*-value	
School characteristics										
Net (GO, OGO, VGO)					Favourable	0.0000	***	Favourable	0.000	***
School size					Favourable	0.0035	***	Favourable	0.000	***
% Change school					Unfavourable	0.7650		Unfavourable	0.000	***
Student characteristics										
Special students in primary								Unfavourable	0.000	***
% Man								Unfavourable	0.691	
Teacher characteristics										
Teacher seniority	Favourable	1.000	Unfavourable	1.000	Favourable	0.0345	**	Favourable	0.000	***
Teacher diploma	Favourable	0.000	Favourable	1.000	Favourable	0.0000	***	Favourable	0.000	***
School principal seniority	Unfavourable	0.1025	Unfavourable	1.000	Favourable	0.0000	***	Favourable	0.000	***
Teacher age			Favourable	1.000	Unfavourable	0.5525		Unfavourable	0.000	***
Teacher contract			Favourable	1.000	Favourable	0.6525		Unfavourable	0.008	***
% female teachers			Unfavourable	1.000	Favourable	0.3455		Favourable	0.000	***

* p < 0.10, ** p < 0.05, *** p < 0.01





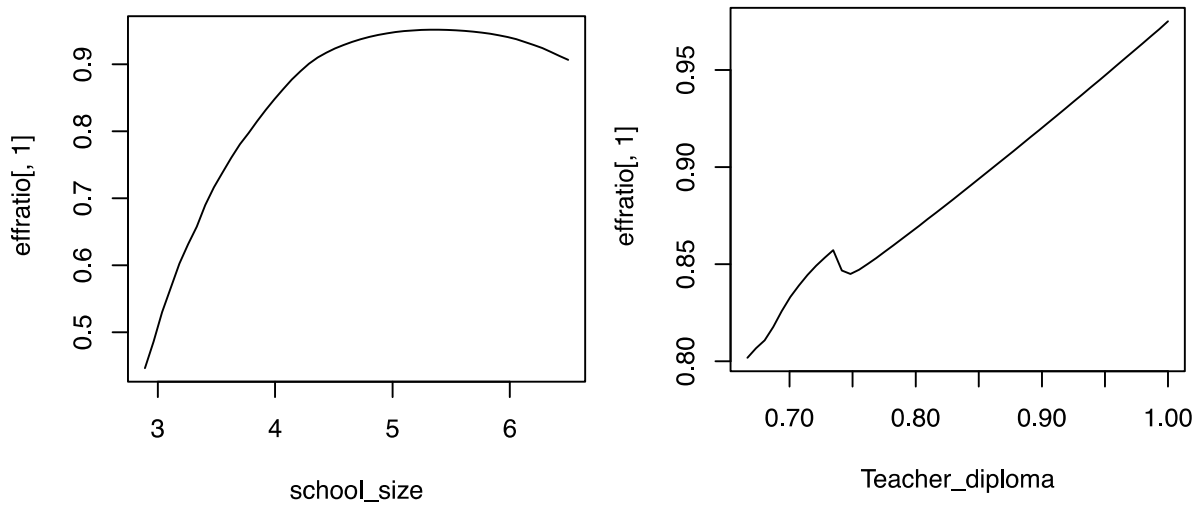


Figure 5. Smoothed regression plots: on the x axis the contextual variable, on the y axis the efficiency ratio between unconditional and conditional estimates.

8. Discussion and policy implications

This paper proposed an innovative approach to evaluate the causal impact of a policy intervention on the efficiency, by combining insights from policy evaluation techniques and the standard efficiency analysis. Specifically, we designed a three-step procedure that can be applied whenever the treatment status depends on an exogenously set threshold. In the first step, we focus on the observations around the threshold to handle potential endogeneity issues and, accordingly, we define a discontinuity sample in the spirit of a regression discontinuity design. In this way, we distinguish two groups of units very similar in their baseline characteristics but different in the treatment (treated *versus* untreated). In the second step, we adapt the concept of the nonparametric metafrontier approach to decompose the overall efficiency into a `managerial' and a `program' efficiency component. To do so, we estimate both a group-specific local production frontier for each group (i.e. treated and non-treated group) as well as a pooled production frontier for the discontinuity sample: the program efficiency is obtained residually by comparing the latter with the former. In the third step, we include heterogeneity in the estimation of the production frontier of step 2 by proposing a conditional analysis. Furthermore, the comparison between conditional and unconditional estimates leads to insightful statistical inference, detecting the direction of the influence of the contextual variables under a non-separable production context. Because of the quasi-experimental setting introduced in step 1, we can give causal interpretation to the estimates.

We showed the practical usefulness of our methodology evaluating the causal impact on school performance of the "Equal Educational Opportunities" ("*gelijkeonderwijskansenbeleid*, GOK") program, promoted by the Flemish Ministry of Education in Belgium since 2002 to support schools with (a large share of) disadvantaged students in secondary education. Specifically, the program assigns additional "GOK" resources to secondary schools that exceed an exogenously set threshold of disadvantaged students (10% for the first two years and 25% for the next two cycles of secondary education). To validate the regression discontinuity setting, we performed a number of checks that indicated the absence of manipulation around the threshold. For the educational production frontier estimation, we considered two inputs (namely the total teaching hours per student, including the additional hours, and

the operating grants per student) and four outputs (namely s*hare of students with "A certificate",* s*hare of students with "A certificate", share of students progressing through school,* s*hare of students enrolled in higher education*). For the conditional analysis, we considered three sets of contextual variables: school, teacher and student characteristics. In primary education, there is a similar program for equal educational opportunities (so-called 'SES-middelen'). In contrast to secondary education, there is no exogenously set threshold.

Examining secondary schools close to the exogenously determined cutoff level, the results of the unconditional models indicate that additional resources do not causally influence efficiency around the threshold. In particular, the schools in the first, second and third cycle of secondary education which are close to the threshold and are receiving the additional resources have a lower program efficiency. These results seem to be very robust to several sub-analysis (e.g. by education track, different input and output variables, different bandwidth). Nevertheless, despite the assumption that schools close to the threshold are very similar, some observed characteristics might still be different. Using a conditional efficiency model, we account for the school, teacher and pupil characteristics. The results of the conditional efficiency analyses indicate that the difference in program efficiency largely disappears in the second and third cycle, and completely disappears in the first cycle of secondary education. This suggests that the policy did not improve the efficiency of the treated schools, but did not harm them as well. The analyses also allow to infer the direction of influence of contextual variables on efficiency scores: secondary schools providing general education (ASO) in the second or third stage have a favourable influence on the efficiency, while the opposite holds for vocational school (BSO). In addition, a high share of students that change school has an unfavourable influence, whereas the positive influence of school size may be an indicator of the presence of economies of scale.

In addition, separate analyses for different subsamples were performed. Restricting the sample to schools organizing at least vocational education shows that average program efficiency scores of the treated schools are lower than the program efficiency scores of non-treated schools and that control schools perform on average better on overall efficiency than the treated ones. However, controlling for the school, teacher and pupil characteristics significantly reduces the gap in the program efficiency scores, even to the extent that the difference is no longer significant in some models. The same conclusion holds for a subsample restricted to schools providing only general education (ASO). Since schools located in the Brussels-Capital Region have a more favorable student-staff ratio, these schools may be a source of potential bias of the results. Therefore, we performed additional robustness checks by (1) restricting the sample to schools located in the Brussels-Capital Region and (2) by omitting these schools from the full sample. Program efficiency for treated schools in Brussels is significantly lower than for non-treated schools, but adding control variables leads to insignificant differences in program efficiency between treated and non-treated schools. The results for the sample excluding schools located in Brussels show (for the unconditional as well as all conditional models) that program efficiency is significantly lower for schools above the threshold.

Since the equal opportunities program that is applied to primary education does not set a threshold, all analyses for primary education are based on the full sample of primary schools. Hence, we cannot interpret the results as causal with respect to additional funding provided by this particular equal opportunities program. The results show that average efficiency scores obtained for the unconditional models is around 0.80, pointing at the fact that on average schools might reduce their input by 20% and still produce the same level of outputs. Adding contextual variables increases average efficiency scores to approximately 0.90. Similar to the sub-analyses for secondary education, separate analyses were performed for schools located in the Brussels-Capital Region and for schools not located in the Brussels-Capital Region. The results for schools located in Brussels show average efficiency scores of

approximately 0.89 for the unconditional models, compared to an average efficiency score of approximately 0.81 for the sample excluding Brussels. Adding more contextual variables leads to average efficiency scores (for the most elaborate models) close to 1 for schools in Brussels, compared to approximately 0.91 for the sample excluding Brussels. However, higher average efficiency scores for a particular subsample does not necessary imply that schools in this subsample are more efficient than schools in another subsample: it may just mean that schools in the former subsample are more homogeneous (regarding individual efficiency scores) than schools in the latter subsample. Regarding the direction of the influence of contextual variables on efficiency, the analyses show that that most indicators capturing the share of low socio-economic status students do not have a significant influence on the school efficiency, suggesting that the additional teaching hours meant to target low `SES' students help to reduce the influence of this variable on the efficiency scores of schools. Similar to the results of secondary education, school size has a favourable influence on efficiency and a high share of students that change school has an unfavourable influence on efficiency. Specifically for primary schools, a higher share of pupils that were enrolled in kindergarten has a positive influence on efficiency. Finally, contrary to secondary education, teacher characteristics play an important role. This is indicated by the favorable (and significant) influence that teacher seniority and diploma plays. From a policy perspective, this finding suggest that teacher training and experience are important determinants in school efficiency. For the experience of the school principal, we observe mixed evidence.

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Appendix A: The Flemish education system and its equal educational opportunities program

In the Flemish Community of Belgium, education is compulsory from age 6 to 18. Compulsory education includes two levels: primary (6-12 years old) and secondary (12-18 years old) education. Parents can freely choose any primary or secondary school for their children. In secondary education there are four ability tracks. General secondary education prepares students for higher education. Artistic secondary education provides general education with an emphasis on arts. While technical secondary education takes a more technical approach, intended to provide students with the necessary skills to start a professional career, it also provides them with sufficient knowledge to enroll in higher education. This is in contrast with the vocational secondary education track that explicitly trains students for a specific occupation. While choice between these tracks is, in theory, up to the students' ability and ambitions, general education is generally perceived as the most prestigious of the tracks and vocational education is perceived as the least prestigious. In the absence of standardized exams, this creates segregation in schools (for further discussion, see De Witte and Hindriks, 2017). The segregation can be observed in the significant differences in the average SES levels among schools.

Schools are funded through their school boards. The funding of teaching hours for schools in Flanders is mainly based on the number of students and certain point envelopes (see De Witte, Titl, Holz and Smet, 2017). A key aspect in the Flemish school funding mechanism concerns the way additional funding is obtained for staff in supporting low socio-economic status students. Specifically, in secondary education, there is no adjustment in the formula, but schools might receive additional teaching hours based on the "Equal Educational Opportunities (*gelijkeonderwijskansenbeleid*, *GOK*) program", enacted in the Flemish Community of Belgium since 2002 (OECD, 2015). The additional resources are assigned to school based on an exogenously defined cut-off. In particular, schools are eligible only if they have more than 25% disadvantaged students in the second and third stage of secondary education (and 10% in the first stage of secondary education). Even if all secondary schools with a minimum share of disadvantaged students are eligible for additional funding, schools need to apply for this funding. The eligibility criteria for defining 'disadvantaged students' shifted slightly throughout the years. Before 2008, the focus was mainly on the educational outcomes of students as a disadvantaged student was defined as a student who satisfies at least one of the following indicators. (i) The student has two or more years of grade retention; (ii) The student was part of a program for non-Dutch speaking newcomers; (iii) Students in vocational or technical education who received a school advise to repeat the year or to change their field of study. After 2008, the focus shifted to the socio-economic status of students. In particular, there are 5 equal opportunities indicators specified in the decree. To each of these indicators a weight, expressed in points is assigned. Below, find the 5 indicators with their respective point-values. The indicator school grant has 2 point values, one for students that only indicate this indicator and one (potentially together with non-Dutch home speakers) for those that indicate at least one other as well.

1. Parents belong to the travelling population (Roma, circus etc.) This indicator has a weight coefficient of 0.8 points.

2. The mother does not own a degree of secondary education. This indicator has a weight coefficient of 0.6 points.

3. The student is temporarily or permanently admitted outside of the family. This indicator has a point value of 0.8 points.

4. The family receives one or more school grants. If this is the only indicator checked the point value is 0.4. This weight is however corrected as the number of students that meet this requirement is

multiplied by 0.4417. This brings the real point value to 0.17668. When the student also checks another indicator the weight is set at 0.18 points.

5. The language the student speaks at home is not Dutch. This indicator has a weight coefficient of 0.2 points. For students that meet multiple indicators the weights are cumulative up to a maximum of 1.2 points per student.

The weight coefficient of 0.4417 for school grants also counts towards the count of weighted disadvantaged students. All other indicators are weighted as one in this regard. This calculation happens at the school level. Afterwards the points generated in the first cycle are summed and multiplied by 1.5 when the school is domiciled in the Brussels Capital Region or if the school has more than 55% disadvantaged students. If the school meets both criteria the multiplication happens twice. The total amount of points is multiplied with 0.2916 teacher hours.

The point values of students in second and third grade are also summarized. This value is than multiplied by 1.5 when the school is domiciled in the Brussels Capital Region or if the school has more than 55% disadvantaged students. If the school meets both criteria the multiplication happens twice. The total amount of points is multiplied with 0.1225 teacher hours.

A school receives the sum of these teacher hour students only if the result over all cycles yields 6 extra teacher hours or more. The calculation happens every 3 years (GOK-period) and during this period the additional hours remain the same. The extra teacher hours can be used across cycles as long as they aim to improve equal educational outcomes.

The total amount of additional funding for a school is decided upon every three years and is based on the amount and type of the disadvantaged students per school in the year before the start of the 3-year cycle. The latest cycles started in the school years 2008/2009, 2011-2012 and 2014/2015. Interestingly, schools are flexible in the use of these additional inputs. This might increase the differences in inefficiency between schools.

Appendix B: Bandwidth and manipulation tests

B.1 Optimal bandwidths

The following table lists the optimal bandwidths computed for each output under analysis using the 'rdrobust package' in Stata (Calonico et al. 2014a). Without loss of generality, we can focus on a range of optimal bandwidths between 6% and 8% and accordingly we obtain the 6% discontinuity sample, as the smallest focus on observations, as well as the 8% discontinuity sample, as the largest one.

Table 20. Optimal bandwidths for second and third grade of secondary education. Threshold at 25% of disadvantaged students.

		Number of schools	
Outputs	Bandwidths	# Below	# Above
Share of students with "A certificate"	0.084	99	115
Share of students without problems of absenteeism	0.084	99	115
Share of students progressing through school	0.053	56	62
Share of students enrolled in higher education	0.082	97	113
Observations in the full sample		236	406

Note: Bandwidths computed using the 'rdrobust package' in Stata (Calonico, Cattaneo and Rocío Titiunik 2014).

B.2 Comparison control and treated group for different samples

The following tables list the variable sample means for the control and the treated group of schools, respectively below and above the exogenously set threshold, together with the full sample mean. Each table shows the means for a different sample: the 8% discontinuity samples and the full sample of schools under analysis. The last column of each table reports the *p*-values obtained from t-test conducted to examine whether the control and the treated group variables are statistically different in means. Specifically, this test provides valuable information on the discontinuity samples under analysis and in comparison with the full sample. First, it gives a preliminary overview of the relation among the inputs and the outputs across treated and control group and gives the basis for a more in-depth analysis as suggested by this paper. Second, it checks whether control and treated groups have similar environmental characteristics and to which extent the regression discontinuity design mimics a randomized experiment.

Table 21 shows that the treated group has, on average, a higher level of inputs, but a lower level of outputs. This might suggest the presence of inefficiency in the treated group: the analysis proposed by this paper helps in disentangling the source of this inefficiency and in detecting the possible mechanisms behind the observed picture. As for the control variables, Table 22 displays that the two groups are not statistically different in means for all the variables we consider, but for few exceptions, mostly related to student characteristics: the conditional analysis is able to capture this left heterogeneity. We can observe that if we consider the full sample, then the two groups turn out to be systematically different for almost every variable. Specifically, on average treated schools have a bigger

size, a higher share of students that change school in the next year, a higher share of students with special needs, less teachers with a proper diploma for the subject they are responsible for and there are less privately managed schools.

Table 21. Sample means for control/treated group and population. Input and output variables. 8% discontinuity sample.

	Below		*Above*				
	Control		Treated		Total		p-value
Inputs							
Teaching hours per student	2.127	(0.503)	2.482	(0.451)	2.318	(0.507)	0.0000
Operating grants per student	912.7	(83.53)	1005.4	(157.9)	962.5	(136.7)	0.0000
Outputs							
Share of students with "A certificate"	66.07	(5.762)	61.01	(7.864)	63.35	(7.400)	0.0000
Share of students without problems of absenteeism	99.68	(0.722)	99.26	(0.706)	99.45	(0.741)	0.0001
Share of students progressing through school	94.62	(3.034)	93.31	(3.329)	93.92	(3.254)	0.0045
Share of students enrolled in higher education	77.19	(14.34)	58.60	(17.11)	67.19	(18.37)	0.0000
Observations (school level)	92		107		199		

Note: Results for 8%-discontinuity sample. Standard deviation in parentheses. *p*-values obtained from t-test to examine whether the control and the treated group variables are statistically different in means.

Table 22. Sample means for control/treated group and population. Control variables. 8% discontinuity sample.

	Below		*Above*				
	Control		Treated		Total		*p*-test
School track - General	0.804	(0.399)	0.393	(0.491)	0.583	(0.494)	**0.0000**
School track - Vocational	0.0803	(0.133)	0.261	(0.189)	0.178	(0.188)	**0.0000**
School size (log)	6.150	(0.472)	6.193	(0.460)	6.173	(0.465)	0.5203
Share of students changing school	0.0984	(0.0472)	0.0967	(0.0380)	0.0975	(0.0424)	0.7749
Previously treated school	0.185	(0.390)	0.720	(0.451)	0.472	(0.500)	**0.0000**
School type							0.124
GO	0.195		0.159				
OGO	0.054		0.140				
VGO	0.750		0.701				

School with special need students	0.424	(0.497)	0.551	(0.500)	0.492	(0.501)	0.0735
Teacher seniority	3.869	(0.366)	3.854	(0.361)	3.861	(0.362)	0.7772
Teacher diploma	0.965	(0.0404)	0.961	(0.0349)	0.963	(0.0375)	0.3797
School principal seniority	5.295	(1.175)	5.451	(1.002)	5.379	(1.085)	0.3150
Teacher age	4.162	(0.331)	4.170	(0.302)	4.166	(0.315)	0.8599
Teacher full-time	0.290	(0.114)	0.305	(0.0972)	0.298	(0.105)	0.3171
Female teachers	0.597	(0.111)	0.576	(0.133)	0.586	(0.123)	0.2345
Share of students with grade retention in primary school	0.0908	(0.0578)	0.162	(0.0655)	0.129	(0.0713)	**0.0000**
Share of special need students in primary school	0.0118	(0.0211)	0.0349	(0.0323)	0.0242	(0.0299)	**0.0000**
Share of male students	0.463	(0.142)	0.536	(0.240)	0.502	(0.204)	**0.0106**
Share of disadvantaged students	0.210	(0.0236)	0.294	(0.0245)	0.255	(0.0483)	**0.0000**
Observations (school level)	92		107		199		

Note: Results for 8%-discontinuity sample. Standard deviation in parentheses. *p*-values obtained from t-test to examine whether the control and the treated group variables are statistically different in means.

Table 23. Sample means for control/treated group and population. Input and output variables. Full sample.

	Below Control		Above Treated		Total		p-value
Inputs							
Teaching hours per student	1.897	(0.447)	2.770	(0.511)	2.449	(0.644)	0.0000
Operating grants per student	869.4	(79.21)	1080.6	(170.2)	1003.0	(176.1)	0.0000
Outputs							
Share of students with "A certificate"	67.85	(5.315)	58.20	(8.466)	61.75	(8.794)	0.0000
Share of students without problems of absenteeism	99.84	(0.485)	97.67	(3.696)	98.47	(3.133)	0.0000
Share of students progressing through school	95.83	(2.733)	92.63	(3.399)	93.81	(3.523)	0.0000
Share of students enrolled in higher education	84.13	(13.23)	45.21	(18.75)	59.52	(25.28)	0.0000
Observations (school level)	236		406		642		

Note: Results for the full sample. Standard deviation in parentheses. *p*-values obtained from t-test to examine whether the control and the treated group variables are statistically different in means.

Table 24 - Sample means for control/treated group and population. Control variables. Full sample.

	Below Control		*Above* Treated		Total		p-value
School track - General	0.911	(0.285)	0.342	(0.475)	0.551	(0.498)	**0.0000**
School track - Vocational	0.0352	(0.0927)	0.414	(0.227)	0.275	(0.263)	**0.0000**
School size (log)	6.275	(0.475)	6.092	(0.503)	6.159	(0.501)	**0.0000**
Share of students changing school	0.0887	(0.0451)	0.0988	(0.0509)	0.0951	(0.0491)	**0.0124**
Previously treated school	0.0763	(0.266)	0.877	(0.329)	0.583	(0.494)	**0.0000**
School type							**0.0000**
GO	0.075		0.298				
OGO	0.03		0.121				
VGO	0.873		0.581				
School with special need students	0.364	(0.482)	0.527	(0.500)	0.467	(0.499)	**0.0001**
Teacher seniority	3.869	(0.360)	3.823	(0.400)	3.840	(0.386)	0.1487
Teacher diploma	0.973	(0.0330)	0.946	(0.0440)	0.955	(0.0423)	**0.0000**
School principal seniority	5.422	(1.182)	5.509	(1.065)	5.477	(1.109)	0.3355
Teacher age	4.134	(0.331)	4.178	(0.312)	4.162	(0.320)	0.0951
Teacher full-time	0.288	(0.123)	0.304	(0.0981)	0.298	(0.108)	0.0716
Female teachers	0.596	(0.102)	0.559	(0.144)	0.573	(0.131)	**0.0006**
Share of students with grade retention in primary school	0.0555	(0.0534)	0.241	(0.0959)	0.173	(0.122)	**0.0000**
Share of special need students in primary school	0.00524	(0.0145)	0.0531	(0.0392)	0.0355	(0.0398)	**0.0000**
Share of male students	0.458	(0.126)	0.535	(0.265)	0.506	(0.227)	**0.0000**
Share of disadvantaged students	0.154	(0.0546)	0.431	(0.139)	0.329	(0.176)	**0.0000**
Observations (school level)	236		406		642		

Note: Results for the full sample. Standard deviation in parentheses. *p*-values obtained from t-test to examine whether the control and the treated group variables are statistically different in means.

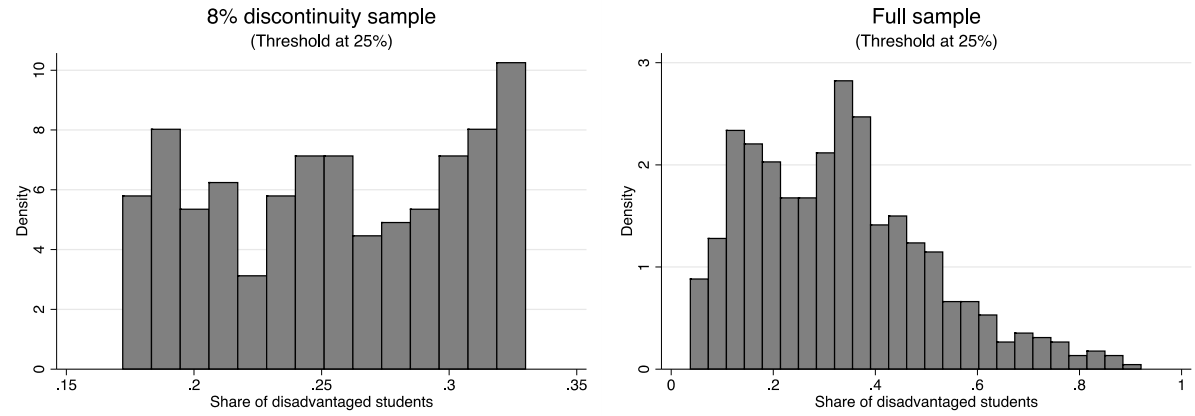
B.3 Manipulation tests

The following table shows the results of the manipulation test implemented using the 'rddensity package' in Stata (Cattaneo et al. 2018). There is no evidence of sorting around the cutoff, independently on whether we specify the bandwidth at both sides of the cutoff.

Table 25. Manipulation tests for secondary education. Threshold at 25% share of disadvantaged students

	Bandwidths		Number of schools		Test	
	Below	Above	# Below	# Above	T	p-value
$h_- = h_+$						
	0.06	0.06	68	71	0.3252	0.7450
	0.08	0.08	92	107	0.2151	0.8297
$h_- \neq h_+$						
	0.116	0.096	149	128	0.4433	0.6576
Observations in the full sample			236	406		

Note: Results obtained using the 'rddensity package' in Stata (Cattaneo et al. 2018). The first two tests have been obtained by specifying the bandwidth at both sides of the cutoff (6% is the lower bound and 8% is the upper bound of the computed optimal bandwidth range) to construct the density estimators on the two sides of the cutoff. The third one has been obtained without specifying the bandwidth.



Appendix C: Figures

C.1 Choice of *m*

Depending on the choice of the partial sample size, *m*, the share of super-efficient observations varies: the size of the drawn sample (*m*) with respect to the total sample size *n* influences the probability of the observation under analysis not to belong to the production frontier. The value of *m* is set to attain a sufficiently small decrease in the share of super-efficient schools for different control/treated/overall groups and for different bandwidths (here, *m*=40).

6% discontinuity sample

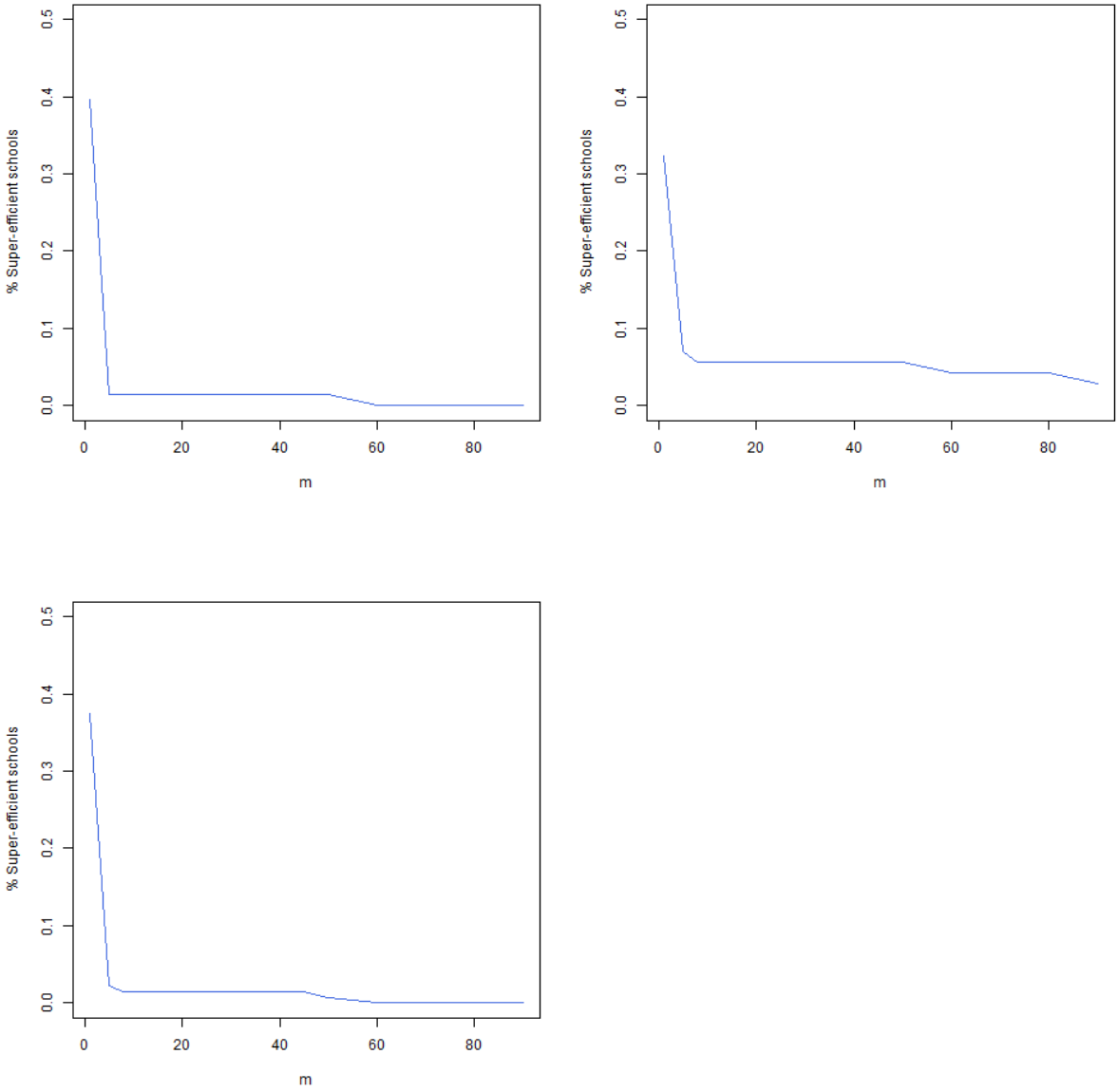


Figure 6. Marginal decrease in percentage of super-efficient schools. Control/treated/overall groups. 6% discontinuity sample.

8% discontinuity sample

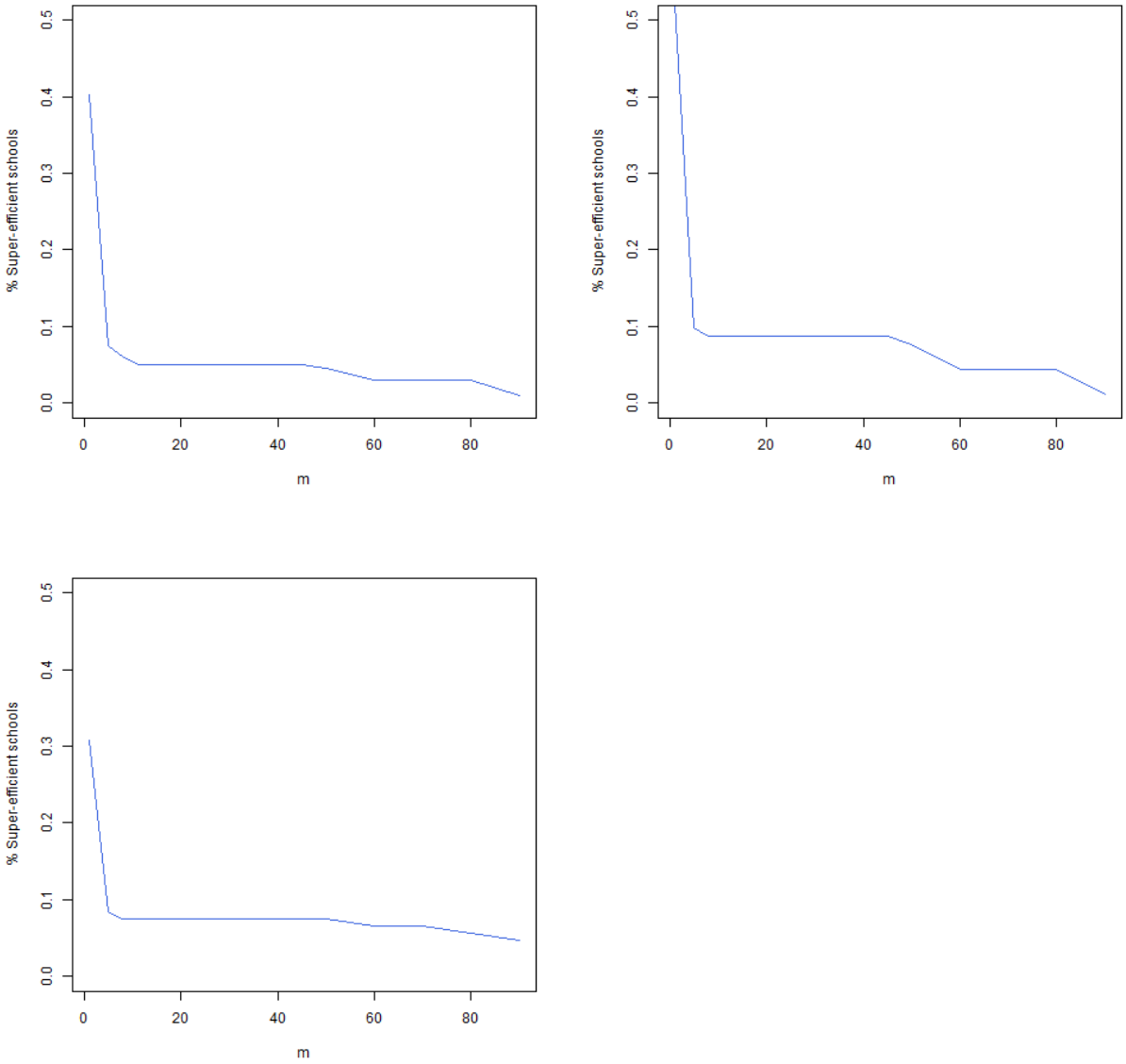


Figure 7. Marginal decrease in percentage of super-efficient schools. Control/treated/overall groups. 8% discontinuity sample.

Full sample

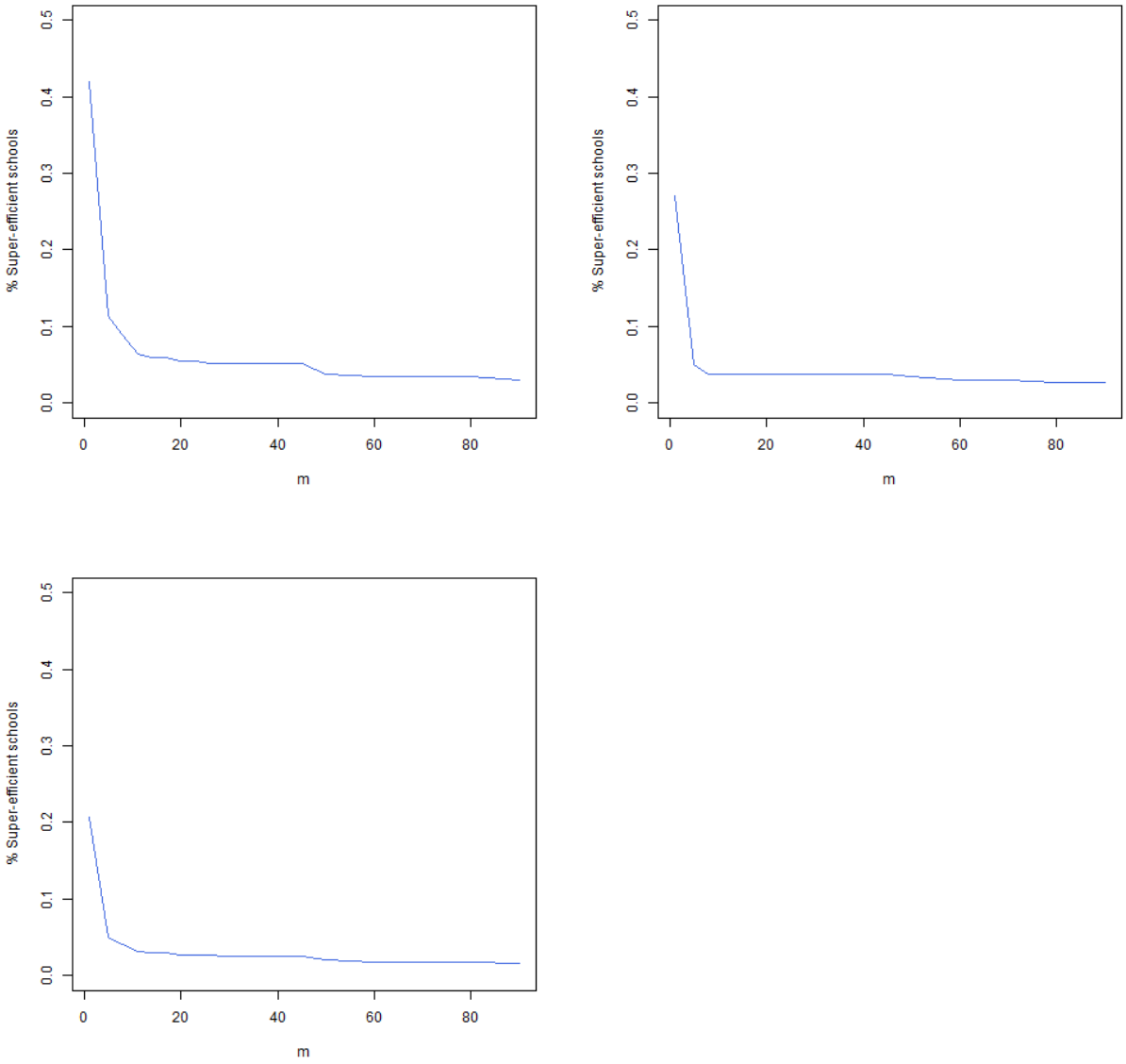


Figure 8. Marginal decrease in percentage of super-efficient schools. Control/treated/overall groups. Full sample.

Appendix D: Complete descriptive statistics of the efficiency estimates

In this section, we present the results of the main efficiency analysis for the second and third stage of secondary schools in Flanders.

We consider two inputs (*Teaching hours per student*, *Operating grants per student*), four outputs (*Share of students with A certificate*, *Share of students without problems of absenteeism*, *Share of students progressing though school*, *Share of students enrolled in higher education*), three groups of contextual variables (School, Teacher and Student characteristics) and *m* is set to 40.

In the 6% discontinuity sample there are 68 schools below the threshold and 71 above.

In the 8% discontinuity sample there are 92 schools below the threshold and 107 above.

In the full sample there are 236 schools below the threshold and 406 above.

D.1 Descriptive statistics of the efficiency scores for 6% discontinuity sample. 2 inputs, 4 outputs

unconditional model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8554	0.0837	0.6504	1.0000	0.8026	0.0996	0.4945	1.0000
School efficiency	0.8538	0.0848	0.6434	1.0000	0.8789	0.1151	0.5192	1.0007
Program efficiency	1.0021	0.0029	1.0000	1.0108	0.9160	0.0560	0.7272	1.0000
Observations (school level)	68				71			

conditional1 model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9018	0.0886	0.6811	1.0000	0.8374	0.1077	0.5032	1.0000
School efficiency	0.8987	0.0834	0.6761	1.0000	0.9141	0.1067	0.5491	1.0000
Program efficiency	1.0033	0.0272	0.9126	1.1038	0.9182	0.0736	0.7111	1.0082
Observations (school level)	68				71			

conditional2 model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9093	0.0770	0.6962	1.0000	0.8570	0.0990	0.6154	1.0000

School efficiency	0.9079	0.0736	0.6941	1.0000	0.9295	0.0830	0.6811	1.0000
Program efficiency	1.0014	0.0201	0.8942	1.0720	0.9219	0.0651	0.7719	1.0022
Observations (school level)	68				71			

conditional3 model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9404	0.0775	0.7516	1.0000	0.9332	0.0875	0.4980	1.0000
School efficiency	0.9322	0.0750	0.7506	1.0000	0.9608	0.0781	0.5195	1.0000
Program efficiency	1.0089	0.0209	0.9734	1.1199	0.9721	0.0592	0.7856	1.1748
Observations (school level)	68				71			

conditional4 model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9452	0.0729	0.7708	1.0000	0.9400	0.0836	0.5033	1.0000
School efficiency	0.9357	0.0720	0.7643	1.0000	0.9667	0.0720	0.5501	1.0000
Program efficiency	1.0104	0.0227	0.9808	1.1186	0.9726	0.0530	0.8249	1.1241
Observations (school level)	68				71			

conditional5 model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9302	0.0835	0.7152	1.0000	0.8888	0.1154	0.5190	1.0000
School efficiency	0.9062	0.0893	0.6723	1.0000	0.9065	0.1112	0.5190	1.0000
Program efficiency	1.0288	0.0560	0.8656	1.2047	0.9846	0.1031	0.7388	1.4822
Observations (school level)	68				71			

conditional6 model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9639	0.0607	0.7336	1.0000	0.9287	0.0935	0.5337	1.0000
School efficiency	0.9463	0.0693	0.7190	1.0000	0.9477	0.0812	0.5391	1.0000
Program efficiency	1.0201	0.0418	0.9373	1.1810	0.9809	0.0671	0.7630	1.2296

Observations (school level)	68				71			

conditional7 model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9180	0.0787	0.7330	1.0000	0.9138	0.0924	0.4911	1.0000
School efficiency	0.9278	0.0773	0.7450	1.0000	0.9507	0.0787	0.5241	1.0000
Program efficiency	0.9901	0.0393	0.8262	1.0904	0.9615	0.0611	0.7861	1.1011
Observations (school level)	68				71			

conditional8 model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9498	0.0697	0.7088	1.0000	0.8959	0.1073	0.5190	1.0000
School efficiency	0.9442	0.0731	0.7108	1.0000	0.9323	0.0967	0.5233	1.0000
Program efficiency	1.0070	0.0372	0.8895	1.1127	0.9641	0.1007	0.7764	1.4664
Observations (school level)	68				71			

conditional9 model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9868	0.0243	0.9042	1.0000	0.9621	0.0541	0.7800	1.0000
School efficiency	0.9862	0.0261	0.9031	1.0000	0.9846	0.0334	0.8338	1.0000
Program efficiency	1.0007	0.0135	0.9652	1.0743	0.9770	0.0407	0.7820	1.0137
Observations (school level)	68				71			

conditional10 model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9960	0.0109	0.9463	1.0000	0.9952	0.0115	0.9369	1.0000
School efficiency	0.9949	0.0147	0.9227	1.0000	0.9974	0.0087	0.9409	1.0000
Program efficiency	1.0012	0.0060	0.9720	1.0292	0.9978	0.0080	0.9441	1.0097
Observations (school level)	68				71			

Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: School track (Vocational), School size, % of students changing school, Previously treated school

Conditional 4: School track (Vocational), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 5: Teacher seniority, Teacher diploma, School principal seniority

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 7: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 8: School track (General), School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 9: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 10: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male student

D.2 Descriptive statistics of the efficiency scores for 8% discontinuity sample. 2 inputs, 4 outputs

unconditional model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8611	0.0887	0.6432	1.0000	0.7826	0.1060	0.4966	1.1200
School efficiency	0.8598	0.0899	0.6345	1.0000	0.8555	0.1216	0.5194	1.0423
Program efficiency	1.0017	0.0027	1.0000	1.0137	0.9178	0.0536	0.7169	1.0746
Observations (school level)	92				107			

conditional1 model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9027	0.0815	0.7044	1.0000	0.8454	0.0974	0.5156	1.0000
School efficiency	0.8988	0.0821	0.6821	1.0000	0.9022	0.1078	0.5947	1.0000
Program efficiency	1.0045	0.0153	0.9621	1.0534	0.9403	0.0692	0.7692	1.1146
Observations (school level)	92				107			

conditional2 model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9138	0.0726	0.7246	1.0000	0.8596	0.0941	0.6245	1.0000
School efficiency	0.9133	0.0735	0.6928	1.0000	0.9303	0.0821	0.6655	1.0000
Program efficiency	1.0008	0.0172	0.9540	1.0540	0.9247	0.0667	0.6838	1.0032
Observations (school level)	92				107			

conditional3 model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9323	0.0820	0.7221	1.0000	0.9373	0.0871	0.5000	1.0001
School efficiency	0.9291	0.0817	0.7220	1.0000	0.9618	0.0729	0.5190	1.0000
Program efficiency	1.0037	0.0175	0.9376	1.0994	0.9744	0.0523	0.7858	1.0735
Observations (school level)	92				107			

conditional4 model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9385	0.0763	0.7625	1.0000	0.9456	0.0800	0.5049	1.0000
School efficiency	0.9359	0.0754	0.7499	1.0000	0.9676	0.0677	0.5436	1.0000
Program efficiency	1.0029	0.0205	0.9486	1.1064	0.9772	0.0467	0.8248	1.0715
Observations (school level)	92				107			

conditional5 model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9301	0.0839	0.6948	1.0000	0.8505	0.1158	0.5192	1.0000
School efficiency	0.9099	0.0885	0.6722	1.0000	0.8876	0.1203	0.5192	1.0000
Program efficiency	1.0235	0.0343	0.9234	1.1582	0.9624	0.0871	0.7069	1.4068
Observations (school level)	92				107			

conditional6 model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9654	0.0611	0.7382	1.0000	0.9092	0.0898	0.5773	1.0000
School efficiency	0.9599	0.0662	0.6956	1.0000	0.9537	0.0742	0.5711	1.0000
Program efficiency	1.0077	0.0561	0.8004	1.2067	0.9543	0.0688	0.7024	1.1554
Observations (school level)	92				107			

conditional7 model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9177	0.0806	0.7241	1.0000	0.9238	0.0865	0.4919	1.0000
School efficiency	0.9075	0.0823	0.7248	1.0000	0.9538	0.0721	0.5348	1.0000
Program efficiency	1.0116	0.0233	0.9761	1.1212	0.9688	0.0600	0.7887	1.2155
Observations (school level)	92				107			

conditional8 model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9473	0.0708	0.6992	1.0000	0.8731	0.1038	0.5191	1.0000
School efficiency	0.9365	0.0724	0.7003	1.0000	0.9251	0.0956	0.5911	1.0000
Program efficiency	1.0121	0.0305	0.9503	1.1331	0.9479	0.1063	0.7157	1.4462
Observations (school level)	92				107			

conditional9 model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9882	0.0241	0.8879	1.0000	0.9678	0.0472	0.7596	1.0000
School efficiency	0.9836	0.0299	0.8671	1.0000	0.9874	0.0277	0.8432	1.0000
Program efficiency	1.0049	0.0116	0.9724	1.0421	0.9800	0.0353	0.7920	1.0188
Observations (school level)	92				107			

conditional10 model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9957	0.0110	0.9228	1.0000	0.9949	0.0124	0.9248	1.0000
School efficiency	0.9952	0.0132	0.9004	1.0000	0.9977	0.0075	0.9411	1.0000
Program efficiency	1.0006	0.0050	0.9725	1.0250	0.9972	0.0099	0.9249	1.0065
Observations (school level)	92				107			

Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: School track (Vocational), School size, % of students changing school, Previously treated school

Conditional 4: School track (Vocational), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 5: Teacher seniority, Teacher diploma, School principal seniority

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 7: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 8: School track (General), School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 9: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 10: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male student

D.3 Descriptive statistics of the efficiency scores for the full sample. 2 inputs, 4 outputs

unconditional model. Full sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.870	0.084	0.626	1.001	0.706	0.095	0.488	1.143
School efficiency	0.869	0.085	0.619	1.001	0.790	0.112	0.520	1.121
Program efficiency	1.001	0.001	1.000	1.012	0.896	0.047	0.649	1.058
Observations (school level)	236				406			

conditional1 model. Full sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.908	0.074	0.668	1.000	0.825	0.093	0.494	1.000
School efficiency	0.899	0.073	0.668	1.000	0.874	0.097	0.635	1.000
Program efficiency	1.010	0.025	0.969	1.234	0.947	0.066	0.529	1.079
Observations (school level)	236				406			

conditional2 model. Full sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.916	0.067	0.677	1.000	0.855	0.090	0.634	1.000
School efficiency	0.907	0.069	0.663	1.000	0.895	0.091	0.665	1.000
Program efficiency	1.011	0.023	0.923	1.178	0.957	0.061	0.652	1.084
Observations (school level)	236				406			

conditional3 model. Full sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.912	0.078	0.713	1.000	0.950	0.079	0.485	1.002
School efficiency	0.915	0.077	0.714	1.000	0.934	0.078	0.545	1.000
Program efficiency	**0.997**	0.019	0.860	1.174	**1.021**	0.089	0.654	1.454
Observations (school level)	236				406			

conditional4 model. Full sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.914	0.077	0.712	1.000	0.958	0.074	0.487	1.000
School efficiency	0.919	0.074	0.708	1.000	0.926	0.079	0.648	1.000
Program efficiency	**0.994**	0.019	0.854	1.154	**1.039**	0.096	0.663	1.502
Observations (school level)	236				406			

conditional6 model. Full sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.926	0.079	0.637	1.000	0.785	0.124	0.498	1.000
School efficiency	0.928	0.078	0.635	1.000	0.868	0.123	0.544	1.000
Program efficiency	0.998	0.008	0.894	1.006	0.907	0.088	0.609	1.192
Observations (school level)	236				406			

conditional7 model. Full sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.952	0.067	0.649	1.000	0.844	0.127	0.507	1.000
School efficiency	0.950	0.068	0.646	1.000	0.918	0.096	0.562	1.000
Program efficiency	1.002	0.015	0.914	1.107	0.920	0.116	0.627	1.349
Observations (school level)	236				406			

conditional5 model. Full sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			

	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.899	0.076	0.671	1.000	0.926	0.085	0.491	1.000
School efficiency	0.904	0.075	0.712	1.000	0.933	0.079	0.543	1.000
Program efficiency	**0.994**	0.023	0.862	1.041	**0.994**	0.070	0.726	1.233
Observations (school level)	236				406			

conditional8 model. Full sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.943	0.068	0.698	1.000	0.876	0.107	0.502	1.000
School efficiency	0.944	0.067	0.699	1.000	0.925	0.092	0.658	1.000
Program efficiency	0.999	0.009	0.944	1.035	0.949	0.082	0.611	1.166
Observations (school level)	236				406			

conditional9 model. Full sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.975	0.041	0.746	1.000	0.965	0.055	0.692	1.000
School efficiency	0.974	0.042	0.740	1.000	0.978	0.044	0.745	1.000
Program efficiency	1.001	0.010	0.962	1.061	0.987	0.035	0.716	1.048
Observations (school level)	236				406			

conditional10 model. Full sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.980	0.035	0.818	1.000	0.994	0.017	0.845	1.000
School efficiency	0.985	0.031	0.804	1.000	0.992	0.020	0.892	1.000
Program efficiency	**0.995**	0.015	0.883	1.042	**1.002**	0.014	0.845	1.076
Observations (school level)	236				406			

Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: School track (Vocational), School size, % of students changing school, Previously treated school

Conditional 4: School track (Vocational), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 5: Teacher seniority, Teacher diploma, School principal seniority

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

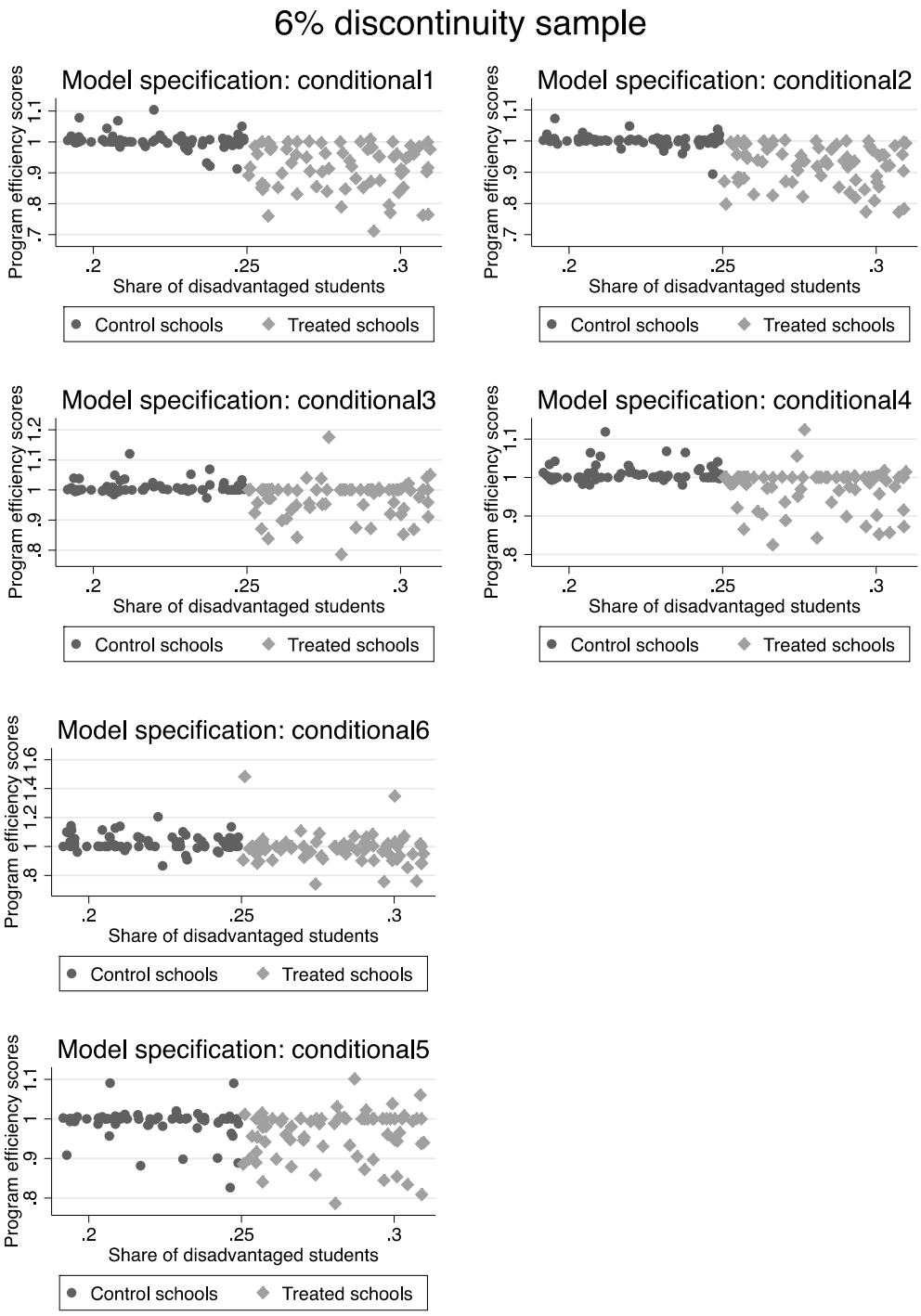
Conditional 7: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 8: School track (General), School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 9: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 10: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

D.4 Distribution of the program efficiency scores with respect to the share of disadvantaged students



Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

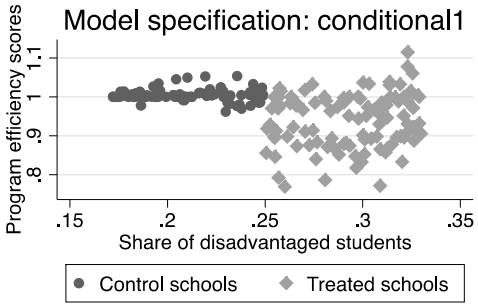
Conditional 3: School track (Vocational), School size, % of students changing school, Previously treated school

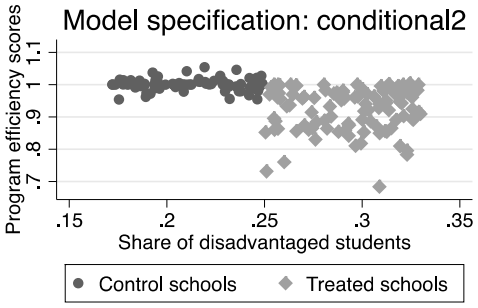
Conditional 4: School track (Vocational), School size, % of students changing school, Previously treated school, School type, School with special need students

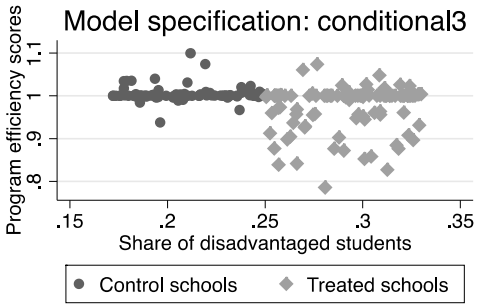
Conditional 5: % students with problems in primary school, % students with special needs in primary school, % male students

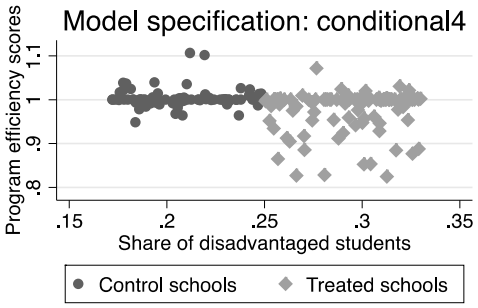
Conditional 6: Teacher seniority, Teacher diploma, School principal seniority

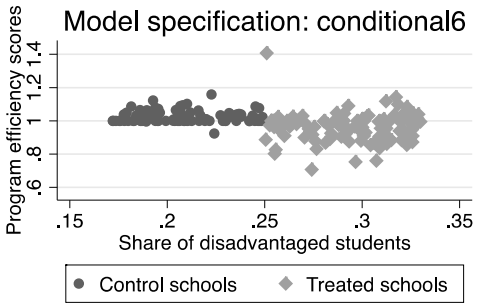
8% discontinuity sample

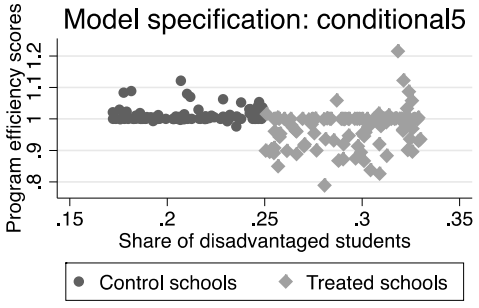












Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

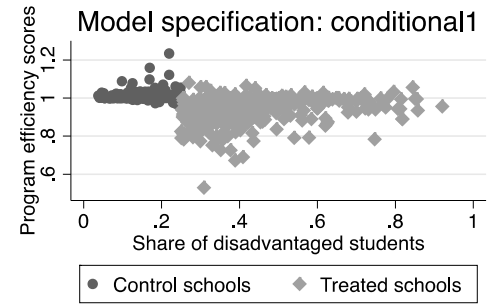
Conditional 3: School track (Vocational), School size, % of students changing school, Previously treated school

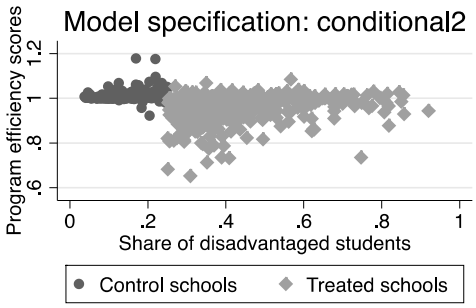
Conditional 4: School track (Vocational), School size, % of students changing school, Previously treated school, School type, School with special need students

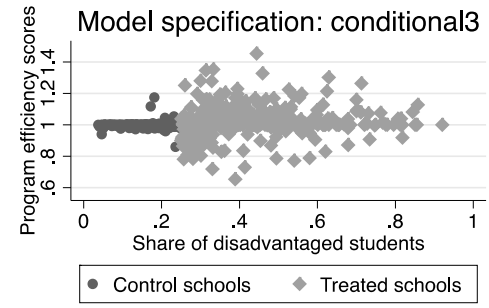
Conditional 5: % students with problems in primary school, % students with special needs in primary school, % male students

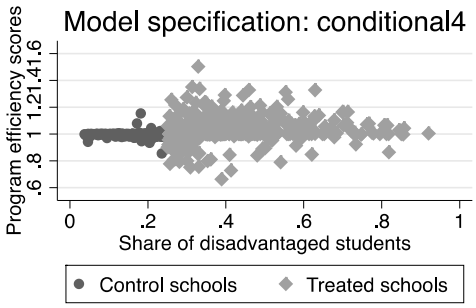
Conditional 6: Teacher seniority, Teacher diploma, School principal seniority

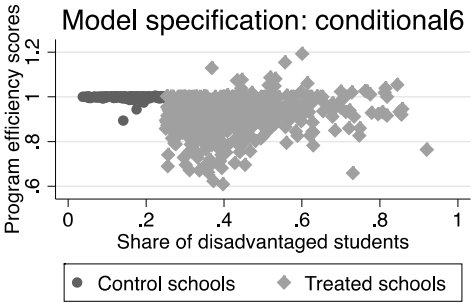
Full sample

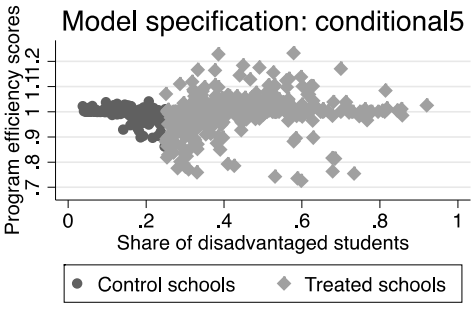












Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: School track (Vocational), School size, % of students changing school, Previously treated school

Conditional 4: School track (Vocational), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 5: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority

D.5 Results on statistical inference for second and third cycle of secondary education. 2 inputs and 4 outputs model

D.5.1 Results on statistical inference for 8% bandwidth

Table 26

	Model 1			Model 2			Model 3			Model 4		
	Influence	p-value		Influence	p-value		Influence	p-value		Influence	p-value	
School characteristics												
ASO	Favorable	0.000	***	Favorable	0.0005	***						
BSO							Unfavorable	0.000	***	Unfavorable	0.000	***
School size	Favorable	0.2335		Favorable	0.173		Favorable	0.2815		Favorable	0.1585	
% Change school	Unfavorable	0.001	***	Unfavorable	0.003	***	Favorable	0.5665		Favorable	0.450	
Previously treated	Unfavorable	0.000	***	Unfavorable	0.0015	***	Unfavorable	0.160		Unfavorable	0.214	
Net (GO, OGO, VGO)				Favorable	0.1665					Favorable	0.131	
GON school				Favorable	0.252					Favorable	0.910	
Teacher characteristics												
Teacher seniority												
Teacher diploma												
Teacher age												
School principal seniority												
Teacher contract												
% female teachers												
Student characteristics												
Primary retention												
Special students in primary												
% Man												

* p < 0.10, ** p < 0.05, *** p < 0.01

Table 27

	Model 5			Model 6			Model 7			Model 8		
	Influence	p-value		Influence	p-value		Influence	p-value		Influence	p-value	
School characteristics												
ASO										Favorable	0.000	***
BSO												
School size										Favorable	0.051	*
% Change school										Unfavorable	0.155	
Previously treated										Favorable	0.1175	
Net (GO, OGO, VGO)												
GON school												

Teacher characteristics										
Teacher seniority	Favorable	0.0035	***	Favorable	0.017	**			Favorable	0.008	***
Teacher diploma	Favorable	0.0595	*	Favorable	0.702				Unfavorable	0.0015	***
Teacher age	Unfavorable	0.420		Unfavorable	0.010	**					
School principal seniority				Favorable	0.261						
Teacher contract				Unfavorable	0.001	***					
% female teachers				Favorable	0.000	***					
Student characteristics										
Primary retention							Unfavorable	0.0115	**	
Special students in primary							Unfavorable	0.000	***	
% Man							Unfavorable	0.3235		

* p < 0.10, ** p < 0.05, *** p < 0.01

Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: School track (Vocational), School size, % of students changing school, Previously treated school

Conditional 4: School track (Vocational), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 5: Teacher seniority, Teacher diploma, School principal seniority

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 7: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 8: School track (General), School size, % of students changing school, Previously treated school, Teacher seniority & diploma

D.5.2 Results on statistical inference for the full sample

Table 28

	Model 1			Model 2			Model 3			Model 4		
	Influence	p-value		Influence	p-value		Influence	p-value		Influence	p-value	
School characteristics												
ASO_1	Favorable	0.000	***	Favorable	0.000	***						
BSO							Unfavorable	0.000	***	Unfavorable	0.180	
School size	Favorable	0.000	***	Favorable	0.000	***	Favorable	0.000	***	Favorable	0.195	
Change school	Unfavorable	0.005	***	Unfavorable	0.000	***	Favorable	0.000	***	Favorable	0.000	***
Duration	Unfavorable	0.000	***	Unfavorable	0.000	***	Unfavorable	0.000	***	Unfavorable	0.000	***
Net (GO, OGO, VGO)				Favorable	0.130					Favorable	0.070	*
GON school				Favorable	0.475					Favorable	0.005	***
Teacher characteristics												
leerkracht seniority												
leerkracht diploma												
directie seniority												
leerkracht age												
leerkracht fulltime												
leerkracht female												
Student characteristics												
Primary retention												
BULO												
Man												

* p < 0.10, ** p < 0.05, *** p < 0.01

Table 29

	Model 5			Model 6			Model 7			Model 8		
	Influence	p-value		Influence	p-value		Influence	p-value		Influence	p-value	
School characteristics												
ASO_1										Favorable	0.000	***
BSO												
School size										Favorable	0.000	***
Change school										Unfavorable	0.030	**
Duration										Unfavorable	0.000	***
Net (GO, OGO, VGO)												
GON school												
Teacher characteristics												
leerkracht seniority	Favorable	0.6665		concave	0.0305	**				Unfavorable	0.000	***
leerkracht diploma	Favorable	0.002	***	Favorable	0.0000	***				Favorable	0.000	***
directie seniority	Favorable	0.000	***	Favorable	0.0005	***						
leerkracht age				Unfavorable	0.4595							

leerkracht fulltime	Favorable	0.941			
leerkracht female	Favorable	0.000	***		
Student characteristics					
Primary retention				Unfavorable	0.4495
BULO				Unfavorable	0.9745
Man				Unfavorable	0.247

* p < 0.10, ** p < 0.05, *** p < 0.01

Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: School track (Vocational), School size, % of students changing school, Previously treated school

Conditional 4: School track (Vocational), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 5: Teacher seniority, Teacher diploma, School principal seniority

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 7: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 8: School track (General), School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Appendix E: Robustness check results

In this section we present several sub-analysis we performed to test the robustness of the main results for the second and third stage of secondary schools in Flanders (while in the next section Appendix F we present the results for the first stage of secondary education). In this way we address some left potential criticisms and we make sure that these elements do not drive the findings.

Specifically, first we run the main analysis as presented in the main text (2 inputs and 4 outputs) but excluding the eligible but not treated schools. Second, we perform an analysis with 2 inputs and 3 outputs, namely without the *share of student enrolled in bachelor*. Third, we run an analysis with 1 input and 3 outputs, namely without *operating grants per student* and *share of student enrolled in bachelor*. Four, we perform an analysis considering only those schools that offer at least vocational education as a track choice (namely excluding those schools where 0% of students are in BSO track). Finally, we focus on schools providing exclusively general education (namely considering just schools where 100% of students are in ASO track).

E.1 Descriptive statistics of the efficiency scores (excluding eligible but not treated schools)

In the following, we present the results of the efficiency analysis where we exclude from the sample the schools that are eligible but not treated because unable to generate a minimum of six teaching hours (for further explanation, see also Appendix A). Nevertheless, we consider the same optimal bandwidth range, between 6% and 8%.

For the following estimation, we consider two inputs (*Teaching hours per student*, *Operating grants per student*), four outputs (*Share of students with A certificate*, *Share of students without problems of absenteeism*, *Share of students progressing though school*, *Share of students enrolled in higher education*), three groups of contextual variables (School, Teacher and Student characteristics) and *m* is set to 40.

In the 6% discontinuity sample there are 68 schools below the threshold and 53 above.

In the 8% discontinuity sample there are 92 schools below the threshold and 89 above.

In the full sample there are 236 schools below the threshold and 381 above.

E.1.1 Descriptive statistics of the efficiency scores for 6% discontinuity sample. 2 inputs, 4 outputs

unconditional model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.855	0.084	0.649	1.000	0.787	0.090	0.612	1.000
School efficiency	0.854	0.085	0.643	1.000	0.872	0.109	0.644	1.000
Program efficiency	1.002	0.002	1.000	1.009	0.905	0.056	0.727	1.000
Observations (school level)	68				53			

conditional1 model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold	*Above threshold*

	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.904	0.087	0.677	1.000	0.837	0.092	0.631	1.000
School efficiency	0.899	0.083	0.676	1.000	0.938	0.089	0.669	1.000
Program efficiency	1.005	0.018	0.953	1.069	0.894	0.074	0.712	1.000
Observations (school level)	68				53			

conditional2 model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.916	0.075	0.703	1.000	0.858	0.092	0.626	1.000
School efficiency	0.908	0.074	0.694	1.000	0.960	0.056	0.774	1.000
Program efficiency	1.009	0.020	0.958	1.074	0.893	0.081	0.670	1.000
Observations (school level)	68				53			

conditional3 model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.939	0.078	0.752	1.000	0.929	0.075	0.758	1.000
School efficiency	0.932	0.075	0.751	1.000	0.966	0.059	0.779	1.000
Program efficiency	1.007	0.019	0.977	1.117	0.963	0.076	0.758	1.118
Observations (school level)	68				53			

conditional4 model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.943	0.073	0.771	1.000	0.931	0.072	0.770	1.000
School efficiency	0.936	0.072	0.764	1.000	0.965	0.054	0.778	1.000
Program efficiency	1.008	0.020	0.982	1.113	0.968	0.081	0.821	1.156
Observations (school level)	68				53			

Conditional5 model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.907	0.088	0.672	1.000	0.838	0.108	0.620	1.000

School efficiency	0.906	0.089	0.672	1.000	0.908	0.100	0.637	1.000
Program efficiency	1.001	0.019	0.863	1.034	0.923	0.065	0.729	1.022
Observations (school level)	68				53			

Conditional6 model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.954	0.065	0.738	1.000	0.897	0.090	0.670	1.000
School efficiency	0.946	0.069	0.719	1.000	0.965	0.051	0.767	1.000
Program efficiency	1.008	0.018	0.968	1.087	0.929	0.075	0.750	1.023
Observations (school level)	68				53			

Conditional7 model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.917	0.079	0.733	1.000	0.917	0.083	0.715	1.000
School efficiency	0.928	0.077	0.745	1.000	0.958	0.061	0.768	1.000
Program efficiency	0.989	0.039	0.823	1.089	0.958	0.064	0.786	1.041
Observations (school level)	68				53			

conditional8 model. 6% discontinuity sample. 2 inputs 4 outputs

	Below Control				Above Treated			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.937	0.075	0.706	1.000	0.881	0.093	0.679	1.000
School efficiency	0.944	0.073	0.711	1.000	0.971	0.058	0.752	1.000
Program efficiency	0.992	0.019	0.915	1.027	0.910	0.095	0.702	1.217
Observations (school level)	68				53			

conditional9 model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.989	0.022	0.909	1.000	0.964	0.050	0.780	1.000
School efficiency	0.986	0.026	0.903	1.000	0.991	0.024	0.859	1.000

Program efficiency	1.003	0.013	0.967	1.072	0.973	0.043	0.780	1.007

conditional10 model. 6% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.996	0.010	0.950	1.000	0.994	0.013	0.941	1.000
School efficiency	0.995	0.015	0.923	1.000	0.998	0.008	0.941	1.000
Program efficiency	1.001	0.007	0.971	1.029	0.996	0.009	0.942	1.005
Observations (school level)	68				53			

Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: School track (Vocational), School size, % of students changing school, Previously treated school

Conditional 4: School track (Vocational), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 5: Teacher seniority, Teacher diploma, School principal seniority

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 7: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 8: School track (General), School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 9: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 10: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

E.1.2 Descriptive statistics of the efficiency scores for 8% discontinuity sample. 2 inputs, 4 outputs

unconditional model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.861	0.089	0.642	1.000	0.770	0.100	0.540	1.115
School efficiency	0.860	0.090	0.635	1.000	0.850	0.116	0.542	1.022
Program efficiency	1.001	0.002	1.000	1.012	0.909	0.054	0.717	1.091
Observations (school level)	92				89			

conditional1 model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.908	0.083	0.677	1.000	0.852	0.099	0.634	1.000

School efficiency	0.899	0.082	0.682	1.000	0.923	0.096	0.619	1.000
Program efficiency	1.010	0.018	0.991	1.089	0.925	0.069	0.747	1.030
Observations (school level)	92				89			

conditional2 model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.922	0.072	0.736	1.000	0.870	0.096	0.627	1.000
School efficiency	0.913	0.073	0.693	1.000	0.944	0.073	0.665	1.000
Program efficiency	1.010	0.020	0.968	1.081	0.922	0.074	0.662	1.017
Observations (school level)	92				89			

conditional3 model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.932	0.082	0.722	1.000	0.941	0.074	0.750	1.000
School efficiency	0.929	0.082	0.722	1.000	0.942	0.079	0.665	1.000
Program efficiency	1.003	0.016	0.932	1.099	1.006	0.111	0.768	1.496
Observations (school level)	92				89			

conditional4 model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.938	0.076	0.762	1.000	0.946	0.069	0.761	1.000
School efficiency	0.936	0.075	0.750	1.000	0.946	0.073	0.665	1.000
Program efficiency	1.003	0.018	0.956	1.105	1.005	0.106	0.812	1.495
Observations (school level)	92				89			

Conditional5 model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold	*Above threshold*

	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.927	0.085	0.687	1.000	0.834	0.107	0.561	1.000
School efficiency	0.910	0.088	0.672	1.000	0.894	0.111	0.529	1.000
Program efficiency	1.020	0.032	0.923	1.155	0.936	0.081	0.694	1.236
Observations (school level)	92				89			

Conditional6 model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.961	0.064	0.710	1.000	0.905	0.103	0.607	1.000
School efficiency	0.960	0.066	0.696	1.000	0.960	0.059	0.778	1.000
Program efficiency	1.001	0.023	0.876	1.102	0.944	0.097	0.670	1.216
Observations (school level)	92				89			

Conditional7 model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.916	0.081	0.725	1.000	0.926	0.080	0.718	1.000
School efficiency	0.908	0.082	0.725	1.000	0.959	0.058	0.784	1.000
Program efficiency	1.010	0.021	0.978	1.105	0.965	0.055	0.788	1.086
Observations (school level)	92				89			

conditional8 model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.948	0.068	0.713	1.000	0.886	0.084	0.679	1.000
School efficiency	0.937	0.072	0.700	1.000	0.949	0.070	0.739	1.000
Program efficiency	1.013	0.025	0.946	1.117	0.936	0.078	0.759	1.286
Observations (school level)	92				89			

conditional9 model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.989	0.023	0.896	1.000	0.969	0.046	0.769	1.000

School efficiency	0.984	0.030	0.867	1.000	0.990	0.023	0.856	1.000
Program efficiency	1.005	0.012	0.968	1.043	0.978	0.035	0.799	1.013
Observations (school level)	92				89			

conditional10 model. 8% discontinuity sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.996	0.011	0.922	1.000	0.994	0.013	0.926	1.000
School efficiency	0.995	0.013	0.900	1.000	0.998	0.007	0.941	1.000
Program efficiency	1.001	0.005	0.970	1.024	0.996	0.011	0.926	1.006
Observations (school level)	92				89			

Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: School track (Vocational), School size, % of students changing school, Previously treated school

Conditional 4: School track (Vocational), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 5: Teacher seniority, Teacher diploma, School principal seniority

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 7: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 8: School track (General), School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 9: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 10: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

E.1.3 Descriptive statistics of the efficiency scores for the full sample. 2 inputs, 4 outputs

Unconditional model. Full sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8696	0.0843	0.6253	1.0014	0.7008	0.0922	0.4984	1.1409
School efficiency	0.8692	0.0848	0.6186	1.0014	0.7989	0.1070	0.5744	1.1415
Program efficiency	1.0005	0.0013	1.0000	1.0109	0.8791	0.0461	0.6401	1.0771
Observations (school level)	236				381			

Conditional1 model. Full sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max

Overall efficiency	0.9083	0.0741	0.6685	1.0003	0.8250	0.0914	0.6238	1.0000
School efficiency	0.8991	0.0735	0.6683	1.0000	0.8773	0.0940	0.6377	1.0001
Program efficiency	1.0105	0.0258	0.9692	1.2388	0.9423	0.0620	0.6725	1.0764
Observations (school level)	236				381			

Conditional2 model. Full sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9161	0.0674	0.6779	1.0000	0.8556	0.0884	0.6348	1.0000
School efficiency	0.9068	0.0692	0.6634	1.0000	0.8992	0.0882	0.6655	1.0000
Program efficiency	1.0107	0.0214	0.9808	1.1739	0.9530	0.0591	0.6779	1.0842
Observations (school level)	236				381			

Conditional3 model. Full sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9261	0.0788	0.6371	1.0002	0.7811	0.1223	0.5231	1.0000
School efficiency	0.9280	0.0784	0.6353	1.0001	0.8788	0.1157	0.5954	1.0000
Program efficiency	0.9980	0.0087	0.8890	1.0055	0.8909	0.0896	0.6091	1.1667
Observations (school level)	236				381			

Conditional4 model. Full sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9519	0.0671	0.6493	1.0000	0.8403	0.1263	0.5410	1.0000
School efficiency	0.9501	0.0680	0.6463	1.0000	0.9238	0.0911	0.6300	1.0000
Program efficiency	1.0021	0.0148	0.9108	1.1065	0.9111	0.1152	0.6274	1.3169
Observations (school level)	236				381			

Conditional5 model. Full sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8998	0.0758	0.6687	1.0000	0.9308	0.0820	0.6183	1.0000
School efficiency	0.9043	0.0747	0.7117	1.0001	0.9387	0.0733	0.6446	1.0000

Program efficiency	0.9951	0.0231	0.8617	1.0548	0.9932	0.0691	0.7275	1.2316
Observations (school level)	236				381			

Conditional6 model. Full sample. 2 inputs 4 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9429	0.0676	0.7012	1.0000	0.8761	0.1038	0.6047	1.0000
School efficiency	0.9437	0.0668	0.6986	1.0000	0.9254	0.0904	0.6574	1.0000
Program efficiency	0.9991	0.0082	0.9502	1.0316	0.9484	0.0826	0.7049	1.1774
Observations (school level)	236				381			

Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: Teacher seniority, Teacher diploma, School principal seniority

Conditional 4: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 5: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 6: School track (General), School size, % of students changing school, Previously treated school, Teacher seniority & diploma

E.2 Descriptive statistics of the efficiency scores for 2 inputs, 3 outputs.

In the following, differently from the main analysis we do not consider the *Share of students enrolled in higher education* as output. Therefore for the following estimation we consider two inputs (*Teaching hours per student*, *Operating grants per student*), three outputs (*Share of students with A certificate*, *Share of students without problems of absenteeism*, *Share of students progressing though school*), three groups of contextual variables (School, Teacher and Student characteristics) and *m* is set to 40.

In the 6% discontinuity sample there are 68 schools below the threshold and 71 above.

In the 8% discontinuity sample there are 92 schools below the threshold and 107 above.

In the full sample there are 236 schools below the threshold and 406 above.

E.2.1 Descriptive statistics of the efficiency scores for 6% discontinuity sample. 2 input, 3 outputs

unconditional model. 6% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8566	0.0810	0.6514	1.0000	0.8059	0.1004	0.4968	1.0000
School efficiency	0.8535	0.0824	0.6440	1.0000	0.8758	0.1126	0.5213	1.0007
Program efficiency	1.0039	0.0040	1.0000	1.0143	0.9222	0.0492	0.7599	1.0000
Observations (school level)	68				71			

conditional1 model. 6% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8991	0.0856	0.6812	1.0000	0.8401	0.1069	0.5043	1.0000
School efficiency	0.8960	0.0818	0.6766	1.0000	0.9143	0.1075	0.5542	1.0000
Program efficiency	1.0034	0.0248	0.9126	1.1007	0.9212	0.0747	0.7133	1.0098
Observations (school level)	68				71			

conditional2 model. 6% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9072	0.0745	0.6969	1.0000	0.8585	0.0979	0.6141	1.0000
School efficiency	0.9043	0.0723	0.6948	1.0000	0.9272	0.0858	0.6473	1.0000

Program efficiency	1.0032	0.0196	0.8942	1.0631	0.9262	0.0621	0.7719	1.0032
Observations (school level)	68				71			

conditional3 model. 6% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9380	0.0760	0.7517	1.0000	0.9322	0.0865	0.4983	1.0000
School efficiency	0.9294	0.0731	0.7506	1.0000	0.9600	0.0777	0.5205	1.0000
Program efficiency	1.0092	0.0209	0.9699	1.1199	0.9719	0.0607	0.7861	1.1748
Observations (school level)	68				71			

conditional4 model. 6% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9419	0.0727	0.7708	1.0000	0.9390	0.0831	0.5044	1.0000
School efficiency	0.9325	0.0714	0.7643	1.0000	0.9659	0.0718	0.5508	1.0000
Program efficiency	1.0103	0.0228	0.9786	1.1186	0.9724	0.0530	0.8249	1.1241
Observations (school level)	68				71			

Conditional5 model. 6% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9274	0.0833	0.7152	1.0000	0.8882	0.1152	0.5190	1.0000
School efficiency	0.9046	0.0876	0.6723	1.0000	0.8984	0.1120	0.5191	1.0000
Program efficiency	1.0273	0.0550	0.8672	1.2034	0.9922	0.0965	0.7598	1.4820
Observations (school level)	68				71			

Conditional6 model. 6% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9607	0.0608	0.7344	1.0000	0.9281	0.0943	0.5329	1.0000
School efficiency	0.9439	0.0691	0.7190	1.0000	0.9425	0.0857	0.5388	1.0000

Program efficiency	1.0193	0.0421	0.9257	1.1811	0.9855	0.0622	0.8198	1.2296
Observations (school level)	68				71			

Conditional7 model. 6% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9172	0.0758	0.7334	1.0000	0.9143	0.0918	0.4916	1.0000
School efficiency	0.9242	0.0767	0.7453	1.0000	0.9476	0.0785	0.5263	1.0000
Program efficiency	0.9930	0.0319	0.8877	1.0937	0.9651	0.0590	0.7866	1.1011
Observations (school level)	68				71			

conditional8 model. 6% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9458	0.0703	0.7089	1.0000	0.8959	0.1068	0.5190	1.0000
School efficiency	0.9415	0.0724	0.7108	1.0000	0.9279	0.0992	0.5227	1.0000
Program efficiency	1.0056	0.0399	0.8761	1.1127	0.9686	0.0964	0.7764	1.4664
Observations (school level)	68				71			

conditional9 model. 6% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9853	0.0270	0.8867	1.0000	0.9595	0.0596	0.7043	1.0000
School efficiency	0.9844	0.0287	0.8836	1.0000	0.9815	0.0424	0.7284	1.0000
Program efficiency	1.0011	0.0127	0.9791	1.0743	0.9775	0.0403	0.7820	1.0137
Observations (school level)	68				71			

conditional10 model. 6% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9948	0.0155	0.9031	1.0000	0.9948	0.0119	0.9366	1.0000
School efficiency	0.9931	0.0193	0.8912	1.0000	0.9968	0.0093	0.9409	1.0000
Program efficiency	1.0018	0.0050	0.9968	1.0291	0.9980	0.0082	0.9438	1.0097

Observations (school level)	68	71

Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: School track (Vocational), School size, % of students changing school, Previously treated school

Conditional 4: School track (Vocational), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 5: Teacher seniority, Teacher diploma, School principal seniority

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 7: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 8: School track (General), School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 9: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 10: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

E.2.2 Descriptive statistics of the efficiency scores for 8% discontinuity sample. 2 input, 3 outputs

unconditional model. 8% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8622	0.0854	0.6441	1.0015	0.7850	0.1074	0.4996	1.1457
School efficiency	0.8592	0.0872	0.6350	1.0009	0.8516	0.1205	0.5239	1.1127
Program efficiency	1.0037	0.0044	0.9971	1.0177	0.9241	0.0484	0.7609	1.0296
Observations (school level)	92				107			

conditional1 model. 8% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9010	0.0808	0.7047	1.0000	0.8512	0.0956	0.5232	1.0000
School efficiency	0.8974	0.0805	0.6828	1.0000	0.9032	0.1066	0.5959	1.0000
Program efficiency	1.0042	0.0189	0.9099	1.0546	0.9458	0.0673	0.7698	1.1145
Observations (school level)	92				107			

conditional2 model. 8% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max

Overall efficiency	0.9118	0.0709	0.7249	1.0000	0.8627	0.0928	0.6179	1.0000
School efficiency	0.9101	0.0725	0.6930	1.0000	0.9276	0.0829	0.6655	1.0000
Program efficiency	1.0023	0.0167	0.9592	1.0551	0.9307	0.0624	0.7501	1.0022
Observations (school level)	92				107			

conditional3 model. 8% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9280	0.0822	0.7194	1.0000	0.9321	0.0878	0.5003	1.0001
School efficiency	0.9267	0.0802	0.7220	1.0000	0.9549	0.0797	0.5192	1.0000
Program efficiency	1.0013	0.0162	0.9195	1.0715	0.9767	0.0523	0.7866	1.0825
Observations (school level)	92				107			

conditional4 model. 8% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9344	0.0758	0.7621	1.0000	0.9408	0.0816	0.5058	1.0000
School efficiency	0.9329	0.0749	0.7499	1.0000	0.9621	0.0714	0.5443	1.0000
Program efficiency	1.0017	0.0168	0.9520	1.0993	0.9779	0.0457	0.8248	1.0715
Observations (school level)	92				107			

Conditional5 model. 8% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9274	0.0826	0.6949	1.0000	0.8509	0.1157	0.5192	1.0000
School efficiency	0.9072	0.0877	0.6722	1.0000	0.8823	0.1193	0.5195	1.0000
Program efficiency	1.0236	0.0331	0.9235	1.1555	0.9679	0.0804	0.7597	1.4032
Observations (school level)	92				107			

Conditional6 model. 8% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9635	0.0598	0.7395	1.0000	0.9088	0.0901	0.5707	1.0000

School efficiency	0.9595	0.0658	0.6956	1.0000	0.9498	0.0778	0.5625	1.0000
Program efficiency	1.0064	0.0576	0.8004	1.2052	0.9578	0.0661	0.7056	1.1554
Observations (school level)	92				107			

Conditional7 model. 8% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9159	0.0783	0.7250	1.0000	0.9230	0.0856	0.4928	1.0000
School efficiency	0.9061	0.0802	0.7252	1.0000	0.9476	0.0735	0.5364	1.0000
Program efficiency	1.0113	0.0238	0.9317	1.1218	0.9744	0.0584	0.7895	1.2129
Observations (school level)	92				107			

conditional8 model. 8% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9442	0.0707	0.6993	1.0000	0.8730	0.1032	0.5192	1.0000
School efficiency	0.9352	0.0717	0.7003	1.0000	0.9217	0.0977	0.5911	1.0000
Program efficiency	1.0102	0.0273	0.9500	1.1348	0.9512	0.1019	0.7157	1.4462
Observations (school level)	92				107			

conditional9 model. 8% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9870	0.0250	0.8880	1.0000	0.9653	0.0502	0.7092	1.0000
School efficiency	0.9821	0.0303	0.8671	1.0000	0.9841	0.0332	0.7816	1.0000
Program efficiency	1.0052	0.0117	0.9799	1.0414	0.9807	0.0349	0.7928	1.0188
Observations (school level)	92				107			

conditional10 model. 8% discontinuity sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9944	0.0146	0.9077	1.0000	0.9936	0.0142	0.9248	1.0000
School efficiency	0.9939	0.0155	0.9004	1.0000	0.9960	0.0109	0.9265	1.0000

Program efficiency	1.0004	0.0050	0.9773	1.0250	0.9976	0.0104	0.9249	1.0238
Observations (school level)	92				107			

Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: School track (Vocational), School size, % of students changing school, Previously treated school

Conditional 4: School track (Vocational), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 5: Teacher seniority, Teacher diploma, School principal seniority

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 7: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 8: School track (General), School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 9: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 10: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

E.2.3 Descriptive statistics of the efficiency scores for the full sample. 2 input, 3 outputs

unconditional model. Full sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8730	0.0823	0.6281	1.0020	0.7088	0.0961	0.4900	1.1591
School efficiency	0.8709	0.0834	0.6189	1.0014	0.7960	0.1113	0.5292	1.2176
Program efficiency	1.0026	0.0030	1.0000	1.0196	0.8921	0.0409	0.6516	1.0000
Observations	236				406			

conditional1 model. Full sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9062	0.0728	0.6750	1.0012	0.8325	0.0938	0.4951	1.0000
School efficiency	0.8988	0.0726	0.6742	1.0013	0.8756	0.0952	0.6346	1.0001
Program efficiency	1.0085	0.0225	0.9137	1.2337	0.9525	0.0621	0.6614	1.0680
Observations	236				406			

conditional2 model. Full sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9144	0.0659	0.6836	1.0007	0.8591	0.0899	0.6270	1.0000
School efficiency	0.9059	0.0684	0.6668	1.0009	0.8952	0.0893	0.6655	1.0000
Program efficiency	1.0099	0.0218	0.9225	1.1754	0.9612	0.0588	0.6632	1.0844
Observations	236				406			

conditional3 model. Full sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9114	0.0771	0.7129	1.0000	0.9446	0.0795	0.4855	1.0022
School efficiency	0.9141	0.0753	0.7142	1.0000	0.9272	0.0787	0.5473	1.0009
Program efficiency	**0.9970**	0.0183	0.8853	1.1607	**1.0223**	0.0861	0.6570	1.3458
Observations	236				406			

conditional4 model. Full sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9129	0.0756	0.7119	1.0000	0.9525	0.0745	0.4876	1.0000
School efficiency	0.9175	0.0729	0.7083	1.0000	0.9222	0.0783	0.6390	1.0000
Program efficiency	**0.9949**	0.0174	0.8814	1.1523	**1.0375**	0.0946	0.6640	1.5019
Observations	236				406			

Conditional5 model. Full sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9243	0.0774	0.6380	1.0009	0.7856	0.1235	0.4989	1.0000
School efficiency	0.9258	0.0777	0.6353	1.0006	0.8670	0.1215	0.5444	1.0028
Program efficiency	0.9984	0.0085	0.8940	1.0143	0.9085	0.0856	0.6091	1.1737
Observations	236				406			

Conditional6 model. Full sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9503	0.0668	0.6525	1.0000	0.8436	0.1261	0.5072	1.0000
School efficiency	0.9483	0.0680	0.6463	1.0000	0.9139	0.0962	0.5617	1.0000
Program efficiency	1.0024	0.0145	0.9135	1.1065	0.9247	0.1130	0.6364	1.3383
Observations	236				406			

Conditional7 model. Full sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8989	0.0734	0.6708	1.0000	0.9210	0.0844	0.4918	1.0000
School efficiency	0.9042	0.0732	0.7118	1.0000	0.9259	0.0795	0.5437	1.0000
Program efficiency	**0.9944**	0.0226	0.8620	1.0405	**0.9965**	0.0675	0.7238	1.2418
Observations	236				406			

conditional8 model. Full sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9402	0.0666	0.7030	1.0000	0.8774	0.1049	0.5028	1.0000
School efficiency	0.9410	0.0662	0.6986	1.0000	0.9227	0.0915	0.6585	1.0000
Program efficiency	0.9992	0.0088	0.9519	1.0369	0.9521	0.0778	0.6299	1.1945
Observations	236				406			

conditional9 model. Full sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9724	0.0419	0.7449	1.0000	0.9611	0.0583	0.6920	1.0000
School efficiency	0.9714	0.0427	0.7384	1.0000	0.9735	0.0482	0.7449	1.0000
Program efficiency	1.0011	0.0107	0.9115	1.0611	0.9873	0.0352	0.7162	1.0485

Observations	236				406			

conditional10 model. Full sample. 2 inputs 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9774	0.0355	0.8176	1.0000	0.9920	0.0209	0.8225	1.0000
School efficiency	0.9831	0.0317	0.8044	1.0000	0.9893	0.0257	0.8168	1.0000
Program efficiency	**0.9941**	0.0152	0.8828	1.0423	**1.0029**	0.0152	0.8450	1.0840
Observations	236				406			

Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: School track (Vocational), School size, % of students changing school, Previously treated school

Conditional 4: School track (Vocational), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 5: Teacher seniority, Teacher diploma, School principal seniority

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 7: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 8: School track (General), School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 9: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 10: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

E.3 Descriptive statistics of the efficiency scores for 1 input, 3 outputs.

In the following, differently from the main analysis we do not consider the *Operating grants per student* as input and the *Share of students enrolled in higher education* as output. Therefore for the following estimation we consider one input (*Teaching hours per student*), three outputs (*Share of students with A certificate*, *Share of students without problems of absenteeism*, *Share of students progressing though school*), three groups of contextual variables (School, Teacher and Student characteristics) and *m* is set to 40.

In the 6% discontinuity sample there are 68 schools below the threshold and 71 above.

In the 8% discontinuity sample there are 92 schools below the threshold and 107 above.

In the full sample there are 236 schools below the threshold and 406 above.

E.3.1 Descriptive statistics of the efficiency scores for 6% discontinuity sample. 1 input, 3 outputs

unconditional model. 6% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.7553	0.1440	0.4641	1.0000	0.6699	0.1334	0.4591	1.0000
School efficiency	0.7531	0.1449	0.4578	1.0000	0.7504	0.1600	0.4805	1.0002
Program efficiency	1.0032	0.0035	1.0000	1.0139	0.8988	0.0703	0.7069	1.0000
Observations	68				71			

conditional1 model. 6% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8029	0.1568	0.4750	1.0000	0.7125	0.1438	0.4795	1.0000
School efficiency	0.8004	0.1481	0.4730	1.0000	0.8149	0.1672	0.4855	1.0000
Program efficiency	1.0017	0.0372	0.8503	1.1451	0.8850	0.1130	0.5637	1.0502
Observations	68				71			

conditional2 model. 6% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8173	0.1414	0.4911	1.0000	0.7444	0.1370	0.5144	1.0000

School efficiency	0.8149	0.1384	0.5004	1.0000	0.8577	0.1252	0.5233	1.0000
Program efficiency	1.0026	0.0271	0.8716	1.0722	0.8697	0.1006	0.6225	1.0000
Observations	68				71			

conditional3 model. 6% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8987	0.1309	0.4580	1.0000	0.9061	0.1195	0.4511	1.0000
School efficiency	0.8817	0.1253	0.4574	1.0000	0.9375	0.1111	0.4714	1.0000
Program efficiency	1.0196	0.0496	0.9660	1.2314	0.9676	0.0719	0.7327	1.1721
Observations	139							

conditional4 model. 6% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9030	0.1293	0.4712	1.0000	0.9154	0.1137	0.4600	1.0000
School efficiency	0.8846	0.1254	0.4665	1.0000	0.9486	0.1017	0.4769	1.0000
Program efficiency	1.0215	0.0515	0.9602	1.2459	0.9654	0.0669	0.7327	1.1203
Observations	68				71			

Conditional5 model. 6% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8556	0.1463	0.5026	1.0000	0.7843	0.1649	0.4971	1.0000
School efficiency	0.8222	0.1509	0.5001	1.0000	0.8020	0.1532	0.5191	1.0000
Program efficiency	1.0489	0.1134	0.5609	1.4703	0.9870	0.1696	0.6146	1.5677
Observations	68				71			

Conditional6 model. 6% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9209	0.1075	0.5757	1.0000	0.8637	0.1321	0.5329	1.0000
School efficiency	0.8845	0.1221	0.5734	1.0000	0.8843	0.1319	0.5388	1.0000

Program efficiency	1.0469	0.0826	0.9215	1.3225	0.9834	0.1217	0.7127	1.4896
Observations	139							

Conditional7 model. 6% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8647	0.1232	0.5269	1.0000	0.8607	0.1323	0.4905	1.0000
School efficiency	0.8841	0.1140	0.5459	1.0000	0.8799	0.1418	0.5003	1.0000
Program efficiency	0.9804	0.0828	0.5924	1.2063	0.9855	0.1080	0.7349	1.2913
Observations	68				71			

conditional8 model. 6% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8814	0.1346	0.5510	1.0000	0.7987	0.1588	0.4720	1.0000
School efficiency	0.8779	0.1289	0.5733	1.0000	0.8525	0.1446	0.4718	1.0000
Program efficiency	1.0061	0.0840	0.7158	1.3321	0.9442	0.1523	0.6246	1.4982
Observations	68				71			

conditional9 model. 6% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9622	0.0707	0.6716	1.0000	0.9248	0.0920	0.6540	1.0000
School efficiency	0.9649	0.0606	0.6832	1.0000	0.9673	0.0692	0.6406	1.0000
Program efficiency	0.9971	0.0389	0.8127	1.1542	0.9563	0.0661	0.7168	1.0528
Observations	68				71			

conditional10 model. 6% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9905	0.0221	0.8933	1.0000	0.9922	0.0173	0.8907	1.0000
School efficiency	0.9891	0.0262	0.8560	1.0000	0.9948	0.0123	0.9327	1.0000
Program efficiency	1.0017	0.0099	0.9617	1.0436	0.9974	0.0125	0.9112	1.0171

Observations	68				71			

Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: School track (Vocational), School size, % of students changing school, Previously treated school

Conditional 4: School track (Vocational), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 5: Teacher seniority, Teacher diploma, School principal seniority

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 7: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 8: School track (General), School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 9: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 10: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

E.3.2 Descriptive statistics of the efficiency scores for 8% discontinuity sample. 1 input, 3 outputs

unconditional model. 8% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.7690	0.1545	0.3517	1.0004	0.6466	0.1322	0.4291	1.0310
School efficiency	0.7669	0.1554	0.3499	1.0002	0.7207	0.1576	0.4518	1.0371
Program efficiency	1.0032	0.0034	1.0000	1.0151	0.9037	0.0716	0.7077	1.0000
Observations	92				107			

conditional1 model. 8% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8073	0.1487	0.3865	1.0000	0.7371	0.1240	0.4877	1.0000
School efficiency	0.7990	0.1514	0.3729	1.0000	0.8135	0.1544	0.4795	1.0000
Program efficiency	1.0124	0.0328	0.9569	1.1495	0.9173	0.1080	0.6336	1.1470
Observations	92				107			

conditional2 model. 8% discontinuity sample. 1 input 3 outputs

	Below threshold	*Above threshold*

	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8230	0.1361	0.4654	1.0000	0.7549	0.1220	0.5199	1.0000
School efficiency	0.8168	0.1445	0.4529	1.0000	0.8768	0.1137	0.5241	1.0000
Program efficiency	1.0109	0.0434	0.9461	1.1992	0.8637	0.0977	0.6057	1.0000
Observations	92				107			

conditional3 model. 8% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8814	0.1491	0.3533	1.0000	0.9062	0.1265	0.4548	1.0000
School efficiency	0.8746	0.1466	0.3563	1.0000	0.9333	0.1185	0.4723	1.0000
Program efficiency	1.0078	0.0333	0.9289	1.1524	0.9715	0.0621	0.7102	1.0717
Observations	92				107			

conditional4 model. 8% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8876	0.1465	0.3757	1.0000	0.9160	0.1216	0.4655	1.0000
School efficiency	0.8804	0.1434	0.3746	1.0000	0.9409	0.1119	0.4826	1.0000
Program efficiency	1.0081	0.0383	0.9145	1.1676	0.9736	0.0587	0.7063	1.0685
Observations	92				107			

Conditional5 model. 8% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8666	0.1433	0.5026	1.0000	0.7276	0.1579	0.4880	1.0000
School efficiency	0.8329	0.1432	0.5023	1.0000	0.7800	0.1579	0.4668	1.0000
Program efficiency	1.0442	0.0738	0.5843	1.1987	0.9404	0.1322	0.6097	1.4022
Observations	92				107			

Conditional6 model. 8% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max

Overall efficiency	0.9242	0.1084	0.5800	1.0000	0.8176	0.1407	0.4884	1.0000
School efficiency	0.9157	0.1234	0.5238	1.0000	0.8943	0.1303	0.4871	1.0000
Program efficiency	1.0221	0.1542	0.6764	1.7495	0.9197	0.1224	0.5595	1.2783
Observations	92				107			

Conditional7 model. 8% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8647	0.1364	0.3587	1.0000	0.8731	0.1323	0.4915	1.0000
School efficiency	0.8479	0.1351	0.3592	1.0000	0.8853	0.1327	0.5156	1.0000
Program efficiency	1.0209	0.0496	0.8850	1.1869	0.9907	0.0938	0.7439	1.3237
Observations	92				107			

conditional8 model. 8% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8793	0.1363	0.5209	1.0000	0.7591	0.1511	0.4800	1.0000
School efficiency	0.8628	0.1328	0.5441	1.0000	0.8625	0.1420	0.4882	1.0000
Program efficiency	1.0195	0.0478	0.8894	1.1617	0.8914	0.1697	0.5215	1.5160
Observations	92				107			

conditional9 model. 8% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9669	0.0605	0.6883	1.0000	0.9359	0.0801	0.5968	1.0000
School efficiency	0.9594	0.0620	0.6830	1.0000	0.9722	0.0551	0.6532	1.0000
Program efficiency	1.0083	0.0283	0.8241	1.0996	0.9625	0.0588	0.7029	1.0689
Observations	92				107			

conditional10 model. 8% discontinuity sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9886	0.0229	0.9027	1.0000	0.9906	0.0197	0.9013	1.0000

School efficiency	0.9884	0.0243	0.8869	1.0000	0.9933	0.0157	0.9158	1.0000
Program efficiency	1.0004	0.0111	0.9535	1.0400	0.9973	0.0141	0.9181	1.0485
Observations	92				107			

Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: School track (Vocational), School size, % of students changing school, Previously treated school

Conditional 4: School track (Vocational), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 5: Teacher seniority, Teacher diploma, School principal seniority

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 7: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 8: School track (General), School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 9: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 10: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

E.3.3 Descriptive statistics of the efficiency scores for the full sample. 1 input, 3 outputs

unconditional model. Full sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8243	0.1347	0.3170	1.0020	0.5660	0.1135	0.2905	1.0259
School efficiency	0.8230	0.1351	0.3164	1.0014	0.6453	0.1379	0.3186	1.0788
Program efficiency	1.0017	0.0018	1.0000	1.0127	0.8821	0.0630	0.6427	1.0000
Observations	236				406			

conditional1 model. Full sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8595	0.1209	0.3740	1.0005	0.7345	0.1256	0.3390	1.0000
School efficiency	0.8496	0.1211	0.3728	1.0008	0.7946	0.1351	0.3748	1.0000
Program efficiency	1.0124	0.0332	0.9254	1.2337	0.9297	0.0961	0.4949	1.1532
Observations	236				406			

conditional2 model. Full sample. 1 input 3 outputs

	Below threshold	*Above threshold*

	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8717	0.1056	0.5107	1.0001	0.7770	0.1215	0.3678	1.0000
School efficiency	0.8603	0.1110	0.4954	1.0000	0.8353	0.1264	0.3691	1.0000
Program efficiency	1.0153	0.0402	0.8699	1.2632	0.9344	0.0887	0.5466	1.1626
Observations	236				406			

conditional3 model. Full sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8833	0.1185	0.3515	1.0000	0.9277	0.1029	0.4588	1.0004
School efficiency	0.8847	0.1177	0.3565	1.0000	0.9066	0.0967	0.4839	1.0009
Program efficiency	**0.9985**	0.0269	0.8834	1.3008	**1.0270**	0.0967	0.6421	1.3895
Observations	236				406			

conditional4 model. Full sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8849	0.1170	0.3580	1.0000	0.9393	0.0950	0.4652	1.0000
School efficiency	0.8887	0.1149	0.3650	1.0000	0.8973	0.0931	0.5272	1.0000
Program efficiency	**0.9956**	0.0266	0.8746	1.2800	**1.0523**	0.1089	0.6475	1.5200
Observations	236				406			

Conditional5 model. Full sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8810	0.1282	0.3333	1.0009	0.6564	0.1709	0.3134	1.0000
School efficiency	0.8835	0.1281	0.3333	1.0006	0.7679	0.1756	0.3495	1.0028
Program efficiency	0.9974	0.0153	0.7927	1.0069	0.8637	0.1444	0.4766	1.5229
Observations	236				406			

Conditional6 model. Full sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9171	0.1124	0.4697	1.0000	0.7372	0.1878	0.3325	1.0000

School efficiency	0.9144	0.1141	0.4363	1.0000	0.8479	0.1488	0.3546	1.0000
Program efficiency	1.0037	0.0254	0.7764	1.2313	0.8768	0.2009	0.4773	1.6017
Observations	236				406			

Conditional7 model. Full sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8598	0.1173	0.3183	1.0000	0.8749	0.1284	0.4192	1.0000
School efficiency	0.8712	0.1119	0.3178	1.0000	0.8744	0.1226	0.4098	1.0000
Program efficiency	**0.9871**	0.0484	0.6082	1.0631	**1.0044**	0.0961	0.6187	1.3658
Observations	236				406			

conditional8 model. Full sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9051	0.1064	0.4664	1.0000	0.7937	0.1560	0.3633	1.0000
School efficiency	0.9063	0.1037	0.4712	1.0000	0.8711	0.1403	0.3859	1.0000
Program efficiency	0.9983	0.0164	0.9054	1.0517	0.9156	0.1289	0.5673	1.3694
Observations	236				406			

conditional9 model. Full sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9494	0.0739	0.6673	1.0000	0.9365	0.0902	0.4681	1.0000
School efficiency	0.9497	0.0725	0.6602	1.0000	0.9586	0.0724	0.5550	1.0000
Program efficiency	0.9999	0.0228	0.8138	1.0659	0.9772	0.0605	0.6047	1.0947
Observations	236				406			

conditional10 model. Full sample. 1 input 3 outputs

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9631	0.0540	0.7525	1.0000	0.9878	0.0284	0.8212	1.0000
School efficiency	0.9738	0.0448	0.7957	1.0000	0.9843	0.0343	0.7978	1.0000
Program efficiency	**0.9890**	0.0290	0.7659	1.0423	**1.0040**	0.0196	0.8560	1.1081
Observations	236				406			

Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: School track (Vocational), School size, % of students changing school, Previously treated school

Conditional 4: School track (Vocational), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 5: Teacher seniority, Teacher diploma, School principal seniority

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 7: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 8: School track (General), School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 9: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 10: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

E.4 Efficiency scores for vocational education (BSO) schools only.

In the following, we present the results of the efficiency analysis when considering only those schools that offer at least vocational education as a track choice (namely excluding those schools where 0% of students are in BSO track). We consider two inputs (*Teaching hours per student*, *Operating grants per student*), three outputs (*Share of students with A certificate*, *Share of students without problems of absenteeism*, *Share of students progressing though school*), three groups of contextual variables (School, Teacher and Student characteristics) and *m* is set to 20. Given the reduced number of observations, we focus on one optimal bandwidth and specifically on the largest one, so to have the greatest number of observations below and above the threshold. In the 4.6% discontinuity sample there are 24 schools below the threshold and 34 above. In the full sample there are 43 schools below the threshold and 361 above.

E.4.1 Descriptive statistics of the efficiency scores for BSO schools (4.6% discontinuity sample).

unconditional model. 4.6% discontinuity sample. BSO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8733	0.0818	0.6783	1.0000	0.8339	0.1025	0.6623	1.0000
School efficiency	0.8720	0.0815	0.6819	1.0000	0.8896	0.1131	0.6641	1.0019
Program efficiency	1.0014	0.0048	0.9918	1.0175	0.9415	0.0765	0.6880	1.0026
Observations	24				34			

conditional1 model. 4.6% discontinuity sample. BSO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9252	0.0814	0.7190	1.0000	0.8742	0.1028	0.6839	1.0000
School efficiency	0.9229	0.0824	0.7149	1.0000	0.9502	0.0746	0.7461	1.0000
Program efficiency	1.0026	0.0074	0.9866	1.0281	0.9207	0.0846	0.7244	1.0026
Observations	24				34			

conditional2 model. 4.6% discontinuity sample. BSO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9309	0.0708	0.7146	1.0000	0.8774	0.1016	0.6699	1.0000
School efficiency	0.9313	0.0725	0.7143	1.0000	0.9497	0.0754	0.7465	1.0000
Program efficiency	0.9998	0.0127	0.9684	1.0458	0.9244	0.0809	0.7310	1.0010

Observations	24				34			

Conditional3 model. 4.6% discontinuity sample. BSO schools

	Control				Treated			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9426	0.0857	0.6730	1.0000	0.8896	0.1098	0.6670	1.0000
School efficiency	0.9431	0.0836	0.7203	1.0000	0.9569	0.0856	0.6977	1.0000
Program efficiency	0.9995	0.0280	0.9324	1.0715	0.9341	0.1196	0.6670	1.2974
Observations	24				34			

Conditional4 model. 4.6% discontinuity sample. BSO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9851	0.0416	0.8087	1.0000	0.9545	0.0754	0.6943	1.0000
School efficiency	0.9689	0.0588	0.7557	1.0000	0.9763	0.0611	0.6955	1.0000
Program efficiency	1.0184	0.0390	0.9758	1.1679	0.9778	0.0501	0.8375	1.0530
Observations	24				34			

conditional5 model. 4.6% discontinuity sample. BSO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9585	0.0467	0.8439	1.0000	0.9491	0.0724	0.7213	1.0000
School efficiency	0.9502	0.0458	0.8564	1.0000	0.9580	0.0727	0.7464	1.0000
Program efficiency	1.0091	0.0282	0.9359	1.0809	0.9919	0.0500	0.8899	1.2017
Observations	24				34			

Conditional6 model. 4.6% discontinuity sample. BSO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9529	0.0712	0.7359	1.0000	0.9142	0.0882	0.6923	1.0000
School efficiency	0.9406	0.0771	0.7172	1.0000	0.9693	0.0746	0.6978	1.0000
Program efficiency	1.0138	0.0167	0.9999	1.0542	0.9468	0.0977	0.6928	1.1835

Observations	24				34			

Conditional7 model. 4.6% discontinuity sample. BSO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9929	0.0180	0.9157	1.0000	0.9798	0.0367	0.8239	1.0000
School efficiency	0.9925	0.0157	0.9488	1.0000	0.9902	0.0305	0.8302	1.0000
Program efficiency	1.0005	0.0168	0.9623	1.0514	0.9895	0.0192	0.9159	1.0085
Observations	24				34			

Conditional8 model. 4.6% discontinuity sample. BSO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9971	0.0101	0.9503	1.0000	0.9965	0.0078	0.9596	1.0000
School efficiency	0.9944	0.0127	0.9451	1.0000	0.9983	0.0047	0.9759	1.0000
Program efficiency	1.0027	0.0060	1.0000	1.0266	0.9981	0.0040	0.9833	1.0014
Observations	24				34			

m=20, 2 inputs (teaching hours per student, operating grants per student) and 3 outputs (Share of students with "A certificate", Share of students without problems of absenteeism, Share of students progressing through school)

Conditional 1: School size, % of students changing school, Previously treated school

Conditional 2: School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: Teacher seniority, Teacher diploma, School principal seniority

Conditional 4: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 5: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 6: School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 7: School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 8: School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

E.4.2 Descriptive statistics of the efficiency scores for BSO schools (full sample).

unconditional model. Full sample. BSO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max

Overall efficiency	0.9062	0.0830	0.6906	1.0187	0.7748	0.0919	0.5778	1.1417
School efficiency	0.8979	0.0864	0.6744	1.0037	0.8261	0.0989	0.6007	1.1767
Program efficiency	1.0097	0.0108	1.0000	1.0463	0.9390	0.0395	0.7869	1.0075
Observations	43				361			

conditional1 model. Full sample. BSO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9317	0.0772	0.7163	1.0000	0.8498	0.0895	0.6428	1.0024
School efficiency	0.9164	0.0823	0.7157	1.0000	0.8842	0.0890	0.6470	1.0143
Program efficiency	1.0176	0.0240	0.9998	1.0931	0.9615	0.0373	0.7372	1.0052
Observations	43				361			

conditional2 model. Full sample. BSO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9438	0.0662	0.7149	1.0000	0.8725	0.0887	0.6584	1.0000
School efficiency	0.9226	0.0750	0.7093	1.0000	0.9032	0.0832	0.6655	1.0053
Program efficiency	1.0243	0.0333	0.9984	1.1196	0.9660	0.0387	0.7323	1.0193
Observations	43				361			

Conditional3 model. Full sample. BSO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9598	0.0689	0.7028	1.0000	0.8732	0.1037	0.5679	1.0000
School efficiency	0.9584	0.0745	0.6901	1.0000	0.9053	0.0959	0.6324	1.0000
Program efficiency	1.0023	0.0239	0.9323	1.1023	0.9647	0.0522	0.7433	1.0403
Observations	43				361			

Conditional4 model. Full sample. BSO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9771	0.0460	0.8048	1.0000	0.9251	0.0863	0.5751	1.0000
School efficiency	0.9669	0.0591	0.7755	1.0000	0.9529	0.0702	0.6541	1.0000

Program efficiency	1.0116	0.0250	0.9646	1.1047	0.9702	0.0448	0.7150	1.0173
Observations	43				361			

conditional5 model. Full sample. BSO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9601	0.0473	0.8217	1.0000	0.9219	0.0759	0.6887	1.0001
School efficiency	0.9534	0.0506	0.8161	1.0001	0.9371	0.0687	0.7068	1.0000
Program efficiency	1.0076	0.0260	0.9154	1.0673	0.9843	0.0458	0.7206	1.0330
Observations	43				361			

Conditional6 model. Full sample. BSO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9731	0.0585	0.7453	1.0000	0.9248	0.0796	0.6689	1.0000
School efficiency	0.9668	0.0689	0.7106	1.0000	0.9125	0.0811	0.6669	1.0000
Program efficiency	1.0076	0.0227	0.9819	1.1185	1.0160	0.0713	0.8318	1.3267
Observations	43				361			

Conditional7 model. Full sample. BSO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9934	0.0176	0.9239	1.0000	0.9744	0.0456	0.6826	1.0000
School efficiency	0.9886	0.0222	0.8965	1.0000	0.9798	0.0406	0.7423	1.0000
Program efficiency	1.0051	0.0156	0.9427	1.0647	0.9943	0.0157	0.8853	1.0077
Observations	43				361			

Conditional8 model. Full sample. BSO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9953	0.0122	0.9433	1.0000	0.9920	0.0188	0.8633	1.0000
School efficiency	0.9935	0.0151	0.9304	1.0000	0.9928	0.0186	0.8655	1.0000
Program efficiency	1.0020	0.0138	0.9434	1.0478	0.9993	0.0040	0.9554	1.0091
Observations	43				361			

m=20, 2 inputs (teaching hours per student, operating grants per student) and 3 outputs (Share of students with "A certificate", Share of students without problems of absenteeism, Share of students progressing through school)

Conditional 1: School size, % of students changing school, Previously treated school

Conditional 2: School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: Teacher seniority, Teacher diploma, School principal seniority

Conditional 4: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 5: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 6: School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 7: School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 8: School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

E.5 Efficiency scores for general education (ASO) schools only.

In the following, we present the results of the efficiency analysis when considering only those schools that provide exclusively general education (namely considering just schools where 100% of students are in ASO track). We consider two inputs (*Teaching hours per student*, *Operating grants per student*), three outputs (*Share of students with A certificate*, *Share of students without problems of absenteeism*, *Share of students progressing though school*), three groups of contextual variables (School, Teacher and Student characteristics) and *m* is set to 20. Given the reduced number of observations, we focus just on one optimal bandwidth and specifically on the largest, so to have the greatest number of observations below and above the threshold. In the 6.7% discontinuity sample there are 26 schools below the threshold and 11 above. In the full sample there are 140 schools below the threshold and 22 above.

E.5.1 Descriptive statistics of the efficiency scores for ASO schools (6.7% discontinuity sample).

Unconditional model. 6.7% discontinuity sample. ASO schools

	Below threshold				*Above threshold*				
	mean	sd	min	max	mean	sd	min	max	max
Overall efficiency	0.901	0.083	0.742	1.004	0.877	0.063	0.767	0.966	1.004
School efficiency	0.898	0.085	0.738	1.004	0.973	0.046	0.875	1.004	1.004
Program efficiency	1.004	0.003	1.000	1.012	0.901	0.054	0.796	0.962	1.012
Observations	26				11				

Conditional1 model. 6.7% discontinuity sample. ASO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.922	0.071	0.797	1.000	0.912	0.088	0.764	1.000
School efficiency	0.917	0.074	0.795	1.000	0.986	0.030	0.921	1.000
Program efficiency	1.006	0.015	0.999	1.070	0.924	0.074	0.790	1.000
Observations	26				11			

Conditional2 model. 6.7% discontinuity sample. ASO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.946	0.057	0.823	1.000	0.970	0.034	0.912	1.000
School efficiency	0.917	0.074	0.795	1.000	0.992	0.022	0.928	1.000
Program efficiency	1.034	0.047	0.990	1.129	0.978	0.028	0.917	1.000

Observations	26				11			

Conditional3 model. 6.7% discontinuity sample. ASO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.951	0.072	0.775	1.000	0.979	0.030	0.926	1.000
School efficiency	0.966	0.068	0.740	1.000	0.987	0.030	0.900	1.000
Program efficiency	0.987	0.079	0.786	1.213	0.993	0.049	0.926	1.111
Observations	26				11			

Conditional4 model. 6.7% discontinuity sample. ASO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.968	0.060	0.789	1.000	0.984	0.034	0.885	1.000
School efficiency	0.973	0.060	0.771	1.000	0.997	0.008	0.974	1.000
Program efficiency	0.995	0.011	0.965	1.024	0.987	0.035	0.885	1.005
Observations	26				11			

Conditional5 model. 6.7% discontinuity sample. ASO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.918	0.079	0.748	1.000	0.922	0.081	0.788	1.000
School efficiency	0.921	0.080	0.750	1.000	0.986	0.032	0.910	1.000
Program efficiency	0.997	0.010	0.962	1.009	0.936	0.081	0.788	1.000
Observations	26				11			

Conditional6 model. 6.7% discontinuity sample. ASO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.961	0.049	0.851	1.000	0.970	0.041	0.877	1.000
School efficiency	0.980	0.039	0.846	1.000	0.993	0.017	0.947	1.000
Program efficiency	0.981	0.043	0.877	1.090	0.977	0.031	0.897	1.000
Observations	26				11			

Conditional7 model. 6.7% discontinuity sample. ASO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.994	0.015	0.943	1.000	0.999	0.002	0.994	1.000
School efficiency	0.992	0.021	0.898	1.000	1.000	0.000	0.999	1.000
Program efficiency	1.002	0.013	0.984	1.051	0.999	0.002	0.994	1.000
Observations	26				11			

Conditional8 model. 6.7% discontinuity sample. ASO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.996	0.009	0.966	1.000	1.000	0.001	0.996	1.000
School efficiency	0.998	0.006	0.976	1.000	1.000	0.001	0.997	1.000
Program efficiency	0.998	0.007	0.971	1.009	1.000	0.001	0.996	1.002
Observations	26				11			

m=20, 2 inputs (teaching hours per student, operating grants per student) and 3 outputs (Share of students with "A certificate", Share of students without problems of absenteeism, Share of students progressing through school)

Conditional 1: School size, % of students changing school, Previously treated school

Conditional 2: School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: Teacher seniority, Teacher diploma, School principal seniority

Conditional 4: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 5: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 6: School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 7: School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 8: School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

E.5.2 Descriptive statistics of the efficiency scores for ASO schools (full sample).

Unconditional model. Full sample. ASO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9260	0.0709	0.7287	1.0345	0.8456	0.1059	0.6629	1.0857

School efficiency	0.9247	0.0706	0.7287	1.0301	0.9534	0.0934	0.7307	1.0902
Program efficiency	1.0014	0.0012	0.9990	1.0101	0.8879	0.0741	0.6705	0.9958
Observations	140				22			

Conditional1 model. Full sample. ASO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9405	0.0600	0.7882	1.0179	0.8957	0.0921	0.6709	1.0003
School efficiency	0.9400	0.0601	0.7884	1.0179	0.9587	0.0721	0.7270	1.0006
Program efficiency	1.0005	0.0038	0.9710	1.0168	0.9364	0.0909	0.6709	1.1671
Observations	140				22			

Conditional2 model. Full sample. ASO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9498	0.0526	0.8138	1.0137	0.9597	0.0624	0.7245	1.0000
School efficiency	0.9499	0.0529	0.8133	1.0136	0.9728	0.0651	0.7254	1.0000
Program efficiency	0.9999	0.0093	0.9208	1.0225	0.9880	0.0526	0.9009	1.1547
Observations	140				22			

Conditional3 model. Full sample. ASO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9551	0.0612	0.7604	1.0075	0.9177	0.0940	0.6868	1.0000
School efficiency	0.9579	0.0590	0.7598	1.0055	0.9693	0.0719	0.7326	1.0002
Program efficiency	0.9970	0.0088	0.9303	1.0024	0.9472	0.0716	0.7437	1.1009
Observations	140				22			

Conditional4 model. Full sample. ASO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9720	0.0514	0.7585	1.0000	0.9521	0.0767	0.7351	1.0000
School efficiency	0.9741	0.0498	0.7584	1.0000	0.9817	0.0543	0.7661	1.0000
Program efficiency	0.9978	0.0070	0.9659	1.0082	0.9690	0.0439	0.8598	1.0005

Observations	140				22			

Conditional5 model. Full sample. ASO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9322	0.0666	0.7454	1.0090	0.9314	0.0804	0.7691	1.0000
School efficiency	0.9313	0.0674	0.7433	1.0097	0.9740	0.0542	0.8053	1.0003
Program efficiency	1.0010	0.0028	0.9955	1.0160	0.9580	0.0871	0.7691	1.1986
Observations	140				22			

Conditional6 model. Full sample. ASO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9457	0.0569	0.7995	1.0062	0.9367	0.0689	0.7551	1.0000
School efficiency	0.9496	0.0553	0.8059	1.0063	0.9730	0.0652	0.7373	1.0000
Program efficiency	0.9958	0.0087	0.9204	1.0030	0.9649	0.0739	0.8202	1.2024
Observations	140				22			

Conditional7 model. Full sample. ASO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9876	0.0253	0.8640	1.0000	0.9947	0.0126	0.9606	1.0000
School efficiency	0.9897	0.0229	0.8686	1.0000	0.9908	0.0369	0.8271	1.0000
Program efficiency	0.9978	0.0067	0.9656	1.0194	1.0052	0.0367	0.9648	1.1614
Observations	140				22			

Conditional8 model. Full sample. ASO schools

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9878	0.0239	0.8759	1.0000	0.9994	0.0018	0.9915	1.0000
School efficiency	0.9916	0.0194	0.8909	1.0000	0.9999	0.0002	0.9989	1.0000
Program efficiency	0.9961	0.0078	0.9484	1.0001	0.9994	0.0019	0.9915	1.0011
Observations	140				22			

m=20, 2 inputs (teaching hours per student, operating grants per student) and 3 outputs (Share of students with "A certificate", Share of students without problems of absenteeism, Share of students progressing through school)

Conditional 1: School size, % of students changing school, Previously treated school

Conditional 2: School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: Teacher seniority, Teacher diploma, School principal seniority

Conditional 4: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 5: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 6: School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 7: School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 8: School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

E.6 Efficiency scores by the Brussels-Capital Region.

In the following, we present the results of the efficiency analysis when considering only those schools that belong to the Brussels-Capital Region or alternatively excluding these schools and focusing only on the others. We consider two inputs (*Teaching hours per student*, *Operating grants per student*), four outputs (*Share of students with A certificate*, *Share of students without problems of absenteeism*, *Share of students progressing though school, Share of students enrolled in higher education*), three groups of contextual variables (School, Teacher and Student characteristics).

Given the reduced number of observations for the schools in the Brussels-Capital Region, we focus directly on the full sample and there are 10 schools below the threshold and 18 above. For the analysis excluding the schools in the Brussels-Capital Region, in the 6% discontinuity sample there are 65 schools below the threshold and 68 above, in the 8% discontinuity sample there are 86 schools below the threshold and 104 above, in the full sample there are 226 schools below the threshold and 388 above.

E.6.1 Descriptive statistics of the efficiency scores for the schools in the Brussels-Capital Region (full sample).

Unconditional model. Full sample. Schools in the Brussels-Capital Region

	Below threshold				*Above threshold*				
	mean	sd	min	max	mean	sd	min	max	max
Overall efficiency	0.936	0.065	0.788	1.000	0.802	0.087	0.710	1.000	0.936
School efficiency	0.925	0.074	0.775	1.000	0.890	0.068	0.796	1.000	0.925
Program efficiency	1.013	0.016	1.000	1.052	0.900	0.037	0.853	1.000	1.013
Observations	10				18				

Conditional1 model. Full sample. Schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.981	0.027	0.916	1.000	0.950	0.071	0.766	1.008
School efficiency	0.975	0.030	0.911	1.000	0.913	0.066	0.796	1.000
Program efficiency	1.007	0.008	1.000	1.028	1.044	0.096	0.880	1.215
Observations	10				18			

Conditional2 model. Full sample. Schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.983	0.022	0.945	1.000	0.953	0.070	0.791	1.003

School efficiency	0.977	0.028	0.930	1.000	0.918	0.063	0.822	1.000
Program efficiency	1.006	0.009	1.000	1.026	1.041	0.089	0.889	1.215
Observations	10				18			

Conditional3 model. Full sample. Schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.975	0.036	0.894	1.000	0.901	0.087	0.715	1.000
School efficiency	0.990	0.021	0.937	1.000	0.957	0.054	0.843	1.000
Program efficiency	0.984	0.035	0.894	1.024	0.940	0.054	0.817	1.000
Observations	10				18			

Conditional4 model. Full sample. Schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.998	0.003	0.992	1.000	0.968	0.051	0.854	1.000
School efficiency	0.995	0.016	0.950	1.000	0.987	0.030	0.872	1.000
Program efficiency	1.004	0.016	0.992	1.049	0.981	0.044	0.861	1.008
Observations	10				18			

Conditional5 model. Full sample. Schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.964	0.043	0.868	1.000	0.987	0.027	0.906	1.000
School efficiency	0.980	0.033	0.893	1.000	0.991	0.021	0.919	1.001
Program efficiency	0.984	0.044	0.868	1.018	0.996	0.024	0.906	1.020
Observations	10				18			

Conditional6 model. Full sample. Schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.990	0.012	0.973	1.000	0.979	0.036	0.843	1.000
School efficiency	0.992	0.016	0.957	1.000	0.965	0.049	0.854	1.000
Program efficiency	0.998	0.013	0.974	1.017	1.015	0.034	0.988	1.116

Observations	10				18			

Conditional7 model. Full sample. Schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.999	0.001	0.996	1.000	0.993	0.025	0.895	1.000
School efficiency	0.998	0.004	0.986	1.000	0.992	0.027	0.883	1.000
Program efficiency	1.001	0.005	0.998	1.014	1.000	0.005	0.989	1.013
Observations	10				18			

Conditional8 model. Full sample. Schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.999	0.002	0.994	1.000	1.000	0.001	0.996	1.000
School efficiency	0.999	0.001	0.996	1.000	0.999	0.004	0.982	1.000
Program efficiency	1.000	0.002	0.995	1.004	1.001	0.003	1.000	1.014
Observations	10				18			

m=5, 2 inputs (teaching hours per student, operating grants per student) and 4 outputs (Share of students with "A certificate", Share of students without problems of absenteeism, Share of students progressing through school, Share of students enrolled in higher education)

Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: Teacher seniority, Teacher diploma, School principal seniority

Conditional 4: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 5: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 6: School track (General), School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 7: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 8: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

E.6.2 Descriptive statistics of the efficiency scores excluding the schools in the Brussels-Capital Region (6% discontinuity sample).

Unconditional model. 6% discontinuity sample. Excluding schools in the Brussels-Capital Region

	Below threshold	*Above threshold*

	mean	sd	min	max	mean	sd	min	max	max
Overall efficiency	0.857	0.085	0.650	1.000	0.804	0.100	0.494	1.000	0.857
School efficiency	0.856	0.086	0.643	1.000	0.879	0.115	0.519	1.000	0.856
Program efficiency	1.002	0.003	1.000	1.010	0.917	0.055	0.727	1.000	1.002
Observations	65				68				

Conditional1 model. 6% discontinuity sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.905	0.090	0.679	1.000	0.839	0.108	0.503	1.000
School efficiency	0.899	0.084	0.676	1.000	0.913	0.107	0.547	1.000
Program efficiency	1.006	0.029	0.918	1.105	0.921	0.072	0.733	1.009
Observations	65				68			

Conditional2 model. 6% discontinuity sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.912	0.077	0.697	1.000	0.860	0.099	0.612	1.000
School efficiency	0.909	0.074	0.690	1.000	0.935	0.080	0.698	1.000
Program efficiency	1.004	0.019	0.913	1.074	0.920	0.069	0.776	1.001
Observations	65				68			

Conditional3 model. 6% discontinuity sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.930	0.084	0.716	1.000	0.891	0.115	0.519	1.000
School efficiency	0.908	0.089	0.672	1.000	0.906	0.112	0.519	1.000
Program efficiency	1.026	0.054	0.864	1.156	0.988	0.104	0.734	1.487
Observations	65				68			

Conditional4 model. 6% discontinuity sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.964	0.061	0.731	1.000	0.930	0.092	0.531	1.000

School efficiency	0.946	0.071	0.717	1.000	0.949	0.080	0.540	1.000
Program efficiency	1.020	0.045	0.938	1.179	0.982	0.070	0.762	1.249
Observations	65				68			

Conditional5 model. 6% discontinuity sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.921	0.078	0.733	1.000	0.919	0.089	0.491	1.000
School efficiency	0.921	0.077	0.735	1.000	0.953	0.077	0.524	1.000
Program efficiency	1.000	0.025	0.916	1.105	0.965	0.059	0.786	1.105
Observations	65				68			

Conditional6 model. 6% discontinuity sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.952	0.070	0.707	1.000	0.899	0.106	0.519	1.000
School efficiency	0.941	0.075	0.706	1.000	0.937	0.094	0.534	1.000
Program efficiency	1.013	0.036	0.920	1.125	0.963	0.103	0.767	1.451
Observations	65				68			

Conditional7 model. 6% discontinuity sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.987	0.024	0.902	1.000	0.963	0.052	0.780	1.000
School efficiency	0.984	0.028	0.888	1.000	0.989	0.024	0.878	1.000
Program efficiency	1.003	0.014	0.961	1.073	0.974	0.046	0.781	1.011
Observations	65				68			

Conditional8 model. 6% discontinuity sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.997	0.010	0.947	1.000	0.995	0.012	0.935	1.000
School efficiency	0.996	0.012	0.935	1.000	0.998	0.009	0.941	1.000
Program efficiency	1.001	0.005	0.971	1.013	0.998	0.009	0.940	1.010

Observations	65	68

m=40, 2 inputs (teaching hours per student, operating grants per student) and 4 outputs (Share of students with "A certificate", Share of students without problems of absenteeism, Share of students progressing through school, Share of students enrolled in higher education)

Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: Teacher seniority, Teacher diploma, School principal seniority

Conditional 4: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 5: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 6: School track (General), School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 7: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 8: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

E.6.3 Descriptive statistics of the efficiency scores excluding the schools in the Brussels-Capital Region (8% discontinuity sample).

Unconditional model. 8% discontinuity sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*				
	mean	sd	min	max	mean	sd	min	max	max
Overall efficiency	0.866	0.089	0.643	1.000	0.783	0.107	0.496	1.117	0.866
School efficiency	0.865	0.090	0.634	1.000	0.855	0.121	0.519	1.034	0.865
Program efficiency	1.001	0.002	1.000	1.013	0.919	0.053	0.717	1.080	1.001
Observations	86				104				

Conditional1 model. 8% discontinuity sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.908	0.080	0.705	1.000	0.846	0.097	0.516	1.000
School efficiency	0.903	0.081	0.680	1.000	0.905	0.106	0.609	1.000
Program efficiency	1.006	0.017	0.966	1.063	0.938	0.070	0.743	1.090
Observations	86				104			

Conditional2 model. 8% discontinuity sample. Excluding schools in the Brussels-Capital Region

	Below threshold	*Above threshold*

	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.919	0.071	0.725	1.000	0.862	0.093	0.631	1.000
School efficiency	0.918	0.072	0.689	1.000	0.935	0.080	0.665	1.000
Program efficiency	1.002	0.020	0.944	1.068	0.923	0.069	0.680	1.000
Observations	86				104			

Conditional3 model. 8% discontinuity sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.929	0.084	0.692	1.000	0.845	0.116	0.519	1.000
School efficiency	0.915	0.087	0.662	1.000	0.887	0.121	0.519	1.000
Program efficiency	1.017	0.029	0.956	1.110	0.957	0.081	0.702	1.338
Observations	86				104			

Conditional4 model. 8% discontinuity sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.965	0.059	0.704	1.000	0.915	0.103	0.544	1.000
School efficiency	0.953	0.065	0.737	1.000	0.955	0.073	0.569	1.000
Program efficiency	1.014	0.057	0.918	1.298	0.959	0.091	0.674	1.334
Observations	86				104			

Conditional5 model. 8% discontinuity sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.925	0.076	0.732	1.000	0.927	0.084	0.492	1.000
School efficiency	0.917	0.076	0.733	1.000	0.955	0.072	0.535	1.000
Program efficiency	1.008	0.025	0.980	1.134	0.971	0.059	0.789	1.230
Observations	86				104			

Conditional6 model. 8% discontinuity sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.948	0.072	0.696	1.000	0.868	0.105	0.519	1.000

School efficiency	0.931	0.076	0.683	1.000	0.927	0.094	0.592	1.000
Program efficiency	1.020	0.036	0.971	1.152	0.940	0.109	0.708	1.438
Observations	86				104			

Conditional7 model. 8% discontinuity sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.989	0.024	0.887	1.000	0.967	0.044	0.789	1.000
School efficiency	0.983	0.031	0.847	1.000	0.989	0.022	0.855	1.000
Program efficiency	1.006	0.013	0.971	1.047	0.978	0.037	0.790	1.017
Observations	86				104			

Conditional8 model. 8% discontinuity sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.996	0.008	0.956	1.000	0.994	0.014	0.922	1.000
School efficiency	0.996	0.010	0.953	1.000	0.997	0.008	0.941	1.000
Program efficiency	1.000	0.005	0.969	1.017	0.997	0.011	0.922	1.007
Observations	86				104			

m=40, 2 inputs (teaching hours per student, operating grants per student) and 4 outputs (Share of students with "A certificate", Share of students without problems of absenteeism, Share of students progressing through school, Share of students enrolled in higher education)

Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: Teacher seniority, Teacher diploma, School principal seniority

Conditional 4: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 5: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 6: School track (General), School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 7: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 8: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

E.6.4 Descriptive statistics of the efficiency scores excluding the schools in the Brussels-Capital Region (full sample).

Unconditional model. Full sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*				
	mean	sd	min	max	mean	sd	min	max	max
Overall efficiency	0.873	0.084	0.625	1.001	0.707	0.096	0.488	1.141	
School efficiency	0.873	0.085	0.618	1.001	0.792	0.112	0.519	1.120	
Program efficiency	1.001	0.001	1.000	1.012	0.896	0.047	0.649	1.068	
Observations	226				388				

Conditional1 model. Full sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.910	0.073	0.667	1.000	0.824	0.093	0.494	1.000
School efficiency	0.901	0.073	0.666	1.000	0.877	0.097	0.635	1.000
Program efficiency	1.010	0.024	0.970	1.218	0.942	0.067	0.533	1.078
Observations	226				388			

Conditional2 model. Full sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.918	0.066	0.677	1.000	0.857	0.090	0.633	1.000
School efficiency	0.909	0.069	0.661	1.000	0.898	0.091	0.665	1.000
Program efficiency	1.011	0.023	0.923	1.187	0.956	0.062	0.667	1.083
Observations	226				388			

Conditional3 model. Full sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.930	0.077	0.637	1.000	0.787	0.125	0.498	1.000
School efficiency	0.932	0.077	0.635	1.000	0.870	0.123	0.544	1.000
Program efficiency	0.998	0.007	0.916	1.006	0.907	0.088	0.609	1.208
Observations	226				388			

Conditional4 model. Full sample. Excluding schools in the Brussels-Capital Region

	Below threshold	*Above threshold*

	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.957	0.064	0.649	1.000	0.847	0.127	0.508	1.000
School efficiency	0.956	0.064	0.646	1.000	0.924	0.094	0.565	1.000
Program efficiency	1.001	0.013	0.924	1.098	0.918	0.116	0.626	1.348
Observations	226				388			

Conditional5 model. Full sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.903	0.074	0.669	1.000	0.928	0.083	0.491	1.000
School efficiency	0.908	0.073	0.711	1.000	0.936	0.077	0.545	1.000
Program efficiency	0.996	0.022	0.876	1.044	0.993	0.070	0.736	1.262
Observations	226				388			

Conditional6 model. Full sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.946	0.066	0.698	1.000	0.878	0.107	0.502	1.000
School efficiency	0.947	0.065	0.704	1.000	0.927	0.092	0.657	1.000
Program efficiency	0.999	0.010	0.926	1.041	0.948	0.081	0.606	1.163
Observations	226				388			

Conditional7 model. Full sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.977	0.039	0.744	1.000	0.966	0.055	0.695	1.000
School efficiency	0.972	0.044	0.745	1.000	0.979	0.044	0.746	1.000
Program efficiency	1.005	0.018	0.969	1.153	0.987	0.035	0.710	1.048
Observations	226				388			

Conditional8 model. Full sample. Excluding schools in the Brussels-Capital Region

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.981	0.033	0.807	1.000	0.994	0.017	0.845	1.000

School efficiency	0.986	0.029	0.800	1.000	0.993	0.020	0.891	1.000
Program efficiency	0.995	0.014	0.880	1.035	1.002	0.013	0.845	1.072
Observations	226				388			

m=40, 2 inputs (teaching hours per student, operating grants per student) and 4 outputs (Share of students with "A certificate", Share of students without problems of absenteeism, Share of students progressing through school, Share of students enrolled in higher education)

Conditional 1: School track (General), School size, % of students changing school, Previously treated school

Conditional 2: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: Teacher seniority, Teacher diploma, School principal seniority

Conditional 4: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 5: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 6: School track (General), School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 7: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 8: School track (General), School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

E.7 Efficiency scores by using Stochastic Frontier Model and panel data

Exploiting the panel structure of the data and estimating the Stochastic Frontier Model as an alternative estimation technique, provides similar outcomes as before. The 2 inputs and 4 outputs are the same as before. The specification of the function form follows a Fourier function, which is a flexible specification that includes quadratic and interaction terms. The specification is presented in the first part 'Frontier specification' of the table below. The second part of the table indicates that the panel model includes random effects, such that unobserved school heterogeneity is accounted for. The persistent efficiency component captures the resources that schools receive for GON. The most relevant part of the estimation concerns the 'transient efficiency component', which consists of three variables: the variable threshold, the GOK percentage and the interaction between these two variables. The latter is the key variable of interest. It suggests that schools above the threshold are significantly less efficient than schools below the threshold. Controlling for school size (Model 2) does not alter this finding.

Table 30. Estimates of the Stochastic Frontier Model (Fourier function specification). Second/third grade of secondary education. School years 2010/2011 - 2013/2014

Parameter	Model 1		Model 2	
Frontier specification				
Intercept	188.35	(<1e-9)	192.49	(<1e-9)
log(x2/x1)	-1.245	-8.00E-04	-7.006	-8.00E-04
log(x2/x1)*log(y1)	1.123	-0.204	1.888	-0.204
log(x2/x1)*log(y2)	-0.353	-0.101	-0.009	-0.101
log(x2/x1)*log(y3)	0.038	-0.522	0.044	-0.522
log(x2/x1)*log(y4)	0.124	-0.08	0.141	-0.08
log(x2/x1)²	-0.163	-0.006	-0.114	-0.006
log(y1)	-33.321	-1.00E-06	-33.96	-1.00E-06
log(y1)*log(y2)	2.34	(<1e-9)	2.289	(<1e-9)
log(y1)*log(y3)	0.28	(<1e-9)	0.401	(<1e-9)
log(y1)*log(y4)	0.018	-0.153	0.117	-0.153
log(y1)²	1.707	-2.00E-04	1.196	-2.00E-04
log(y2)	-50.317	(<1e-9)	-43.226	(<1e-9)
log(y2)*log(y3)	-0.59	(<1e-9)	-0.664	(<1e-9)
log(y2)*log(y4)	-0.032	-5.00E-05	-0.148	-5.00E-05
log(y2)²	4.866	-3.00E-04	3.954	-3.00E-04
log(y3)	0.62	-0.764	0.169	-0.764
log(y3)*log(y4)	0.048	-0.005	0.059	-0.005
log(y3)²	0.076	-3.00E-05	0.103	-3.00E-05
log(y4)	-0.796	-0.057	-0.892	-0.057

log(y4)²	6.70E-04	-0.103	0.003	-0.103
time	-0.05	-0.002	-0.051	-0.002
time²	0.011	-0.242	0.012	-0.242
Random effects component				
Intercept	-6.646	-0.204	-6.835	-0.204
Persistent efficiency component				
Intercept	-4.97	-0.007	-4.7	-0.007
GONschool	0.117	(<1e-9)	0.073	(<1e-9)
Transient underachievement component				
Intercept	-13.396	-1.00E-06	-3.196	-1.00E-06
Threshold	0.51	-0.764	0.309	-0.764
GOKpercentage	32.931	(<1e-9)	18.54	(<1e-9)
GOKpercentagecntr * Threshold	**-31.366**	**-0.057**	**-17.809**	**-0.006**
log(school_size)			-1.03	-0.057
Random noise component				
Intercept	-5.447	-8.00E-04	-5.559	-8.00E-04
N	642		642	
Sim LogL	2381		2390	

Note: Standard errors between parantheses.

Appendix F: Results for the first grade of secondary education for 6% discontinuity sample and full sample.

F.1 Variable sample means for control/treated group and population

Table 31. Sample means for control/treated group and population. Input and output variables. 6% discontinuity sample. First grade of secondary education

	Below threshold		*Above threshold*		Full sample		*p*-value
Inputs							
Teaching hours per student	1.746	(0.167)	1.804	(0.230)	1.778	(0.205)	0.1266
Operating grants per student	823.8	(73.61)	834.2	(83.35)	829.5	(78.97)	0.4833
Outputs							
Share of students with "A certificate"	91.05	(4.932)	92.45	(4.122)	91.82	(4.537)	0.0989
Share of students without problems of absenteeism	99.98	(0.122)	99.97	(0.125)	99.97	(0.123)	0.7725
Share of students progressing through school	98.75	(1.134)	98.88	(1.495)	98.82	(1.341)	0.6000
Observations	52		64		116		

Standard deviation in parentheses. *p*-values obtained from t-test to examine whether the control and the treated group variables are statistically different in means.

Table 32. Sample means for control/treated group and population. Input and output variables. Full sample. First grade of secondary education

	Below threshold		*Above threshold*		Full sample		*p*-value
Inputs							
Teaching hours per student	1.742	(0.170)	2.461	(0.816)	2.401	(0.807)	**0.0000**
Operating grants per student	820.5	(75.92)	983.6	(238.8)	970.0	(234.1)	**0.0000**
Outputs							
Share of students with "A certificate"	90.80	(5.461)	84.57	(12.48)	85.09	(12.18)	**0.0003**
Share of students without problems of absenteeism	99.98	(0.120)	98.96	(2.350)	99.04	(2.268)	**0.0015**
Share of students progressing through school	98.71	(1.228)	96.86	(3.030)	97.02	(2.966)	**0.0000**
Observations	54		595		649		

Standard deviation in parentheses. *p*-values obtained from t-test to examine whether the control and the treated group variables are statistically different in means.

Table 33. Sample means for control/treated group and population. Control variables. 6% discontinuity sample. First grade of secondary education

	Control		Treated		Total		p-value
School size (log)	6.055	(0.768)	6.011	(0.647)	6.031	(0.701)	0.7402
Share of students changing school	0.231	(0.164)	0.154	(0.139)	0.189	(0.155)	**0.0068**
Previously treated school	0.0769	(0.269)	0.547	(0.502)	0.336	(0.474)	**0.0000**
School type							0.198
GO	0.000		0.000				
OGO	0.000		0.031				
VGO	1.000		0.969				
School with special need students	0.192	(0.398)	0.297	(0.460)	0.250	(0.435)	0.1991
Teacher seniority	3.904	(0.348)	3.995	(0.290)	3.954	(0.319)	0.1261
Teacher diploma	0.981	(0.0258)	0.983	(0.0238)	0.982	(0.0246)	0.6268
School principal seniority	5.769	(1.266)	5.776	(1.138)	5.773	(1.192)	0.9757
Teacher age	4.051	(0.333)	4.088	(0.295)	4.071	(0.312)	0.5302
Teacher full-time	0.189	(0.155)	0.219	(0.166)	0.206	(0.161)	0.3168
Female teachers	0.589	(0.117)	0.628	(0.0948)	0.611	(0.107)	**0.0480**
Share of students with grade retention in primary school	0.0330	(0.0200)	0.0452	(0.0298)	0.0397	(0.0265)	**0.0133**
Share of special need students in primary school	0.000402	(0.00233)	0.00185	(0.00714)	0.00120	(0.00556)	0.1638
Share of male students	0.497	(0.114)	0.450	(0.0939)	0.472	(0.106)	**0.0166**
Share of disadvantaged students	0.0756	(0.0144)	0.132	(0.0183)	0.107	(0.0329)	**0.0000**
Observations	52		64		116		

Standard deviation in parentheses. *p*-values obtained from t-test to examine whether the control and the treated group variables are statistically different in means.

Table 34. Sample means for control/treated group and population. Control variables. Full sample. First grade of secondary education

	Control		Treated		Total		p-value
School size (log)	6.033	(0.767)	5.896	(0.662)	5.908	(0.672)	0.1523
Share of students changing school	0.231	(0.164)	0.115	(0.108)	0.124	(0.118)	**0.0000**
Previously treated school	0.0741	(0.264)	0.852	(0.355)	0.787	(0.409)	**0.0000**
School type							**0.0000**
GO	0.000		0.229				
OGO	0.000		0.089				
VGO	1.000		0.682				
School with special need students	0.204	(0.407)	0.464	(0.499)	0.442	(0.497)	**0.0002**
Teacher seniority	3.923	(0.356)	3.868	(0.431)	3.873	(0.425)	0.3608
Teacher diploma	0.981	(0.0255)	0.960	(0.0433)	0.962	(0.0425)	**0.0005**
School principal seniority	5.722	(1.269)	5.570	(1.114)	5.582	(1.128)	0.3418
Teacher age	4.078	(0.358)	4.110	(0.360)	4.107	(0.360)	0.5345
Teacher full-time	0.187	(0.155)	0.260	(0.137)	0.254	(0.140)	**0.0003**
Female teachers	0.590	(0.117)	0.594	(0.129)	0.594	(0.128)	0.8004
Share of students with grade retention in primary school	0.0328	(0.0197)	0.220	(0.138)	0.204	(0.142)	**0.0000**
Share of special need students in primary school	0.000387	(0.00229)	0.0540	(0.0660)	0.0496	(0.0649)	**0.0000**
Share of male students	0.501	(0.116)	0.520	(0.210)	0.518	(0.204)	0.5047
Share of disadvantaged students	0.0742	(0.0158)	0.374	(0.188)	0.349	(0.198)	**0.0000**
Observations	54		595		649		

Standard deviation in parentheses. *p*-values obtained from t-test to examine whether the control and the treated group variables are statistically different in means.

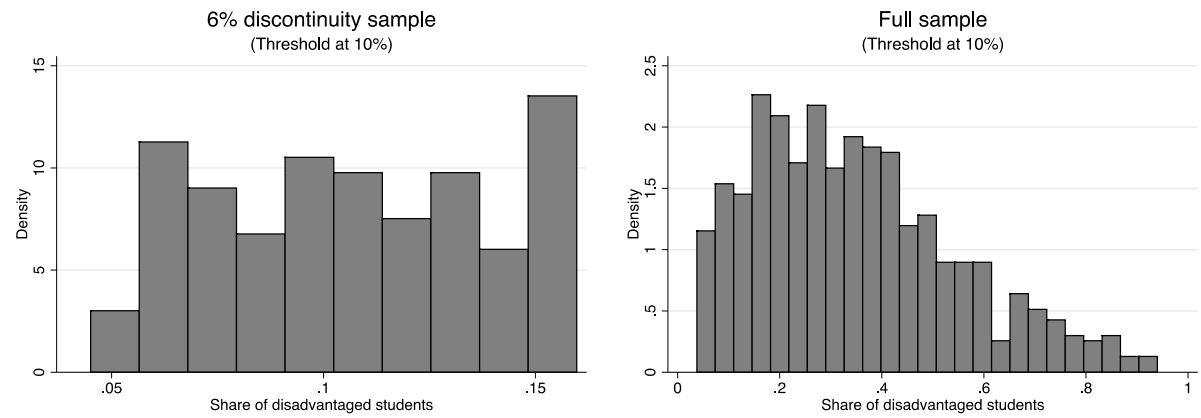


Figure 9. Frequency distribution of the schools with respect to the share of disadvantaged students for the 6% discontinuity sample (left) and for the full sample (right)

F.2 Descriptive statistics of the efficiency scores

F.2.1 For the 6% discontinuity sample

Unconditional model. 6% discontinuity sample. First grade of secondary education

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.797	0.084	0.613	1.106	0.772	0.083	0.629	1.079
School efficiency	0.902	0.076	0.644	1.150	0.750	0.095	0.598	1.049
Program efficiency	0.883	0.056	0.748	1.000	1.032	0.038	0.821	1.065
Observations	52				64			

Conditional1 model. 6% discontinuity sample. First grade of secondary education

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.914	0.090	0.645	1.000	0.907	0.081	0.723	1.000
School efficiency	0.959	0.057	0.728	1.001	0.907	0.095	0.629	1.000
Program efficiency	0.952	0.066	0.728	1.046	1.003	0.062	0.893	1.275
Observations	52				64			

Conditional2 model. 6% discontinuity sample. First grade of secondary education

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.914	0.085	0.645	1.000	0.914	0.084	0.639	1.000
School efficiency	0.946	0.067	0.710	1.000	0.915	0.091	0.629	1.000
Program efficiency	0.967	0.075	0.802	1.174	1.000	0.049	0.851	1.225
Observations	52				64			

Conditional3 model. 6% discontinuity sample. First grade of secondary education

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.921	0.083	0.574	1.017	0.891	0.088	0.678	1.001
School efficiency	0.938	0.056	0.808	1.000	0.913	0.091	0.672	1.000
Program efficiency	0.982	0.075	0.664	1.196	0.978	0.058	0.799	1.154

Observations	52				64			

Conditional4 model. 6% discontinuity sample. First grade of secondary education

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.956	0.056	0.810	1.000	0.942	0.071	0.743	1.000
School efficiency	0.975	0.040	0.792	1.000	0.958	0.065	0.752	1.000
Program efficiency	0.981	0.056	0.849	1.246	0.984	0.029	0.896	1.039
Observations	52				64			

Conditional5 model. 6% discontinuity sample. First grade of secondary education

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.816	0.107	0.544	1.000	0.824	0.103	0.602	1.002
School efficiency	0.920	0.069	0.721	1.015	0.806	0.116	0.597	1.002
Program efficiency	0.885	0.079	0.735	1.013	1.027	0.052	0.821	1.164
Observations	52				64			

Conditional6 model. 6% discontinuity sample. First grade of secondary education

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.932	0.081	0.576	1.001	0.938	0.077	0.657	1.000
School efficiency	0.951	0.052	0.834	1.002	0.944	0.076	0.675	1.000
Program efficiency	0.981	0.072	0.691	1.129	0.994	0.037	0.840	1.138
Observations	52				64			

Conditional7 model. 6% discontinuity sample. First grade of secondary education

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.987	0.020	0.905	1.000	0.974	0.047	0.817	1.000
School efficiency	0.989	0.022	0.904	1.000	0.972	0.047	0.801	1.000
Program efficiency	0.997	0.013	0.949	1.038	1.002	0.023	0.908	1.078
Observations	52				64			

Conditional8 model. 6% discontinuity sample. First grade of secondary education

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.988	0.020	0.905	1.000	0.982	0.041	0.815	1.000
School efficiency	0.992	0.020	0.904	1.000	0.983	0.038	0.831	1.000
Program efficiency	0.996	0.013	0.953	1.032	0.999	0.017	0.918	1.027
Observations	52				64			

m=40, 2 inputs (teaching hours per student, operating grants per student) and 3 outputs (Share of students with "A certificate", Share of students without problems of absenteeism, Share of students progressing through school)

Conditional 1: School size, % of students changing school, Previously treated school

Conditional 2: School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: Teacher seniority, Teacher diploma, School principal seniority

Conditional 4: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 5: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 6: School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 7: School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 8: School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

F.2.2 For the full sample

Unconditional model. Full sample. First grade of secondary education

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8488	0.0837	0.6600	1.1784	0.7315	0.1252	0.1441	1.3678
School efficiency	0.8732	0.0799	0.6337	1.1390	0.7384	0.1266	0.1458	1.3714
Program efficiency	0.9724	0.0387	0.8846	1.0415	0.9907	0.0099	0.9130	1.0079
Observations	54				595			

Conditional1 model. Full sample. First grade of secondary education

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9149	0.0807	0.6968	1.0038	0.8112	0.1412	0.1781	1.0511

School efficiency	0.9529	0.0620	0.7158	1.0007	0.8134	0.1419	0.1780	1.0566
Program efficiency	0.9602	0.0575	0.7357	1.0222	0.9975	0.0178	0.8632	1.0615
Observations	54				595			

Conditional2 model. Full sample. First grade of secondary education

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9181	0.0746	0.7157	1.0000	0.8456	0.1309	0.3074	1.0216
School efficiency	0.9401	0.0678	0.7111	1.0000	0.8461	0.1313	0.3028	1.0255
Program efficiency	0.9783	0.0658	0.8374	1.1197	0.9997	0.0193	0.8623	1.1858
Observations	54				595			

Conditional3 model. Full sample. First grade of secondary education

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8967	0.0990	0.6376	1.0120	0.8047	0.1452	0.1736	1.0451
School efficiency	0.9461	0.0647	0.7615	1.0000	0.8114	0.1460	0.1746	1.0330
Program efficiency	0.9468	0.0699	0.6979	1.0283	0.9924	0.0309	0.7909	1.0468
Observations	54				595			

Conditional4 model. Full sample. First grade of secondary education

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9462	0.0719	0.6795	1.0000	0.8761	0.1277	0.1803	1.0001
School efficiency	0.9697	0.0450	0.8227	1.0000	0.8886	0.1215	0.1834	1.0000
Program efficiency	0.9758	0.0594	0.6956	1.0387	0.9908	0.1164	0.6789	1.7809
Observations	54				595			

Conditional5 model. Full sample. First grade of secondary education

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8189	0.0970	0.5750	1.0104	0.8738	0.1178	0.3969	1.0427
School efficiency	0.8969	0.0787	0.7188	1.0125	0.8710	0.1199	0.3829	1.0273
Program efficiency	0.9133	0.0733	0.6645	1.0104	1.0040	0.0197	0.9053	1.1517

Observations	54				595			

Conditional6 model. Full sample. First grade of secondary education

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9474	0.0626	0.7865	1.0004	0.8719	0.1252	0.1805	1.0212
School efficiency	0.9468	0.0537	0.8130	1.0017	0.8778	0.1245	0.1796	1.0232
Program efficiency	1.0017	0.0560	0.7989	1.1302	0.9933	0.0192	0.8471	1.0451
Observations	54				595			

Conditional7 model. Full sample. First grade of secondary education

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9842	0.0257	0.8708	1.0000	0.9498	0.0786	0.4671	1.0000
School efficiency	0.9895	0.0215	0.9038	1.0000	0.9505	0.0785	0.4676	1.0000
Program efficiency	0.9949	0.0280	0.8860	1.0771	0.9994	0.0146	0.7513	1.0351
Observations	54				595			

Conditional8 model. Full sample. First grade of secondary education

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9754	0.0378	0.8218	1.0000	0.9872	0.0302	0.7956	1.0000
School efficiency	0.9925	0.0192	0.9037	1.0000	0.9863	0.0310	0.7831	1.0000
Program efficiency	0.9828	0.0357	0.8218	1.0392	1.0010	0.0070	0.9426	1.0419
Observations	54				595			

m=40, 2 inputs (teaching hours per student, operating grants per student) and 3 outputs (Share of students with "A certificate", Share of students without problems of absenteeism, Share of students progressing through school)

Conditional 1: School size, % of students changing school, Previously treated school

Conditional 2: School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: Teacher seniority, Teacher diploma, School principal seniority

Conditional 4: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 5: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 6: School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 7: School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 8: School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

F.3 Descriptive statistics of the efficiency scores (excluding eligible but not treated schools)

F.3.1 For the 6% discontinuity sample

Unconditional model. 6% discontinuity sample.

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.906	0.076	0.656	1.178	0.873	0.065	0.710	0.982
School efficiency	0.902	0.076	0.644	1.150	0.934	0.065	0.741	1.002
Program efficiency	1.005	0.006	1.000	1.024	0.935	0.026	0.900	0.979
Observations	52				21			

Conditional1 model. 6% discontinuity sample.

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.962	0.056	0.716	1.001	0.928	0.076	0.745	1.000
School efficiency	0.959	0.057	0.728	1.001	0.974	0.035	0.890	1.000
Program efficiency	1.004	0.017	0.979	1.097	0.953	0.078	0.747	1.017
Observations	52				21			

Conditional2 model. 6% discontinuity sample.

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.962	0.057	0.714	1.000	0.938	0.072	0.753	1.000
School efficiency	0.946	0.067	0.710	1.000	0.975	0.035	0.890	1.000
Program efficiency	1.018	0.044	0.960	1.200	0.963	0.071	0.758	1.020
Observations	73							

Conditional3 model. 6% discontinuity sample.

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.955	0.059	0.780	1.000	0.929	0.081	0.699	1.000

School efficiency	0.938	0.056	0.808	1.000	0.961	0.056	0.782	1.000
Program efficiency	1.018	0.044	0.899	1.173	0.966	0.051	0.862	1.077
Observations	52				21			

Conditional4 model. 6% discontinuity sample.

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.970	0.046	0.799	1.000	0.961	0.057	0.781	1.000
School efficiency	0.975	0.040	0.792	1.000	0.974	0.051	0.788	1.000
Program efficiency	0.994	0.030	0.914	1.088	0.987	0.031	0.896	1.047
Observations	52				21			

Conditional5 model. 6% discontinuity sample.

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.919	0.069	0.722	1.015	0.937	0.059	0.809	1.000
School efficiency	0.920	0.069	0.721	1.015	0.948	0.060	0.776	1.000
Program efficiency	0.999	0.029	0.820	1.055	0.991	0.082	0.902	1.275
Observations	52				21			

Conditional6 model. 6% discontinuity sample.

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.954	0.048	0.857	1.007	0.929	0.071	0.741	1.000
School efficiency	0.951	0.052	0.834	1.002	0.974	0.036	0.887	1.000
Program efficiency	1.003	0.015	0.963	1.050	0.953	0.061	0.836	1.093
Observations	52				21			

Conditional7 model. 6% discontinuity sample.

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.989	0.022	0.904	1.000	0.982	0.030	0.889	1.000
School efficiency	0.989	0.022	0.904	1.000	0.990	0.017	0.943	1.000
Program efficiency	0.999	0.011	0.940	1.028	0.992	0.025	0.889	1.011

Observations	52				21			

Conditional8 model. 6% discontinuity sample.

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.985	0.027	0.872	1.000	0.992	0.020	0.939	1.000
School efficiency	0.992	0.020	0.904	1.000	0.995	0.013	0.941	1.000
Program efficiency	0.993	0.020	0.920	1.057	0.996	0.016	0.947	1.017
Observations	52				21			

m=40, 2 inputs (teaching hours per student, operating grants per student) and 3 outputs (Share of students with "A certificate", Share of students without problems of absenteeism, Share of students progressing through school)

Conditional 1: School size, % of students changing school, Previously treated school

Conditional 2: School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: Teacher seniority, Teacher diploma, School principal seniority

Conditional 4: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 5: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 6: School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 7: School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 8: School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

F.3.2 For the full sample

Unconditional model. Full sample.

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9053	0.0803	0.6856	1.2428	0.7562	0.1305	0.1562	1.4040
School efficiency	0.8732	0.0799	0.6337	1.1390	0.7841	0.1367	0.1693	1.4215
Program efficiency	1.0374	0.0208	1.0001	1.0911	0.9650	0.0207	0.8507	1.0000
Observations	54				522			

Conditional1 model. Full sample.

	Below threshold	*Above threshold*

	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9530	0.0617	0.7299	1.0006	0.8092	0.1386	0.1783	1.0533
School efficiency	0.9529	0.0620	0.7158	1.0007	0.8154	0.1385	0.1783	1.0591
Program efficiency	1.0002	0.0096	0.9644	1.0390	0.9929	0.0353	0.6645	1.0588
Observations	576							

Conditional2 model. Full sample.

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9506	0.0631	0.7235	1.0000	0.8514	0.1293	0.3037	1.0303
School efficiency	0.9401	0.0678	0.7111	1.0000	0.8577	0.1284	0.3050	1.0332
Program efficiency	1.0123	0.0364	0.9388	1.1387	0.9930	0.0348	0.6647	1.1442
Observations	54				522			

Conditional3 model. Full sample.

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9404	0.0653	0.7672	1.0144	0.8303	0.1366	0.1744	1.0730
School efficiency	0.9461	0.0647	0.7615	1.0000	0.8529	0.1332	0.1778	1.0466
Program efficiency	0.9943	0.0274	0.8877	1.0388	0.9735	0.0455	0.7230	1.0695
Observations	54				522			

Conditional4 model. Full sample.

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9675	0.0478	0.7722	1.0000	0.8877	0.1206	0.1878	1.0000
School efficiency	0.9697	0.0450	0.8227	1.0000	0.8998	0.1168	0.1853	1.0000
Program efficiency	0.9985	0.0449	0.8670	1.0924	0.9864	0.0352	0.7717	1.0500
Observations	576							

Conditional5 model. Full sample.

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.8941	0.0779	0.6934	1.0688	0.8907	0.1052	0.4860	1.0483

School efficiency	0.8969	0.0787	0.7188	1.0125	0.8938	0.1045	0.4834	1.0355
Program efficiency	0.9982	0.0477	0.6951	1.0573	0.9969	0.0309	0.8407	1.1607
Observations	54				522			

Conditional6 model. Full sample.

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9656	0.0513	0.8047	1.0000	0.8747	0.1254	0.1785	1.0175
School efficiency	0.9468	0.0537	0.8130	1.0017	0.8809	0.1248	0.1785	1.0191
Program efficiency	1.0211	0.0476	0.8816	1.1591	0.9933	0.0290	0.6610	1.0264
Observations	54				522			

Conditional7 model. Full sample.

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9898	0.0244	0.8602	1.0000	0.9510	0.0794	0.4714	1.0000
School efficiency	0.9895	0.0215	0.9038	1.0000	0.9514	0.0798	0.4629	1.0000
Program efficiency	1.0005	0.0256	0.8752	1.0746	0.9998	0.0155	0.7469	1.0455
Observations	54				522			

Conditional8 model. Full sample.

	Below threshold				*Above threshold*			
	mean	sd	min	max	mean	sd	min	max
Overall efficiency	0.9880	0.0301	0.8236	1.0000	0.9878	0.0286	0.7847	1.0000
School efficiency	0.9925	0.0192	0.9037	1.0000	0.9868	0.0300	0.7666	1.0000
Program efficiency	0.9955	0.0269	0.8236	1.0538	1.0011	0.0074	0.8979	1.0274
Observations	54				522			

m=40, 2 inputs (teaching hours per student, operating grants per student) and 3 outputs (Share of students with "A certificate", Share of students without problems of absenteeism, Share of students progressing through school)

Conditional 1: School size, % of students changing school, Previously treated school

Conditional 2: School size, % of students changing school, Previously treated school, School type, School with special need students

Conditional 3: Teacher seniority, Teacher diploma, School principal seniority

Conditional 4: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 5: % students with problems in primary school, % students with special needs in primary school, % male students

Conditional 6: School size, % of students changing school, Previously treated school, Teacher seniority & diploma

Conditional 7: School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority

Conditional 8: School size, % of students changing school, Previously treated school, School type, School with special need students, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with problems in primary school, % students with special needs in primary school, % male students

Appendix G: Results for primary education by the Brussels-Capital Region.

In the following, we present the results of the efficiency analysis when considering only those primary schools that belong to the Brussels-Capital Region or alternatively excluding these schools and focusing only on the others. We consider one input (*Teaching hours per student*), three outputs (*Share of students progressing in primary school*, the *Share of students in A-stream (I year)* and the *Share of students progressing in secondary school (I-II-III year)*), three groups of contextual variables (School, Teacher and Student characteristics).

Section G.1 reports the efficiency scores obtained by estimating the educational production frontier for 108 primary schools, i.e. only the schools in the Brussels-Capital Region, in 2012 and 2013 respectively, using an input-oriented robust FDH model: as for the choice of *m*, a sensitivity analysis shows that *m=20* is warranted. Section G.2 lists the efficiency scores obtained by estimating the educational production frontier for 1986 primary schools, i.e. excluding the schools in the Brussels-Capital Region, in 2012 and 2013 respectively, using an input-oriented robust FDH model: as for the choice of *m*, a sensitivity analysis shows that *m=300* is warranted.

G.1 Descriptive statistics of the efficiency scores for the schools in the Brussels-Capital Region

G.1.1 Descriptive statistics of the efficiency scores for the schools in the Brussels-Capital Region. 2012

Model specification	mean	sd	min	max
Unconditional	0.8891	0.0889	0.5421	1.0466
Conditional 1 (School characteristics)	0.9270	0.0704	0.7347	1.0001
Conditional 2 (Student characteristics)	0.9265	0.0776	0.5613	1.0058
Conditional 3 (Student characteristics)	0.9657	0.0493	0.8028	1.0000
Conditional 4 (Student characteristics)	0.9338	0.0862	0.5578	1.0001
Conditional 4 bis (Student characteristics)	0.9627	0.0603	0.7590	1.0007
Conditional 5 (Teacher characteristics)	0.9351	0.0809	0.6296	1.0001
Conditional 6 (Teacher characteristics)	0.9613	0.0589	0.7298	1.0000
Conditional 7 (School & Teacher characteristics)	0.9564	0.0656	0.6834	1.0000
Conditional 8 (School & Teacher characteristics)	0.9859	0.0246	0.8673	1.0000
Conditional 9 (School & Teacher & Student characteristics)	0.9907	0.0220	0.8658	1.0000
Observations (school level)	108			

Conditional 1: School type, School size, % of students changing school

Conditional 2: % of disadvantaged students

Conditional 3: % SES – allowance, % SES students - no Dutch, % SES students - mother's education

Conditional 4: % students with special needs in primary school, % of students in kindergarten, % male students

Conditional 4 bis: % students with special needs in primary school, % of students in kindergarten (3 years or more), % male students

Conditional 5: Teacher seniority, Teacher diploma, School principal seniority

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 7: School type, School size, % of students changing school, Teacher seniority, Teacher diploma, School principal seniority

Conditional 8: School type, School size, % of students changing school, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 9: School type, School size, % of students changing school, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with special needs in primary school, % male students

G.1.2 Descriptive statistics of the efficiency scores for the schools in the Brussels-Capital Region. 2013

Model specification	mean	sd	min	max
Unconditional	0.8869	0.0881	0.5514	1.0471
Conditional 1 (School characteristics)	0.9324	0.0715	0.7309	1.0014
Conditional 2 (Student characteristics)	0.9335	0.0687	0.5966	1.0001
Conditional 3 (Student characteristics)	0.9515	0.0565	0.7516	1.0000
Conditional 4 (Student characteristics)	0.9438	0.0847	0.5584	1.0001
Conditional 4 bis (Student characteristics)	0.9488	0.0759	0.7328	1.0001
Conditional 5 (Teacher characteristics)	0.9318	0.0814	0.6863	1.0000
Conditional 6 (Teacher characteristics)	0.9555	0.0687	0.6960	1.0000
Conditional 7 (School & Teacher characteristics)	0.9564	0.0659	0.7253	1.0000
Conditional 8 (School & Teacher characteristics)	0.9796	0.0429	0.7550	1.0000
Conditional 9 (School & Teacher & Student characteristics)	0.9916	0.0258	0.8099	1.0000
Observations (school level)	108			

Conditional 1: School type, School size, % of students changing school

Conditional 2: % of disadvantaged students

Conditional 3: % SES – allowance, % SES students - no Dutch, % SES students - mother's education

Conditional 4: % students with special needs in primary school, % of students in kindergarten, % male students

Conditional 4 bis: % students with special needs in primary school, % of students in kindergarten (3 years or more), % male students

Conditional 5: Teacher seniority, Teacher diploma, School principal seniority

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 7: School type, School size, % of students changing school, Teacher seniority, Teacher diploma, School principal seniority

Conditional 8: School type, School size, % of students changing school, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 9: School type, School size, % of students changing school, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with special needs in primary school, % male students

G.2 Descriptive statistics of the efficiency scores excluding the schools in the Brussels-Capital Region

G.2.1 Descriptive statistics of the efficiency scores excluding the schools in the Brussels-Capital Region. 2012

Model specification	mean	sd	min	max
Unconditional	0.8164	0.0888	0.4143	1.0126
Conditional 1 (School characteristics)	0.8933	0.0877	0.5664	1.0000
Conditional 2 (Student characteristics)	0.8779	0.0804	0.5319	1.0001
Conditional 3 (Student characteristics)	0.8936	0.0793	0.5407	1.0000
Conditional 4 (Student characteristics)	0.8492	0.0856	0.4823	1.0000
Conditional 4 bis (Student characteristics)	0.8503	0.0840	0.4805	1.0000
Conditional 5 (Teacher characteristics)	0.8623	0.0973	0.4255	1.0002
Conditional 6 (Teacher characteristics)	0.8997	0.0944	0.4539	1.0000
Conditional 7 (School & Teacher characteristics)	0.8965	0.0906	0.5446	1.0000
Conditional 8 (School & Teacher characteristics)	0.9053	0.0869	0.5629	1.0000
Conditional 9 (School & Teacher & Student characteristics)	0.9239	0.0769	0.6003	1.0000
Observations (school level)	1986			

Conditional 1: School type, School size, % of students changing school

Conditional 2: % of disadvantaged students

Conditional 3: % SES – allowance, % SES students - no Dutch, % SES students - mother's education

Conditional 4: % students with special needs in primary school, % of students in kindergarten, % male students

Conditional 4 bis: % students with special needs in primary school, % of students in kindergarten (3 years or more), % male students

Conditional 5: Teacher seniority, Teacher diploma, School principal seniority

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 7: School type, School size, % of students changing school, Teacher seniority, Teacher diploma, School principal seniority

Conditional 8: School type, School size, % of students changing school, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 9: School type, School size, % of students changing school, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with special needs in primary school, % male students

G.2.2 Descriptive statistics of the efficiency scores excluding the schools in the Brussels-Capital Region. 2013

Model specification	mean	sd	min	max
Unconditional	0.8087	0.0904	0.2924	1.0104

Conditional 1 (School characteristics)	0.8729	0.0871	0.5172	1.0000
Conditional 2 (Student characteristics)	0.8666	0.0753	0.3760	1.0000
Conditional 3 (Student characteristics)	0.8770	0.0782	0.5014	1.0000
Conditional 4 (Student characteristics)	0.8470	0.0840	0.3783	1.0000
Conditional 4 bis (Student characteristics)	0.8475	0.0826	0.4432	1.0000
Conditional 5 (Teacher characteristics)	0.8408	0.0997	0.2848	1.0001
Conditional 6 (Teacher characteristics)	0.8820	0.0994	0.3110	1.0000
Conditional 7 (School & Teacher characteristics)	0.8780	0.0944	0.5306	1.0000
Conditional 8 (School & Teacher characteristics)	0.8864	0.0931	0.5143	1.0000
Conditional 9 (School & Teacher & Student characteristics)	0.9086	0.0838	0.5574	1.0000
Observations (school level)	1986			

Conditional 1: School type, School size, % of students changing school

Conditional 2: % of disadvantaged students

Conditional 3: % SES – allowance, % SES students - no Dutch, % SES students - mother's education

Conditional 4: % students with special needs in primary school, % of students in kindergarten, % male students

Conditional 4 bis: % students with special needs in primary school, % of students in kindergarten (3 years or more), % male students

Conditional 5: Teacher seniority, Teacher diploma, School principal seniority

Conditional 6: Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 7: School type, School size, % of students changing school, Teacher seniority, Teacher diploma, School principal seniority

Conditional 8: School type, School size, % of students changing school, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers

Conditional 9: School type, School size, % of students changing school, Teacher seniority, Teacher diploma, School principal seniority, Teacher age, Teacher type of contract, % female teachers, % students with special needs in primary school, % male students