

Efficiency in Education

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1. Introduction

Education is now widely considered as a key factor for the productivity and welfare of countries and individuals. In the last decades many countries have increased their spending on education (OECD, 2011). Although the benefits of education have been documented in many studies the increase in spending has also raised concerns. Various researchers have noted a divergence in the pattern of spending and the pattern of performance over time. For instance, Hanushek and Hoxby (2009) show that per pupil spending in the US more than doubled since 1970. However, this spending does not seem to translate into a clear improvement of student performance. For the US performance in primary and secondary education seems not to be improving. A recent study for the Netherlands shows a similar pattern (Kuhry, et al. 2012). Per pupil spending on primary and secondary education increased yearly with 4.1 % and 3.5 % per year¹. In addition, they find no clear evidence for an improvement of performance in these education sectors. The divergence in spending and performance has been interpreted as a signal of inefficiency within the education sector (Kuhry, 2012). In periods of tight governmental budgets these findings and interpretations might have large policy consequences. However, a decrease of educational spending might also be harmful for the production of human capital. Considering the high potential benefits of education ‘penny wise’ policies might also be ‘pound foolish’ policies. This essay takes a closer look at efficiency in education.

The concept of efficiency is important for many discussions about educational policy but often introduces a lot of confusion. Discussions on efficiency in education are not new and can be traced back to the famous Coleman-report from 1966 (Coleman et al. 1966). The first part of the essay aims to clarify the concept and sketches how the concept has been used in studies on the educational production function. Next, different approaches for assessing the efficiency of education are introduced and recent findings for Dutch education are discussed. The final part of the essay touches on educational policies. Why there might be inefficiency in education and what do we know about various policy instruments? The last section discusses implications and challenges for educational policies.

¹ The spending figures are adjusted for inflation.

2. Defining the concept of efficiency

The concept of efficiency is about the relationship between inputs and outputs in a production process. When the production process is characterized by multiple inputs and multiple outputs, like the education sector, a situation can be defined as ‘efficient’ when it is not possible to produce more of some outputs without a reduction in the production of the other outputs. A different allocation of the inputs may yield more of some outputs but will also lead to a lower production of some of the other outputs. A situation can be defined as inefficient when, using the same amount of inputs, it is possible to produce more of some outputs without reducing the production of other outputs. Hence, the concept of efficiency is about the optimal use of resources. The two main types of efficiency that can be distinguished are²:

- Output efficiency: producing more outputs with the same inputs
- Input efficiency: producing the same outputs with fewer inputs.

Figure 1 shows the relationship between inputs and outputs. The upward sloping line shows the maximum output than can be achieved with a certain amount of inputs: the production frontier. Inefficient producers (schools or countries) are shown below this line. These producers achieve less with their inputs than the level that could be achieved according to the production frontier. The input efficiency of this inefficient producer refers to the amount of inputs needed to produce the same output. The output efficiency of this inefficient producer refers to the amount that can be produced with the same amount of inputs. Hence, improving efficiency means that more outputs are produced or less inputs are used for the same amount of output. This leads to an improvement of the welfare of society.

Include figure 1 (see appendix)

The relationship among the different inputs into and outcomes of the educational process is called the education production function. Studies of education production functions examine

² In the literature more types of efficiency are distinguished, such as allocative efficiency, X-efficiency, Pareto-efficiency. These concepts are all related to input or output efficiency.

the influence of various input factors on student performance. It is important to note that inputs of the education process not only include financial resources but also factors such as the social background, ability and educational history of the students. Estimates of the effect of these input factors on the outcomes are informative about the efficiency of the education system. A huge literature exists on the effects of educational resources on student performance. These studies typically estimate the effects of school resources on student performance, as measured by test scores, in models including characteristics of schools, teachers, pupils and parents. This line of research started with Equality of educational opportunity, the famous Coleman-report (Coleman et al., 1966). This report analyses the distribution of educational resources within the United States by race or ethnic background. The study created a statistical base containing survey information for more than one-half million students found in some 3000 separate schools. These data were used to find out which of the various inputs of the educational process were most important in determining the achievement of students. The Coleman-report concluded that differences in schools had little to do with students' achievements. Family background and characteristics of other students in schools were the most important. These findings proved to be controversial and generated extensive discussions, critiques and further research. Hanushek (1986) summarized the results of studies on the education production function that were published since the Coleman-report. He tabulated 147 estimated coefficients on the main expenditure variables according to the sign and the statistical significance (5% level) of the estimated relationship. A more recent update makes use of 377 estimates from 90 studies (Table 1).

Table 1. Percentage distribution of estimated effects of key resources on student performance, based on 377 estimates from 90 studies.

resources	number of estimates	statistically significant (%)		statistically insignificant (%)		
		positive	negative	positive	negative	unknown
teachers-pupil ratio	277	15	13	27	25	20
teacher education	171	9	5	33	27	26
teacher experience	207	29	5	30	24	12
teacher salary	119	20	7	25	20	28
expenditure per pupil	163	27	7	34	19	13
administrative inputs	75	12	5	23	28	32
facilities	91	9	5	23	19	44

Source: Hanushek (1985, 1997), 377 estimates from 90 studies

The first row in Table 1 summarizes the results of 277 estimates of the effect of the teacher/pupil ratio. A statistically significant effect has been found for 28% of these estimates; 15% with a positive effect and 13% with a negative effect. The estimated effect is not significant in 52% of the estimates; 27% with a positive sign and 25% with a negative sign. This tabulation led Hanushek to conclude: ‘it would be easy to conclude that the findings of the studies are inconsistent. But there is a consistency to the results: There appears no strong or systematic relationship between school expenditures and student performance.’ (Hanushek, 1986, p. 1162). This conclusion has had great impact and made economists reluctant of increasing educational budgets. The educational system seemed not to be able to convert extra money in better results, which might be caused by wrong incentives in the system. Hanushek’s review proved to be important for two reasons. First, it stimulated research on the incentive structure of education (see Chub and Moe, 1990; Hanushek and Jorgenson, 1996; Ladd, 1996). Second, it started a discussion on the issue of ‘does money matter?’ This discussion induced a movement towards the use of quasi-experimental research designs that improve the credibility of the findings (see next section). Nevertheless, Hanushek’s conclusion has always been controversial. For instance, a statistical meta-

analysis of the studies in Hanushek's review uncovers a positive effect of resources on performance (Hedges et al., 1994). The main critique is targeted at the validity of the studies on which Hanushek's conclusion has been based (Krueger, 2003). The typical study in Hanushek's table is an observational study that tries to identify the effect of an intervention by controlling for as many inputs as possible. These studies can be biased by unobserved factors. This implies that all estimates in table 1 might be wrong. This notion had led researchers to new empirical strategies that exploit variation from controlled or natural experiments.

3. Assessments of efficiency in education

Although the concept of efficiency in education seems quite straightforward, measuring the efficiency of schools or education systems is complicated. The key problem is the measurement of all the relevant input factors and outcomes. A researcher who aims to measure the efficiency of schools or education systems will in practice only observe a limited range of input factors and outcomes. If unobserved input factors of schools or countries are correlated with the outcomes a comparison of the efficiency of schools or education systems will be biased. In the field of education this is a serious concern because choice and selection are essential elements of education systems: choosing or selecting into schools, classes, types and levels of education. For instance, the quality of the student population of a school is a key input factor but difficult to measure. It is likely that the student population of a school is not a random selection of students but the result of decisions of parents, students and schools. It is now well known that a comparison of the performance of schools or classes that only takes into account observed differences of the student population, such as the education of the parents, gender and age, can yield estimates that not only have the wrong size but also have the wrong sign (!). Hence, unobserved input factors, such as the ambition and motivation of the parents, are a serious concern. In addition, unobserved outcomes might also be a concern. This especially seems to hold for non cognitive outcomes of education. Studies on the education production function typically focus on cognitive outcomes measures such as test scores. However, recent studies show that non cognitive outcomes are also important for adult life (Borghans et al. 2008). If a study on the efficiency of schools only focuses on cognitive outcomes schools that do especially well in producing non cognitive outcomes might be considered as inefficient.

Studies of the efficiency of the education system have used approaches at different levels of aggregation: the country level, the school level and the level of specific interventions or policies. Studies at the country level typically compare spending and performance over time. An example of this approach is the recent study mentioned in the introduction (Kuhry, et al. 2012). This study investigates trends in costs of Dutch primary and secondary education between 1998 and 2009. In addition, an indicator of the ‘production’ of these types of schools is constructed based on the number of students (weighted by socioeconomic background). Moreover, the trend in the quality of the production is assessed using different sources:

performance of Dutch pupils in international tests, reports by the Dutch Inspectorate of Education and a variety of other studies on trends in the quality of Dutch education. The study shows that yearly costs of primary and secondary education increased with 4.1 % and 3.5 % respectively. In addition, based on the different sources about the trends in the quality of education it is concluded that students did not improve their performance between 1998 and 2009. This leads the authors to the overall conclusion about primary and secondary education: ‘the additional investments in education seem not to have yielded a proportional return (in terms of performance).’ ‘Where did all the additional money that became available in the last 15 years go?’.

The conclusion from this study raises concerns about the efficiency of Dutch primary and secondary schools. However, a limitation of the study is that it does not investigate what the performance would have been if the costs would have stayed at the level of 1998. The conclusion is based on the assumption that the performance in 2009 would have been similar to the performance in 1998 if the costs had not increased since 1998. Figure 2 illustrates the problem of the missing counterfactual.

Figure 2 (see appendix)

Panel (1) shows the trends in costs and trends in performance as reported in the study. Panel (2) shows the counterfactual assumed by the authors in their conclusion: performance would have been flat if expenditures had not increased. Panel (3) shows a second counterfactual in which the performance of students deteriorates over time. This deterioration over time could, for instance, be driven by competing sectors of the economy offering nice jobs to excellent teachers³. If panel (3) would be the true counterfactual we would conclude that the additional expenditures have been used in an efficient way. As the study does not attempt to find a counterfactual it remains unclear whether the additional resources have been spent well or not. If panel (2) is the most plausible counterfactual then the study provides suggestive evidence for inefficiency in Dutch primary and secondary education. A second limitation of this study is the measurement of the quality of education. Changes in the quality of education

³ This factor is not based on empirical analyses but is only mentioned for illustrative purposes. Other observed or unobserved factors may also lead to a reduction of the quality of education. The main point is that panel (1) is not informative about the efficiency of spending without an analysis of a plausible counterfactual.

are not based on direct measurements of output indicators but are based on a qualitative assessment of different studies.

The efficiency of the education system has also been investigated at the school level. The most prominent approach at the school level is the so-called 'Data Envelopment Analysis' (DEA). DEA is method for the estimation of production frontiers and searches for the most efficient producers. In the field of education DEA is used for comparing the efficiency of schools. The performance of schools is, conditional on their observed inputs, compared with the best performing schools. DEA techniques have recently been used for estimating the efficiency of primary and secondary schools in the Netherlands. In a study focused on overhead in primary schools Blank (et al. 2007) estimated the so-called technical efficiency of Dutch primary schools. Technical inefficiency is a measure of the realized school production versus the maximum of the school production conditional on the budget⁴. For primary schools in 2005/2006 they estimate an average technical inefficiency of 40 % (this is equal to an efficiency score of $1/(1+40)=74$ %). This suggest that there are large differences in performance between school with the same amount of observed resources. Haelermans et al. (2011) investigate the efficiency of Dutch secondary schools between 2002 and 2007. They find an average technical efficiency of 89 percent. This implies that, conditional on the amount of resources, schools could improve students' educational performance by eleven percent.

What do these studies learn about the efficiency of schools? In my view, caution is needed in interpreting these findings as they are based on strong assumptions. The key problem with these studies is the measurement of the relevant input factors. The estimates of the efficiency of schools are based on the assumption that all relevant inputs have been observed. As mentioned before, many researchers in the economics of education feel that this assumption is not likely to hold and prefer the use of quasi-experimental designs to take account of unobserved differences. A second concern with this approach is the comparison with the best performing schools. The best performing schools might be schools that in a specific year

⁴ The concept of technical efficiency is related to the concept of output efficiency.

surpass expectations because of incidental factors and not because of structural factors. In the next years these schools might fall back to the normal level of their performance. If these schools are used as a bench mark this will lead to an overestimation of the inefficiency of schools. In addition, these studies might show that schools differ in efficiency but do not explain why some schools are more efficient than others. As such, these studies do not provide guidance for educational policies. For instance, it might be expected that differences in the quality of the teaching staff are an important source of differences in efficiency between schools (Rivkin et al. 2005). However, a reallocation of teaching staff will probably not improve the overall performance of schools because some schools will gain and other will lose. The key question would be how to improve the quality of teachers. This question cannot be answered with a DEA-study.

The third approach of investigating the efficiency of education is the evaluation of specific policies or interventions by using (quasi-) experimental designs. The use of (quasi-) experimental designs aims to reduce the bias by omitted input variables. In the field of econometrics this approach has been labeled as the credibility revolution (Angrist & Pischke, 2010). The evidence produced by this approach is much more credible than the evidence produced by the two other approaches discussed above. The studies do not aim to assess the efficiency of education systems or the efficiency of schools but only focus on the effect of specific interventions or policies. The evidence from these studies gives a more favorable picture of the ability of the education system to transform additional resources into better performance (Webbink, 2005). However, this certainly does not mean that all interventions are successful. For instance, Leuven et al. (2007) have shown that a 10 percent budget increase of schools with high proportions of students with a disadvantaged background did not improve the performance of these schools.

4. Efficiency and educational policy: what do we know?

Improving the efficiency of education might yield high returns. An improvement of the input efficiency could save resources. An improvement of the output-efficiency would yield more human capital which is a key factor for the success of modern societies. The next question is how to improve the efficiency of education? For answering this question it might be useful to think about the causes of inefficiency. Many economists believe that market competition leads to efficient production. From this reasoning, the lack of competitive pressure in the education system might lead to inefficient production (see also section 2). Another cause of inefficiency might be that schools or policymakers do not know ‘what works or not’ in education (lack of knowledge).

Inefficiency because of lack of competitive pressures

In general, economists believe that market competition leads to efficient outcomes. Competition will drive inefficient producers out of the market. In most countries the government plays an important role in the provision of education and market forces are limited. In the absence of market competition it is not clear whether the resources are allocated efficiently: why should schools use their resources efficiently in such a situation. The intrinsic motivation of educational staff might stimulate efficient use of resources. However, it remains unclear whether this intrinsic motivation is strong enough to replace external pressures that yield efficient outcomes. From this perspective the introduction of competitive pressures in the education system might improve the efficiency. However, competition can also lead to more segregation of specific groups of students. Various instruments are being used, such as: school choice, competition, school accountability, central exams and inspections. Recently some studies using quasi-experimental designs have provided evidence about these instruments.

School choice and competition

If parents and students can choose between schools and school funding is related to the number of pupils this might stimulate schools to improve the quality of their education. Investigating the effect of variation in school choice and competition is difficult because most

of the variation is between countries and there can be many unobserved differences between countries. However, several recent studies exploiting natural experiments provide evidence about the effects on performance (Hoxby, 2000; Hsieh and Urquiola, 2006; Böhlmark and Lindahl, 2008; Gibbons et al. 2008; Card et al. 2010). The findings of these studies are mixed ranging from no effect to positive effects on performance. These studies also provide evidence that competition increases segregation of students (Hsieh and Urquiola, 2006).

School accountability

The introduction of performance standards (central exams), school accountability systems or supervision by organizations like the Inspectorate of Education can also be seen as instruments that replace competitive market pressures. Central exams may provide incentives for schools, teachers and students to improve performance. The empirical evidence suggests a positive effect of central exams (Bishop, 1997; Woessman, 2003; Jürges et al. 2005; Fuchs and Woessman, 2007). It should be noted that the evidence is based on cross-country or cross-state comparisons that might be biased by omitted variables.

The supervision by an Inspectorate of Education might also put pressure on schools to use their resources more efficiently. To my knowledge there is no empirical evidence about the effect of setting up or introducing an organization like the Inspectorate of Education. A few studies have investigated the effects of school visits by inspectors. For the Netherlands these visits seem to have a small positive effect on performance (Luginbuhl et al. 2009).

School accountability systems have been used especially in the US and the UK. These systems set clear performance targets for schools. Failing to meet these targets might have serious financial consequences for schools. Studies that have investigated the effects of these programs show that they can increase test scores (Dee & Jacob, forthcoming; Hanushek & Raymond, 2005; Jacob, 2005; Rockoff & Turner, 2010, West & Peterson, 2006). However, strategic behavior of schools, such as the exclusion of pupils from the test, teaching to test or cheating of teachers, seems to be a fact of life (for instance Jacob, 2005; Figlio and Rouse, 2006; Figlio and Getzler, 2006; Figlio, 2006; Jacob and Levitt, 2003).

Inefficiency because of lack of knowledge about what works in education

Another important potential source of inefficiency might be a lack of knowledge about what works in education. If schools or policy makers have insufficient knowledge about how to improve performance additional resources might be spend inefficiently. This seems a likely source of inefficiency as several recent studies using credible research designs have shown that some polices do not work (for Dutch examples see Leuven et al. 2007, Van der Steeg et al. 2008).

5. Policy implications and challenges

The previous sections have shown that assessing the (in) efficiency of the education system is difficult. Approaches at the country level and at the school level provide suggestive evidence for substantial inefficiency in the education system. In addition, (quasi-)experimental studies have shown that not all interventions that increased resources in education have been successful.

It should be noted that some of the evidence on the inefficiency of the education system is based on strong assumptions. The approaches at the country and school level might be seriously biased due to omitted input or output factors. A comparison of trends in spending and trends in performance is not informative about the efficiency of the education system because we do not know what would have happened if the level of educational spending had remained constant. Differences in performance between schools might also be the result of differences in unobserved factors such as the quality of the student population.

It is also important to note that reducing cost might harm the production of human capital. A large literature documents that human capital has high private and social returns. One additional year of schooling increases private earnings in developed countries with 5 to 10 percent. This increase in earnings has also been found in studies that estimate the causal effect of education on earnings by exploiting natural experiments or data of identical twins. Education not only has financial returns but also non financial returns. For instance, studies have found that education increases longevity and civic participation. In addition, the social returns of education also seem quite high. Although these studies are based on stronger assumptions, the best studies in this area indicate that social returns might be even higher

than the private returns to education and are estimated around 10 percent (social return = private return + spillover). These high returns to human capital imply that attempts to reduce the costs of education could be ‘penny wise’ and ‘pound foolish’.

This brings a policy dilemma: there seems to be scope for improving the efficiency of the education system but simply reducing spending might yield high future costs. The challenge for policy makers is to improve the allocation of resources without harming the production of human capital. In my view two approaches could provide a way-out of the dilemma.

1. Smart accountability policies

First, accountability policies that include a clear and transparent formulation of the targets that are expected from schools have been shown to be successful. These policies also have induced strategic behavior of schools and teachers that have reduced the gains of these policies. An approach that could be successful would be to design accountability policies in such a way that strategic behavior of schools, such as excluding pupils or teaching to the test, is made impossible or strongly reduced. To design such ‘clever accountability policies’ can be considered a major challenge for educational policy makers. The Dutch Inspectorate of Education could play an important role in enforcing such policies.

2. A learning strategy for educational policy

Second, discovering what works is very useful for educational policy. Combining the introduction of new policies with rigorous research can be labeled as a ‘learning strategy’ for educational policy. Such a ‘learning strategy’ would be most effective if new policies are implemented in such a way that it is possible to create credible comparison groups. Nationwide introductions of new important policies are difficult to evaluate. Phased or partial implementation of new policies would provide opportunities to learn about the effects and support decisions on further introduction of these policies.

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Figure 1. Input and output efficiency

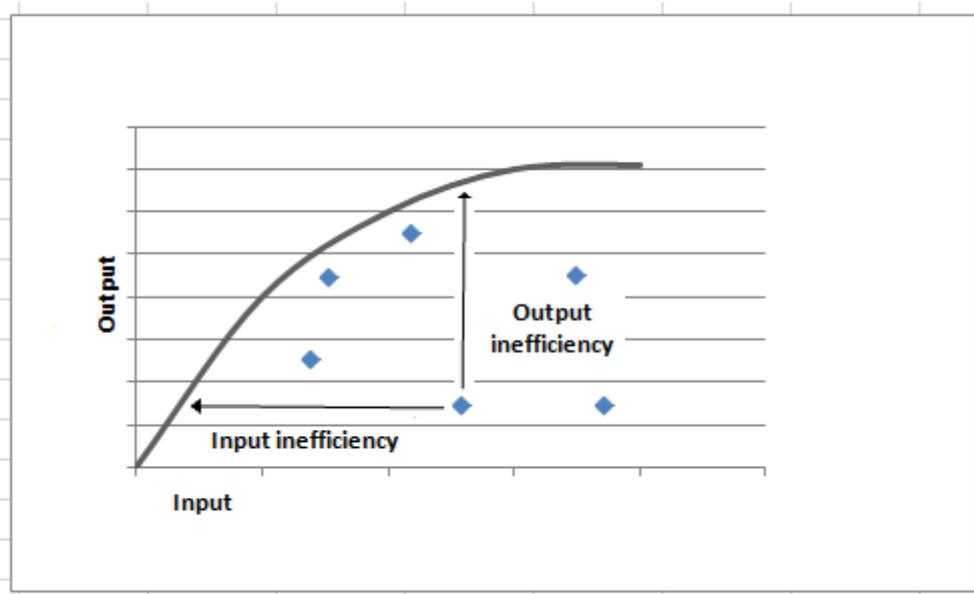


Figure 2. What can be learned from comparing trends in spending and performance without a counterfactual?

