Effects of Class-Size Reduction on Students' Performance

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ABSTRACT

A major factor affecting students' academic performance is the classroom environment, in which class size plays an important role. This study aims to test the impact of class-size reduction on students' performance and examine other factors affecting it. The results are established using a simple model that determines the impact of class size, individuals' earnestness toward studying, and individuals' learning environments on students' performance. The results reveal the benefits of class-size reduction and how elementary students benefited from the smaller class size. This study will help school managers, teachers, and society understand the importance of creating an optimal learning environment based on students' needs.

Keywords: Class-size reduction, eagerness toward studying, learning environment, optimal class size

INTRODUCTION

Education is one of the major factors promoting economic development and can help alleviate poverty. Only through education can people develop adequate skills, acquire knowledge, and adopt the temperament to perform effectively to contribute toward personal and societal development. Many factors associated with education may enhance or weaken students' learning and academic performance. A key factor responsible for falling education standards is the large class size. Numerous studies have been conducted to determine the effect of class size on students' academic performance. Teachers and parents believe that students receive more attention in a smaller class than in a larger class. Some students may also feel more comfortable clarifying their queries and participating in class discussions. Bascia's (2010) findings

support the statement, concluding that parents appear comfortable in frequently meeting with teachers given a reduced class size. Many parents reported developing better relationships with teachers following their frequent one-to-one meetings.

Iacovou (2002) stated that class-size reduction (CSR) has helped children perform well in reading during their early years, producing better test scores. However, it did not have a significant effect on their mathematics scores. The study also observed that the reading score of girls studying in smaller classes was marginally higher than that of boys.

Zyngier (2014) reported that smaller classes positively affected student achievement and narrowed down achievement gaps. The benefits of a smaller class size outweighed the cost comparison in all 112 peer-reviewed studies.

These studies examined the impact of CSR in elementary schools by analyzing the learning environment, consequences of CSR in a poor learning environment, level of comprehension in a small class, and how CSR affects students' academic achievement. The findings established that a smaller class size promotes teachers' ability to monitor students more efficiently using a variety of pedagogies, creates a conducive learning environment, and provides individual attention to students, enhancing teachers' productivity and students' performance. The major variable in the study is class size, which is the number of students a teacher manages in their class. Students' performance measured across various academic subjects is considered

students' academic achievement. The school environment is an important factor contributing to pupils' learning and assimilation abilities. The school environment usually facilitates students' learning, and environments can be either stimulating or unexciting and favorable or obstructive to the development of students. If the school environment is not motivating and challenging and fails to inspire students to learn, it is considered a poor learning environment.

Additionally, the study aims to understand how class size affects teachers' instructional and classroom management practices. Therefore, this study aims to analyze the relationship between class size and academic performance in early elementary levels and how teachers' perceived class size affects students from poor learning environments or economically disadvantaged places. Finally, the study aims to verify the consistency of the class size policy in schools.

Many previous studies have empirically examined the impact of learning environments on students' performance by considering CSR. However, limited studies have analyzed it theoretically, and the mechanism underlying the impact of CSR remains unclear. Therefore, the main objective of this study is to focus on how CSR theoretically increases students' academic performance and determine the optimal class size under various situations.

The second part of the study analyzes previous research on the influence of class size on students' performance. Subsequently, the proposed model is described, and

the study concludes by discussing the implications of the results introduced by the model.

LITERATURE REVIEW

Class size is the number of students that a teacher is responsible for in the classroom. (Kedney, 1989). Many researchers have emphasized that smaller classes have been found to have greater chances of individualizing instructions and achieving a healthier classroom environment. In addition, student attitude, individualization, student participation, quality of instruction, and teachers' attitudes are all positively affected by reducing the class size (Smith & Glass, 1980).

However, do students learn more in smaller classes? Much of the evidence in the literature on education provides mixed opinions. In contrast, some of the literature cited in this study covers the impact of CSR on students' behavior, academic achievement, teachers' employment, wages, and parental convenience.

Shin (2012) found that a reduced class size promoted higher academic achievement in all subjects for black students and a significantly higher academic achievement in reading, math, listening, and word recognition skills among students studying in kindergarten up to Grade 3.

Dynarski et al. (2013) estimated the effects of reduced class size from early elementary school to post-secondary education. Having smaller class sizes from early school days increased students' probability of attending college by an additional 2.7 percentage points. The research also demonstrated the effects of class size on increasing enrollment among black students, children from low-income families, and high-poverty schools. CSR could help close income and racial gaps in post-secondary education attainment during early childhood. Small class size also increases students' probability of attaining a degree by 1.6 percentage points, concentrating in high-earning fields such as STEM, business, and economics. Zyngier's (2014) meta-analysis revealed that out of the 112 peer-reviewed studies, an overwhelming majority found that smaller classes helped narrow students' achievement gaps. In a literature review by Mathis (2017) on poor and minority students, the positive effects of CSR were observed to be twice as large.

According to Siegfried and Kennedy (1995), instructors must adjust their teaching methods, as class size alone will not significantly impact learning. The study suggested that it is mandatory to change teaching strategies based on class size; otherwise, class size does not directly impact students' performance. The study also verified that the actual effect of smaller class size is influenced by students' work ethics (including an aptitude for certain subjects, attentiveness, reticence in class, and attendance).

Bohrnstedt and Stecher (1999), Hruz (2000), and Krueger (2000), summarized studies on CSR. They demonstrated that a class with a student capacity of 15 showed higher achievements than their peers in larger classes in the first year after a CSR.

More advantages and statistically significant results were observed in math classes than in reading classes. The study noted that children from a small class could maintain their advantage during the subsequent years but did not show any advancements in their achievement. Konstantopoulos (2008) determined that higher-ability students benefited more from a smaller class than their average counterparts.

Many studies examined the impact of smaller class sizes on student achievement and have provided affirmative answers to this question, linking reduced class size to positive effects on student achievement (Biddle & Berliner, 2002; Finn & Achilles, 1990; Glass & Smith, 1979; Grissmer, 1999). It has been particularly observed in the case of early primary grade, African-American, and poor students (Bain et al., 1992; Nye et al., 2004; Smith et al., 2003). According to some reports, these effects are sustained beyond the "treatment" years for students exposed to smaller classes (Ehrenberg et al., 2001; Finn et al., 2001; Nye et al., 2002). Positive outcomes in student and teacher attitudes have also been found in smaller classes (Smith & Glass, 1980; Zahorik et al., 2003). Therefore, CSR helps improve student achievement in the early grades and for students often believed to be at risk. It enhances the affective experiences of both teachers and students. Correa (1993) and Lazear (2001) hypothesized a theoretical model to establish the role of class size in improving class productivity and function. These studies also emphasized that a large class size leads to a decline in student learning. They recommended that a smaller class size improves student-teacher interaction.

According to Ingersoll (2015), 54% of the observed teachers left their jobs, citing a larger class size. In the long run, reducing class size may help retain experienced teachers. Correspondingly, it can improve student achievement and reduce the disruption associated with teacher turnover. Isenberg (2010) demonstrated that they had a smaller proportion of first-year teachers. Another study by Loeb et al. (2005) estimated that very large classes (33 students or more) significantly influenced indicators of teacher turnover.

Furthermore, Fredrikkson et al. (2012) analyzed the long-term effects of CSR. They showed that CSR positively affects individual wages in the labor market. Finally, Gilraine et al. (2018) considered the changes in several equilibria, such as the proportion of private schools and housing prices in the area where CSR is being implemented.

On the contrary, Hoxby (2000) mentioned that the positive effects of CSR, as shown in many studies, can be overestimated. For example, parents are inclined toward education and allow their children to enter schools where CSR has been implemented and cooperate with teachers positively. This action boosts students' performance and reaffirms the effectiveness of CSR.[1]

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[1] To eliminate this bias, we assume that the marginal rate of parents' contribution becomes lower in our model in the next section. Specifically, the great the parents' cooperation, the lower the increase in its effect.

In most past studies, students in smaller classes outperformed their peers from larger groups. It was reported that CSR outcomes saw a marginal increase in test scores after two or three years. CSR implementation, students receive more teaching time during class hours, fewer disciplinary issues, and more parent-teacher contact time. Overall, there was enhanced literacy instruction, student talk, and student participation in smaller classes.

Students' interactions with their peers in classrooms helped improve their social skills to build healthy friendships that motivated them to attend classes. According to Hamm and Faircloth (2005), friendships are critical for students during their school life and support their psychological growth and maturity, enhancing their social skills and self-awareness, which influence the development of self-evaluation and self-growth; they demonstrated the unprecedented effects of peer groups on a children's school lives. In addition, CSR can sometimes influence students' opportunities to socialize with a larger number of peers.

Peer groups can also negatively influence the students. The association with friends who are not serious about studies can influence students to neglect their studies, leading to poor academic performance. According to Olalekan (2016), peer groups make students feel more comfortable and relaxed. The author also emphasized that brilliant students' association with dull friends would negatively influence their learning. Similarly, an association with a brilliant peer group would positively affect dull students and stimulate their interest in learning. Olalekan (2016) stated that the nature of a peer group determines its impact on the motivation and achievements of its members. Any environment that does not motivate students' educational needs is considered a poor learning environment.

Wilson (2002) reported lower suspension rates among students in late grades who had been in small classes in their early years of education. For example, tenth-grade students who had been in smaller classes in Grade 3 were suspended on an average of 0.32 days, compared with 0.62 and 0.77 days for students in "regular" and "regular plus aide" classes, respectively. Similarly, the attendance rate of tenth graders who had been assigned to smaller classes in their early years was significantly higher compared with other students (16 days per year of absence compared to 23 and 24 for "regular" and "regular plus aide" classes, respectively).

Finn and Boyd-Zaharias (2005) reported that 11 literature reviews showed a positive impact of smaller class sizes on students' learning behavior, including a reduction in their anti-social behavior (i.e., withdrawing from interactions with the teacher or other students engaging in disruptive acts). It also showed an increase in pro-social behavior (i.e., following rules, interacting positively with the teacher, and collaborating with other children). Another study showed that disciplinary referrals decreased sharply in the two years after smaller class sizes were implemented, with a 26% drop in the first year and a 50% decline in the second year.

Dee and West (2011) studied longitudinal data on eighth-graders that reductions in class size were associated with enhancements in their non-cognitive skills related to psychological engagement with school; more positive reactions to teachers, peers, and academics in general; higher levels of interest and motivation; lower levels of boredom and anxiety; and a greater sense of belonging. In addition, students in smaller classes were more likely to look forward to attending school, believed that the subjects studied would play a useful role in their future, and were less hesitant to ask questions.

Ho and Kelman (2014) found that smaller classes reduced gender gaps in performance. The study was conducted at Stanford Law School via rich individual-level covariate and grade information on every student in every mandatory first-year course to study whether assignment to smaller classes reduces the gender gap in law school in terms of performance. The results revealed a significant relationship between the gender gap and law school performance.

The COVID-19 pandemic has opened up the necessity for online classes; according to most studies, students in large-enrollment online courses had less communication with professors and peers than those in small enrollment online courses (Chen et al., 2017). It is most likely because of the size of the class. The class size frequently influences instructors' teaching and assessment approaches. The professors in this sample acknowledged the need for modifications in design and delivery, such as limiting the number of available products. To successfully teach high-enrollment online courses, they may need to conduct assessments or hire teaching assistants. The faculty also emphasized the significance of creating clear expectations. Trammell and LaForge (2017) discovered that an online course with high enrollment is well-designed and structured and can reduce student complaints, improving their performance.

Lowenthal et al. (2019) emphasized the need to intentionally and carefully design high-enrollment online courses to help their faculty manage the workload involved while still enabling students to have a successful learning experience.

Theoretical Framework

Numerous studies have investigated the effects of class size on academic performance. As a result, this topic has received increasing attention from educators to policymakers in recent years. In the current study, the researchers tested whether elementary school teachers agreed or disagreed with the theory that smaller class sizes increase students' academic performance.

This study explores the various effects of CSR that contribute to the academic success of elementary school students. In addition, this study sought to conceptualize the effect of class size on teaching and learning processes and the learning environment of elementary students, an under-researched area. Importantly, this study also focused on conducting a follow-up study on class-size rules over these periods.

The Model

According to Becker's (2009) human capital theory, we assume that individuals accumulate their human capital through education. This study uses a simple model based on Lazear (2001) to determine how CSR affects every student's performance in a class and the optimal class size for various students.[2]

First, we assume that the maximum value of human capital for an individual i acquired through education, V_i, is as follows:

$$V_i = A\left(\frac{\theta_i}{\left|\theta_i - \frac{1}{n}\sum\theta_i\right| + 1}\right)^\alpha e_i^\beta$$

$$= A(\frac{\theta_i}{|\theta_i - \bar{\theta}| + 1})^\alpha e_i^\beta, \qquad (1)$$

Where A is an exogenous variable, θ_i is the individual's ability to understand teaching, and $0<\theta_i<1$ is satisfied. $\bar{\theta}$ is the average level of students' ability to understand teaching in a classroom, and e_i is the level of individual learning environments, such as the number of school supplies provided by their family or parents' perception and attention toward their children's learning needs. The human capital function is based on the Cobb-Douglas production function, and $0<\alpha$ and $\beta<1$ are satisfied. However, whether human capital can be maximized depends on an individual's earnestness. Specifically, the human capital per student acquired through education is:

$$V_i \bar{p}^n = A\left(\frac{\theta_i}{\left|\theta_i - \bar{\theta}\right| + 1}\right)^\alpha e_i^\beta \left(\frac{1}{n}\sum p_i\right)^n \qquad (2)$$

Where p_i is the level of an individual's earnestness toward studying, $\bar{p}$ is the average level of earnestness in a classroom; $0 \le p \le 1$ is satisfied, and n is the number of students.[3] (2) clarifies that the average level of earnestness in the classroom affects individual human capital because the peer group's effect on academic performance is observed in a classroom. When the average level of earnestness toward studying in a classroom is higher than a particular student's earnestness toward studying, the student's earnestness increases and vice versa; moreover, when an individual's ability to understand teaching approaches the average level of understanding in a classroom, individual human capital increases. Therefore, the level of teaching and teaching style usually focus on a student with average ability in a classroom.

Next, we consider the benefits of education. The classroom operating cost (such as a teacher's salary and installing equipment for learning, such as a blackboard

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[2] The mutual dependence between factors and phenomena can be clear through economic models. Therefore, we can understand human action quantitatively and evaluate school policies.

[3] The concept that the effect of earnestness on individual human capital increases when the number of students in a classroom decreases is based on Lazear (2001). A small class size improves student-teacher interaction and realizes fewer disciplinary issues, as Correa (1993) and Leazer (2001) suggest. However, there is a possibility that the level of an individual's earnestness toward studying increases when a class size becomes larger and students' abilities in a classroom become diversified. Cooperation or competition among them can increase their earnestness toward studying. This possibility should be considered in future research.

or an air conditioner) is W, and students in that classroom pay the cost.[4] The benefits derived from education per student π_i are as follows:

$$\pi_i = V_i \bar{p}^n - \frac{W}{n}$$

$$= A\left(\frac{\theta_i}{|\theta_i - \bar{\theta}| + 1}\right) e_i^\beta \left(\frac{1}{n}\sum p_i\right)^n - \frac{W}{n} \tag{3}$$

We assume that the benefits of education are always positive. That is, $\pi_i > 0$ is satisfied. From (3), we can observe that every student's value of benefits derived through education becomes an increasing function of e_i and p_i In contrast, the decreasing function of W. Individual learning environments and individual earnestness toward studying are the factors that boost benefits through education. In contrast, operation cost decreases the value of benefits.

Let us consider the optimal class size. Then, the first-order condition of (3) for n is s:

$$\frac{\partial \pi_i}{\partial n} = V_i \bar{p}^n \log \bar{p} + \frac{W}{n^2} = 0. \tag{4}$$

From (4), we obtain the optimal class size as:

$$n^* = \sqrt{\frac{-W}{V_i \bar{p}^n \log \bar{p}}}. \tag{5}$$

[4] In a real society, schools incur these costs through grant money provided by the government, and students do not seem to pay for them directly, especially in public schools. However, the grant money provided by the government is collected through taxes. Specifically, citizens pay for the costs indirectly. Therefore, we assume that each student pays the operating cost.

From (3) and (4), it is determined that the value of n increases when the value of p increases and vice versa (see Appendix A).[5] Therefore, the higher the students' earnestness toward studies, the larger the optimal class size. Moreover, we observe that n is the increasing function of W, whereas n is the decreasing function of V_i, from (5). Therefore, the more the individual learning environments increase, the smaller the optimal class size is. In addition, the optimal class size decreases when the deviation of an individual's ability to understand from the average level in a classroom is small. In contrast, the higher the operating cost, the larger the optimal class size.

Subsequently, we examine the benefits of education and transition in the optimal class size. For simplicity, we assume that students receive education for two periods. The benefits of education can be rewritten as:

$$\pi_{1i} + \pi_{2i} = V_{1i}\overline{p_1}^n - \frac{W}{n} + \delta\left(V_{2i}\overline{p_2}^n - \frac{W}{n}\right)$$

$$= A\left(\frac{\theta_{1i}}{|\theta_{1i} - \overline{\theta_1}| + 1}\right)^\alpha e_{1i}^\beta \left(\frac{1}{n}\sum p_{1i}\right)^n - \frac{W}{n} +$$

$$\delta\left(A\left(\frac{\theta_{2i}}{|\theta_{2i} - \overline{\theta_2}| + 1}\right)^\alpha e_{2i}^\beta \left(\frac{1}{n}\sum p_{2i}\right)^n - \frac{W}{n}\right), \tag{6}$$

Where δ is the discounted present value, and π_{ji}, V_{ji}, p_{ji}, and θ_{ji} indicate the benefits from education, human capital, earnestness toward studying, and the ability

[5] The analysis of the relationship between n and p is the same as Lazear (2001).

to understand the teaching of individual i in period j, respectively.

The range of θ_i is smaller in the early elementary grades because the accumulation of knowledge is lower at the elementary level, and the study content is easier to understand. In contrast, the content increases and becomes more advanced during the late elementary grades. Therefore, the deviation of individual ability to understand from the average classroom is narrow in lower grades, whereas it is large in higher grades. That is,

$$\frac{\theta_{1i}}{|\theta_{1i}-\overline{\theta_1}|+1} > \frac{\theta_{2i}}{|\theta_{2i}-\overline{\theta_2}|+1}, \qquad (7)$$

is satisfied. The decline in individual understanding of teaching in the second period decreases the level of earnestness toward study, p_{2i}. On the contrary, as benefits from education are the increasing function of e_i, improving individual learning environments in the first period boosts the level of e_{2i} and p_{2i}. The first-order condition of (6) for n is as follows:

$$\frac{\partial(\pi_{1i} + \pi_{2i})}{\partial n} = V_{1i}\overline{p_1}^n log\overline{p_1} + \frac{W}{n^2} +$$

$$\delta\left(V_{2i}\overline{p_2}^n log\overline{p_2} + \frac{W}{n^2}\right) = 0. \qquad (8)$$

When the class size for two periods is decided before the first period and does not change, from (8), we obtain the optimal class size through two periods as

$$n^{**} = \sqrt{\frac{-(1+\delta)W}{V_{1i}\overline{p_1}^n log\overline{p_1}+\delta V_{2i}\overline{p_2}^n log\overline{p_2}}}. \quad (9)$$

Effects of CSR on Students' Academic Performance

The study obtained four results by examining the effects of CSR on students' academic performance. First, we theoretically clarify how CSR increases students' academic performance using the following proposition.

Proposition 1: CSR is Effective in Increasing Students' Performance

Proof. A small class is amenable to multiple ways of teaching, such as adopting interactive teaching or assignments, which a large class cannot have. These methods effectively prevent deviations in an individual's ability to understand classroom teaching from becoming large. Moreover, CSR can improve the individual learning environment because the teacher in a classroom can easily grasp the individual learning environment in a classroom of a smaller size. It will help the school give the students and their parents some valid advice to improve the learning environment directly or support students whose learning environments are poor. Individuals' earnestness toward studies increases when their ability to understand teaching approaches the average level in a classroom as the content of the subjects is suitable for them and when individual learning environments are improved. Since (2) shows that less deviation from the average level, good individual learning environments, and high earnestness increase the value of human capital, CSR effectively increases students' academic performance. This result introduced by the model is consistent with results from empirical

studies shown in the literature review, which clarifies school students' academic success through CSR.

Second, the study introduces the following proposition.

Proposition 2: CSR can Effectively Increase Students' Academic Performance in Early Elementary Grades Rather than in Late Elementary Grades

Proof. The deviation of individual ability to understand classroom teaching in the early elementary grades is marginal compared to the deviation in late elementary grades since the individual accumulation of knowledge about each subject is not large. Therefore, it is easy for teachers in early elementary grades to prevent the deviation of an individual's ability to understand from becoming larger through various interactive methods to teach, such as group discussion rather than the class where the deviation of individual ability to understand is large. Since a small deviation in an individual's ability to understand classroom teaching increases the value of human capital, as shown by (1), CSR is effective in early elementary grades rather than in late elementary grades.

This model introduces results in line with some empirical studies, such as reduced class size leading to positive effects on student achievement (Biddle & Berliner, 2002), particularly in the early primary grades and for African-American and poor students. Therefore, students may benefit from smaller classes regardless of the teaching method used by the teachers.

Similar to earlier studies, the study also found that children in smaller classes were better achievers and concentrated longer than their counterparts in large classes due to improving individuals' learning environments and their high earnestness toward studies.

Third, this study considers the relationship between individuals' learning environments and academic performance.

Proposition 3: CSR can be Effective for Those with Poor Learning Environments

Proof. Individual learning environments also affect the value of individual human capital, as shown in (2). For example, when parents do not pay attention to their children's studies or their families cannot afford enough school supplies, students' learning environments become poor—the value of human capital and students' earnestness toward their studies decreases. On the contrary, students whose families are rich and their parents want their children to receive quality education always provide sufficient school supplies and plenty of learning opportunities. Proposition 1 demonstrates that CSR improves individual learning environments. The high level of learning environments directly improves the value of human capital and elevates it indirectly by increasing their children's earnestness toward studying. Since these two factors increase the value of human capital, we clarify that CSR can be more effective for those with poor learning environments.

These results support empirical studies, such as that by Tsavga (2011), which states that the learning environment plays a vital role in determining students' success, as it elucidates how students achieve their learning goals and address their learning tasks. Undoubtedly, the environment plays a major role in molding individual behavior to meet learning demands. For example, Correa (1993) and Lazear (2001) recommended that a small class size improves student-teacher interaction and leads to more teaching time during class hours, fewer disciplinary issues, and more reported parent-teacher contact time. Overall, this enhanced literacy instruction, student talk, and participation in smaller classes create a positive learning environment. Conversely, a poor learning environment does not contribute to students' motivation or learning experiences.

Finally, the study calculates the optimal class size through two periods, short and long, and analyzes the transaction of the optimal class size. From (5) and (9), it is clear that $n^* > n^{**}$ is realized when

$$|V_{1i}\overline{p_1}^n log\overline{p_1}| < |V_{2i}\overline{p_2}^n log\overline{p_2}|, \quad (10)$$

is satisfied, and vice versa. Specifically, the optimal class size becomes smaller as individual learning environments increase and the deviation of individual understanding becomes smaller by CSR and vice versa. On the contrary, raising earnestness toward studying increases the optimal number of students in a classroom, as shown in (5). Accordingly, the following proposition can be suggested.

Proposition 4: The Optimal Class Size is Small when Introducing the Policy, and the Class Size Increases with Time

Proof. When students begin to learn, there is a possibility that some students' learning environments are poor. Therefore, (10) is satisfied by CSR because it helps improve the learning environment. As long as the value of e_i increases, the optimal class size decreases. On the contrary, the marginal rate of improvement of individual learning environments becomes low, and students' understanding largely deviates over time. In this case, the effects of CSR are small. Therefore, the optimal class size increases with time.

This two-period model also shows that CSR can effectively increase students' academic performance, especially in elementary grades. Nevertheless, this result is consistent with those of earlier empirical works.

CONCLUSION

This study theoretically clarifies the effects of CSR on students' academic performance by focusing on each student's ability to understand teaching, the learning environment, and earnestness toward studies. Four propositions are suggested based on the model. First, it explains how CSR affects students' academic performance and shows its effectiveness. Second, it demonstrates that CSR is more effective in improving students' human capital in early elementary grades because they receive active attention from teachers rather than those in late elementary grades. In most

cases, small classes allow teachers to engage in more individualized teaching and create a difference in the curriculum. However, it is well known that teachers do not always adapt their teaching strategies to take advantage of smaller classes (Evertson & Randolph, 1989; Graue et al., 2008). Some teachers use the same teaching strategies in smaller and larger classes, which may not always be effective.

Third, it is also effective for students whose learning environments are poor rather than students whose learning environments are rich.

Fourth, this study focuses on the transition of the optimal class sizes. In the initial period, the optimal class size is smaller. In contrast, it increases with time because the individual learning environment has already been organized well and there is little room for improvement, and individual understanding has deviated.

This study will help educational experts determine whether CSR is worthwhile for elementary or secondary levels and determine the economic impact it creates in schools. In addition, research can further explore the need to understand teachers' instructional and classroom management practices of small class sizes, the benefits it can bring to students during their formative years of education, and its impact on children from a long-term perspective.

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APPENDIX

Appendix A

The relationship between n and p.

From (4), the following equation was obtained:

$$W = -n^2 V_i \bar{p}^n \log \bar{p}. \tag{11}$$

Substituting (11) into (3), it is satisfied that

$$\pi_i = V_i \bar{p}^n + \frac{n^2 V_i \bar{p}^n \log \bar{p}}{n}$$

$$= V_i \bar{p}^n (1 + n \log \bar{p}) > 0. \tag{12}$$

Therefore, it can be written as 1+nlogp>0. Using the implicit function in (4), the following equation was introduced:

$$\frac{\partial n}{\partial p} = -\frac{\frac{\partial^2 \pi_i}{\partial n \partial p}}{\frac{\partial^2 \pi_i}{\partial n^2}} > 0. \tag{13}$$