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Three empirical essays on the Economics of Primary Education

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Chapter 3:

Introduction

The manuscript consists of three chapters, each of which contains an empirical analysis emphasising the importance of municipal investments in pre-school education on pupils' educational outcomes, the reopening of schools during the second wave of the Covid-19 pandemic, finally, the role of student bullying on schooling results.

The initial chapter stems from the need to understand how to strengthen the education system, which even before the Covid-19 pandemic had some weaknesses among Italian students. This could potentially be associated with the allocation of spending on pre-school education. The focus of the research is whether spending on pre-school education somehow increases student achievement. Using INVALSI data, public expenditure data and data on the registry of local administrators, we mitigate endogeneity issues by exploiting the presence of women in politics, probably the female gender tends to increase investment in pre-school education. The investigation is conducted on the INVALSI outcomes in Italian and mathematics accumulated from 2013 to 2020, in relation to public expenditure on preschool education, interventions for children, and kindergartens in Italian municipalities, as well as the presence of women in municipal councils. Endogeneity issues linked to local public expenditure are mitigated through the utilization of instrumental variable methods, leveraging the exogenous variation of the change in gender quotas in municipal councils introduced by Law 215/2012. The findings demonstrate that a substantial female presence exerts a positive influence on public expenditure for preschool education and interventions pertaining to children and kindergartens. Furthermore, public expenditure, instrumented by the alteration in the gender composition between 2013 and 2011, positively impacts the INVALSI outcomes.

The focal point of the second chapter revolves around the resumption of educational institutions amidst the pandemic. This decision has sparked numerous controversies, primarily due to the anticipated impact on education and the exacerbation of psychological issues among students. Furthermore, reopening schools during a pandemic, as suggested by existing literature, would have potentially led to a surge in Covid-19 cases. The primary objective of this research endeavour was to ascertain whether schools, during a pandemic scenario akin to the recent one, serve as a medium for the transmission of infections. Consequently, it aimed to determine whether the reopening of schools in Italy contributed to the rise in infection rates. The data utilized in this study were obtained from the Higher Institute of Health on a daily basis, with the province serving as the unit of observation. The dependent variable was the daily infection rate per province, while the key variable under scrutiny was the reopening of schools, which could potentially be endogenous due to the regions' inclination to postpone school

reopening in light of increased infection rates. The employed methodology was that of instrumental variables, with the past academic year acting as the instrumental variable. To account for the incubation period and the time required for testing, the school opening dates were shifted by approximately ten days. The findings of this study demonstrate a statistically significant and positive correlation between the reopening of schools and the escalation of infection rates.

Therefore, it is evident from the latest INVALSI 2023 report that the pandemic has further deteriorated students' academic performance. However, it is important to note that the issue at hand is deeply rooted in the structural aspects, as discussed in the concise overview of the first chapter. A potential contributing factor to the decline in student achievement is the existence of bullying, which is the focus of chapter three. Bullying often occurs within educational institutions, causing not only physical and psychological harm among the victims, but also hampers their academic performance. Consequently, this problem has drawn our attention to pre-adolescent students. We analyse the information provided by the INVALSI Institute on the performance in mathematics and Italian and the questionnaires from the fifth classes of the 2013-2014 school year. We relate the scores obtained in mathematics and Italian to the cases of bullying, identified through the distribution of the questionnaires to the students. Since young students are more likely to be teased by older peers, we exploit the threshold imposed by the law for early enrolment to have a tool to predict bullying and its impact on educational outcomes. The presence of early learners in a class increases the likelihood of bullying among students, which could lead to a worsening of academic performance. The results show that the occurrence of bullying in a mixed class of precocious and regular pupils leads to a worsening of academic performance in Italian and mathematics among fifth grade students.

Do municipal investments in preschool education affect student achievement?

Carmela Ciccarelli*

Abstract

Insufficiently high spending on education could have negative effects on INVALSI results. In this regard, we analyse INVALSI results in Italian and mathematics in the years 2013-2020 in relation to public spending on preschool education in Italian municipalities. Endogeneity problems are minimized by using the instrumental variables method, taking advantage of the exogenous variation of the introduction of Law No. 215/2012, specifically the change in the gender share in municipal collegiate bodies. The results show that a high presence of the female gender has a positive effect on public spending on preschool education, and in turn public spending instrumented by the change in gender share in the years 2013-2011 has a positive effect on INVALSI results. The results are confirmed by robustness checks.

JEL classification: I20 I21 I26 D72 J16

KEYWORDS : Gender Quotas, Instrumental Variables, Law 215/2012, Education, INVALSI

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1.1 Introduction

This study aims to examine the influence of local public spending on the development of human capital, specifically in relation to the educational outcomes of Italian elementary school pupils who have been evaluated by the INVALSI tests. The objective of this research is to explore the impact of two main categories of local public expenditure, managed by Italian municipalities, on the school learning outcomes of primary school pupils. In order to mitigate potential endogeneity problems in the relationship between local public expenditure and educational outcomes, the aim is to use exogenous variations (determined by specific laws[1]) in the participation of the female gender in local decision-making bodies to assess their impact on the allocation of local public expenditure, broken down by mission, and how this affects the educational outcomes of Italian children. The spending of Italian municipalities is classified into subchapters, such as road and land maintenance, justice and local police, education, and sport and culture. By local public expenditure categories, we mean the accrual payments[2] related to Mission[3] 4, Programme[4] 01 (Pre-school Education) and to Mission 12, Programme 01 (Interventions for Children and Kindergartens), while gender quotas refer to policies aimed at increasing the representation of women in municipal councils. Studies confirm that when a government invests in early childhood education, the investments will really make a difference in children's outcomes (Burchinal et al., 2008; Gilliam and Zigler, 2004; Wong, Luo, Zhang, & Rozelle, 2013). OECD data (OECD 2010) showed that public investment in preschool education in Italy was among the lowest in Europe even years ago. Education is widely considered a crucial and potent tool in mitigating economic inequality. Since 2005, municipal investment spending has seen a significant decline, both in real terms and in relation to GDP (World Economic Forum 2017). This decline, which is widespread across regions, has highlighted high territorial variability (Viesti 2016); there are significant disparities in educational inputs and outputs between regions (Sibiano et al., 2013). Among regions with special status, the decrease in those in the North was associated with a significant decline in Sicily and Sardinia, while among regions with an ordinary statute, the

[1] Law No. 81/1993, Law No. 215/2012, Law No. 56/2014

[2] "Pagamenti in conto competenza": Payments on accrual basis, i.e., the amount budgeted for expenditure that represents, with reference to the financial year, the maximum limit of commitments that can be made.

[3] Budget classification unit representing the main functions and strategic objectives pursued with public expenditure. They provide a political-functional representation of the budget, which is necessary in order to make the major expenditure items more transparent and to better communicate the main lines of action. Missions can be allocated to a single ministry or to several ministries. The budget is presented on the basis of Missions as of 2008.

[4] Underlying budget classification unit Missions. They represent homogeneous aggregates of activities carried out in pursuit of predefined objectives. Each Programme represents a product and/or service or an intervention in the economy and society. As a rule, the Programmes are specific to each Administration; in some limited cases, they are shared between several Administrations. The programme constitutes the parliamentary voting unit for the approval of the budget law, pursuant to Article 21, paragraph 2, of Law No 196 of 31 December 2009.

decline was most intense in the Centre-North, where the outsourcing of some important local public services could have had a more pronounced influence. On average, from 2004 to 2010, the ability of municipalities to translate spending commitments into effective payments for planned works was greater in municipalities in the North than in those in the Centre and, most notably, in the South, where the high and persistent discrepancy between commitments and payments reflects, among other factors, the effects of the current financial accounting system (Chiades et al. 2013). In the absence of strict budgetary constraints, this had led, until the middle of the last decade, to a growing mismatch between commitments and capital payments and to the subsequent accumulation of a large mass of remaining liabilities. In a context characterized by the decline in funding sources due to the cut in transfers provided by the highest levels of government, the prolonged phase of crisis in the real estate market and the reduction of the room for manoeuvre on own revenues, the Internal Stability Pact has slowed down investment planning, whose spending is more easily compressible than the current one, historically characterized by a high incidence of the most rigid components, such as labor costs and debt service. The decline in investment spending commitments reflects not only the greater rigidity of imposed constraints, particularly after the introduction of the mixed competence criterion, but also the high degree of uncertainty faced by local administrators due to the undulating regulation of the Pact. These factors have intensified the prudence of institutions in planning investment expenses, given the discrepancy between the progress of work and the available financial margins. However, the restrictions imposed by the Pact have aided in reducing the deficit and stabilizing debt supply held by local governments. Local governments have also been encouraged to adopt a more rigorous approach to financial reporting, seeking greater correlation between allocated and actual spending. The new financial competence principle[5], effective in 2015, requires institutions to provide proof of progress on previously financed interventions and to verify the compatibility of planned interventions with the constraints of the Pact. Financial accounting takes into account management events in a period closer to the final stages, namely cash movements. This article emphasises the importance of investment in education, particularly in Italian municipalities, where public spending is low and exacerbated by severe fiscal consolidation policies. Reduced budgetary allocations for municipal spending can have a negative impact on children's educational outcomes, given the potential deterioration of public services such as schools, resulting in compromised learning conditions that hinder cognitive and developmental progress. Italian funding for early childhood

[5] Legislative Decree No. 118 of 2011, Article 3 specifies that as of January 1, 2015, territorial public administrations and their instrumental financial accounting entities must conform to uniform accounting rules defined by general accounting principles and applied accounting principles. The principle of financial competence is particularly noteworthy, serving as the criterion for ascribing assets and liabilities, including assessments and commitments, to respective financial years.

education is among the lowest in Europe, resulting in a significant gap between demand and supply of childcare services. Moreover, recent data from the INVALSI 2023 report[6] reveals a decline in the academic performance of Italian students, particularly in primary school subjects. Therefore, it is imperative to evaluate the effect of public spending on the human capital formation process to provide recommendations for the efficient allocation of resources, such as investments in education, to address inequalities in contemporary economic systems. Considering this position, current literature has emphasised the economic repercussions of gender quotas in some countries (Cabaleiro and Buch 2018, 2020; Hern´andez-Nicol´as et al., 2018;Priyanka's 2022) The rationale is that, through the promotion of greater female participation in politics, they may exert an influence on the political process and economic policy preferences regarding the allocation of resources, such as public spending. In Italy, various measures have been implemented in recent decades, such as the introduction of gender quotas, to reduce the gender gap in politics. For example, Law No. 81 of 1993, which was repealed in 1995 due to its unconstitutionality, mandated that neither sex could represent more than two-thirds of each municipal electoral list. Law No. 215 of 2012 introduced dual gender preference in municipalities with more than 5,000 inhabitants, enabling each voter to express their preference for two candidates of different genders. Law No. 56 of 2014 stipulates that in municipalities with more than 3,000 inhabitants, neither sex can be represented to an extent less than 40 percent in the councils. By examining the exogenous changes in the participation of women in local political bodies resulting from these legislative provisions, we expect a positive impact on the local public expenditure taken into account, consequently a positive effect on the INVALSI results. Once the aforementioned correlation has been established, it may be further implemented to comprehend the effects of potential alterations in government spending, stemming from the presence of more female politicians, on the academic achievements of Italian children. The Italian municipalities are directly involved in this process by supervising the fundamental foundations that facilitate the development of children during early childhood. Specifically, they are accountable for funding facilities that provide childcare, primary and secondary education, with special emphasis on the construction, renovation, and maintenance of school premises. Jackson (2018) and Jackson and Mackevicius (2021) have shown that investments in school facilities improve student achievement. It should be noted that an analysis of this kind may encounter methodological difficulties, i.e., the higher level of public spending on education may represent an endogenous characteristic of the municipalities deemed most virtuous. This virtuosity is often characterised by a higher accumulation of human and social capital, which subsequently translates into a higher demand for public goods and services in the education sector. There are many aspects of the link between public spending on education and student achievement. Many of these aspects are not precisely measurable, such as variables that influence student learning, including the quality of a community's institutional environment, social capital or the persistence of racial stereotypes, which could lead to problems

[6] On 12 July 2023, the Presentation of the INVALSI Report 2023 took place in the Chamber of Deputies.

of bias from omitted variables. By integrating data on Italian municipal budgets with reference to mission 4 and mission 12, together with information from the registry of local administrators and INVALSI data provided at the municipal level by the National Institute for the Evaluation of the Education and Training System, our aim is to investigate whether spending on pre-school education and spending on interventions for children and nursery school, instrumented by the exogenous change in the percentage of female participation in municipal councils, has had a positive effect on student outcomes. Specifically, we seek to examine the effects of these changes on the academic performance of students in the second grade of primary school, particularly in the subjects of mathematics and Italian language. To this end, we conduct two separate analyses. In the first step, we test whether the proportion of women in local government bodies has a positive or negative influence on the expenditure variable. In the second analysis, the aim is to examine whether spending on pre-school education has an impact on INVALSI evaluation results. In the robustness checks, the same analysis is performed for mission 12, programme 01, Interventions for children and kindergartens. The results show that a significant presence of women has a favourable impact on the allocation of pre-school public expenditure and on Interventions for Children and Kindergartens. Furthermore, public expenditure, which is affected by the alteration of gender representation between 2013 and 2011, shows a positive influence on INVALSI outcomes. The article is structured as follows: section two provides an overview of the literature, which is then divided into two subsections: gender quotas and public expenditure, austerity and achievement; section number three delves into the description of Law 215/2012; section number four presents the data used and the relevant descriptive statistics; section number five explains the model and methodology used in the study and discusses the econometric problems of the analysis; section six presents the results obtained; section number seven provides details on the robustness checks; section number eight contains the concluding remarks; finally, section number nine includes the appendix, while the last section is devoted to the bibliographical references.

1.2 Literature Review

1.2.1 Austerity and Achievement

Student test scores are a function of school resources, teacher quality, and family background (Hanushek 2008). Policymakers can directly influence the allocation of resources for school inputs and infrastructure useful for learning. However, the presence of budget rigidity can greatly limit the extent to which one can reallocate current expenses and eliminate inefficiencies. Austerity policies can have negative effects on student achievement, particularly for children from disadvantaged backgrounds. Politicians should consider the potential social and economic costs of austerity policies when making decisions on public spending. The aforementioned issue is highlighted in the work of Pavese et al. (2023), which aims to show that austerity

measures, which entail a reduction in public spending, have a negative impact on student performance in national standardised tests. To establish this relationship, the researchers use cross-municipality variation in the timing of eligibility for the Italian Domestic Stability Pact as an exogenous shifter of local public spending. Since 1999, fiscal relations between national and local governments in Italy have been regulated through the Domestic Stability Pact, which imposes fiscal rules on municipalities to achieve public finance targets. Eligibility for the DSP is based on municipal population. Following some changes in the early years, the DSP only covered municipalities with more than 5,000 inhabitants until 2012. As of 2013, the exemption threshold was lowered to municipalities with a population over 1,000. The 2015 reform finally extended the DSP to all municipalities. This suggests that spending cuts have a disproportionate impact on disadvantaged students. However, the study also finds that the effects of spending cuts are substantially mitigated in municipalities with more competent and re-election motivated politicians. This is because these politicians are less likely to apply marginal austerity spending cuts to productive expenditure items. This suggests that political factors can play a role in mitigating the negative impact of spending cuts on student performance. Policy makers should consider implementing school finance reforms that aim to equalise funding across districts to improve educational outcomes for disadvantaged students. The article by Card et al. (2002) analyses the nature of school finance reforms during the 1980s, examining the controversies, legislative changes, and the effects of reform on state funding per student and median family income, while also focusing on the consequences of school finance reform on student achievement and SAT scores. They found that spending equalisation leads to lower test scores among lower family background groups. The study's best estimates suggest that spending equalisation following unconstitutional court rulings in 12 states in the 1980s reduced the gap in average SAT scores between children with highly educated parents and those with poorly educated parents by about 8 points, or about 5%. The strength of local teachers' unions can play a crucial role in determining the effectiveness of school finance reforms and the allocation of resources to improve student outcomes. The work of Brunner et al. (2018) examines the impact of teachers' unions on the allocation of state aid to local spending and the effect of this allocation on student outcomes. The results show that school finance reforms caused a significant increase in state aid to local governments in the US, where districts with strong unions increased spending on teacher pay, resulting in increases in student achievement. Access to educational resources is a critical factor in shaping the outcomes of economically disadvantaged children, resulting in a significant reduction in the intergenerational transmission of poverty. State school funding reform policies have been demonstrated to enhance student outcomes and mitigate such transmission. While financial resources alone may not suffice, they are an essential prerequisite for quality education. The allocation of resources is equally important, and any increase in expenditure must be accompanied by efficient systems to ensure optimal utilization of funds. Jackson et al. (2015) conducted a study to examine the causal impact of exogenous increases in school spending, due to the approval of school funding reforms (SFR), on academic and labor market outcomes. The findings indicate that augmented spending per student significantly

enhances education levels, salaries, family income and reduces adult poverty among low-income families. However, the effects of increased spending on academic performance and economic outcomes in adulthood are less pronounced for children from non-poor families. Additional increases in spending have been associated with significant improvements in school quality, such as the reduction in student/teacher ratios, an increase in teacher salaries, and the extension of the school year. The influence of maternal education and the accessibility of public early childhood services can facilitate comprehension of the effects of early education on children's outcomes. Provision of childcare services can be a potent policy instrument to enhance the linguistic abilities of immigrant children, especially those whose mothers have limited education and those who converse in a language that is vastly dissimilar to that of the host nation. Consequently, this can contribute to the advancement of the integration and assimilation of immigrant children in the host country. Italy continues to show a significant surplus in the demand for early childhood services, as well as a significant disparity in the provision of these services between different parts of the country (Del Boca, Pronato et al., 2016). The present work by Corazzini et al. (2021) examines the impact of nursery school attendance on the cognitive outcomes of native and second-generation immigrant children in Italy. The study focuses on the effect of early childcare on the cognitive outcomes of second-generation immigrant children, as investments made early in life have been shown to have higher returns and dynamic complementarities than investments made later in life. Estimates show a positive and significant effect on immigrant children's language test scores, with the effect mainly affecting children with poorly educated mothers and those who speak a language very different from Italian at home. In contrast to immigrants, native students are negatively affected by childcare attendance. The effects are strongest on mathematics test scores for children with highly educated mothers and in municipalities with relatively low public provision of early childhood services. The effect of childcare attendance on the achievement gap between immigrant and native children is positive and significant, suggesting that childcare services can help to reduce the achievement gap between these two groups. The availability of public childcare plays a significant role in the maternal employment and cognitive outcomes of children in Italy. Policy makers should consider expanding public childcare services to increase maternal employment and improve children's cognitive outcomes, particularly in regions with limited availability of childcare services. Investments in childcare policies can help alleviate intergenerational persistence, especially for children from low-income families. In detail, the article by Brilli et al. (2013) analyses the impact of the availability of public childcare services on the maternal employment and educational attainment of children in Italy. The study suggests that increasing the availability of public childcare services may have positive effects on maternal employment and children's language test scores, helping to reduce poverty and inequality. The authors also report that regions with higher childcare coverage are characterised by higher employment rates of mothers and better language test scores.

1.2.2 Gender quotas and Public Spending

The use of gender quotas can be a powerful tool to increase female representation in politics and improve the quality of local politics. Increasing the percentage of female councillors can lead to increased funding for local security, education, social services and also to a reduction in administrative expenses. The gender quota reform (law no. 81/1993) implemented in Italy in 1993 aimed to establish a more balanced gender composition across each list of candidates within municipal elections. Nevertheless, in 1995, the Constitutional Court deemed this law unconstitutional, asserting that the fundamental right to equal access to elected office cannot be subjected to selective treatment based on gender; Law number 215/2012 was implemented in Italy with the objective of enhancing the representation of women in municipal councils. This was achieved through the introduction of measures such as dual preference voting based on gender and gender quotas in the candidate lists. The law is applicable to all Italian municipalities with a population exceeding 5,000 individuals. The underlying studies emphasise the importance of policies that promote gender equity in elected entities and optimise the efficiency of local governance. Svaleryd (2009) demonstrates that the gender composition of municipal councils in Sweden exerts an influence over the patterns of local expenditure. Certain studies posit that both the gender of the mayor and the composition of the council have an impact on municipal spending (Cabaleiro and Buch 2018, 2020; Hern´andez-Nicol´as et al., 2018). Priyanka's (2022) article emphasises the importance of promoting women's leadership at different levels of government to influence human capital accumulation in different ways. The findings of the study have significant implications for education policy in India and other developing countries. The author studies the impact of female political leadership in state legislatures on the learning outcomes of primary school children in India. The results show that an increase in the percentage of female MPs has a positive and statistically significant effect on the reading and mathematical competence of primary school children in India. The study also finds that women politicians increase the likelihood that public schools receive subsidies and useful inputs for learning. In addition, female politicians lead families to show greater confidence in the ability of public schools to provide a better education. Also, the research conducted by Clots-Figueras (2011, 2012) demonstrates that the inclusion of female lawmakers in India yields beneficial outcomes in terms of increased investments in healthcare and education, as well as the implementation of policies aimed at redistributing resources. In a study conducted by Baltrunaite et al. (2019) it is demonstrated that the enactment of law number 215/2012 has effectively diminished the gender gaps in political empowerment within Italian municipalities. The research reveals that the proportion of female counsellors experienced an increase of 18 percentage points subsequent to the introduction of the law. The augmentation in female representation predominantly stems from the preferential votes cast in favor of female candidates, thus highlighting the influential role of dual preference voting. Gender composition within institutions can influence the structure of public spending and the political budget cycle. The study conducted by Ordine et al. (2022) is a valuable contribution to the understanding of the impact of gender representation within

political institutions on the political budget cycle (PBC) and the size and configuration of public spending; in particular, it focuses on the economic outcomes of reducing gender imbalances in political entities, i.e., the influence of female representation on the political budget cycle (PBC) and the size and configuration of public spending within Italian municipalities. Finally, the study finds that the gender composition of political institutions has a significant impact on the political budget cycle (PBC) and the size and structure of public spending. The results suggest that an increase in the number of women elected to municipal councils may lead to a reduction in public spending, particularly in areas typically affected by PBC, except those related to women's needs. Women in politics tend to implement policies in areas conventionally thought to be feminine and allocate larger budgets to these areas. Increased female representation in politics may also prove beneficial for women-centered issues, such as investments in child care. The article by Andreoli et al. (2022) argues that the gender composition of political bodies can have an impact on policy implementation and public spending. The research investigates the ramifications of gender quotas on women's participation in politics and the resulting effect on local policymaking in Italy. The results of the study indicate that the introduction of gender quotas increases the share of women in municipal councils by 14.38 percentage points and has a significant effect on local policymaking. Specifically, the authors find that a 1 percentage point increase in women's participation in councils leads to a 1 percent increase in local security spending and a comparable reduction in administrative costs. Given the disproportionate burden of childcare and elderly care assumed by women, the investigation undertaken by Cavallini et al. (2023) scrutinizes the impact of the escalation in female representation in local governments on the provision of public social services in Italy. The results are conflicting with the rest of the literature regarding public social service spending. The study concludes that, even though the law was successful in enhancing female representation, it failed to result in a significant increase in spending on social services, including childcare, elderly care, and other forms of assistance. It is important to note that the analysis solely focuses on the short-term effects of the gender quota policy, and it remains unclear whether the policy will have long-term effects on spending on social services. Other studies consistent with that of Cavallini et al. (2023), provide no evidence that an increase in female representation has an impact on the composition of municipal spending (Campa and Bagues 2021), nor that female mayors are more likely to implement gender-inclined policies (Gago and Carozzi 2021).

1.3 Law no. 215/12

Law no. 215 of 23 November 2012 contains provisions to promote the rebalancing of gender representation in local councils and councils and regional councils The most significant novelty is the amendment of the law for the election of municipal councils with the introduction of measures to strengthen the presence of women, but also of considerable importance are the interventions aimed at consolidating gender equality in the juntas and, more generally, in all non-elective collegiate bodies of municipalities and provinces. For the

election of municipal councils, in municipalities with a population of more than 5,000 inhabitants the law, taking up a model already tested by the regional electoral law of Campania, provides for a double measure to ensure gender balance:

-the cd. list quota: in the lists of candidates neither of the two sexes can be represented by more than two thirds (with rounding to the upper unit for the least represented gender, even in case of decimal place less than 0,5);

-the introduction of the cd. double gender preference, which allows the voter to express two preferences (instead of one, as provided for in previous legislation) as long as they concern candidates of different sex, otherwise the cancellation of the second preference.

In the event of infringement of the provisions on the quota list, provision is made for a differentiated sanction mechanism, depending on whether the population exceeds 15000 inhabitants or not, which in fact makes the quota effectively binding only in municipalities with population over 15,000 inhabitants. In particular, in municipalities with a population of more than 15,000 inhabitants, the Electoral Commission, in case of non-compliance with the quota, reduces the list, deleting the candidates of the most represented kind, starting from the last, to ensure compliance with the quota; The list which contains fewer than the minimum number of candidates required by law after deletion is rejected and therefore lapses. In municipalities with a population between 5,000 and 15,000 inhabitants, the Electoral Commission, in case of non-compliance with the quota, also in this case proceeds to the cancellation of candidates of the overrepresented gender starting from the last; However, the reduction in the list may not result in fewer candidates than the minimum prescribed by law.

1.4 Data

Combining data on Italian municipal budgets, data on the registry of local administrators provided by the AIDA PA database and the Ministero dell'Interno, respectively, with INVALSI data provided at municipal level by the National Institute for the Evaluation of the Education and Training System[7], we obtain a repeated cross-section. The aim is to establish the effects of changes in local public spending, resulting from exogenous changes in the share of female participation in municipal councils, on the educational achievements of primary school students, using these as a proxy for the level of human capital. The institute provides data on test scores in mathematics, Italian and English for all grades in the school years 2013/2014-2021/2022, the municipality is identified where there are at least three schools. This data provides a means to objectively measure the performance of both individual students and schools. Within this database, one can also find

[7] INVALSI tests consist of standardised performance tests administered to the entire population of Italian students.

demographic and socio-economic data on students, including but not limited to gender, date of birth, pre-school attendance, immigrant status, parental background, school and school complex longitudinal code, student longitudinal code and municipality. These variables allow a high degree of control over the heterogeneities commonly found in the individual circumstances of each student, leading to an effective match with the municipal data available to us. The analysis focuses on grade two education in mathematics and Italian, considering the academic years 2013/2014, 2014/2015, 2015/2016, 2016/2017, 2017/2018, 2018/2019; the following items are extracted from the municipal budgets for ordinary expenditure for Mission 4 and Mission 12: "pagamenti in conto competenza"[8] from 2010 to the year 2016 for Mission 4 and for Mission 12.

1.4.1 Descriptive Statistics

This section provides the descriptive statistics of the analysis. In particular, graphs are shown of the average INVALSI results in Italian and mathematics grade two, the average expenditure per mission 4 and 12 programme 1 (on a logarithmic scale), and the quota of women in municipal councils. Finally, Table 1 shows the descriptive statistics of the INVALSI results in Italian and mathematics grade two, the per capita expenditure per mission 4 and 12, programme 1, and the gender share; Table 2 shows a description of the variables used in the analysis.

[8] The expenses that the municipality actually paid (payments) during the year.

Figure 4.1 The average representation of women in municipal councils

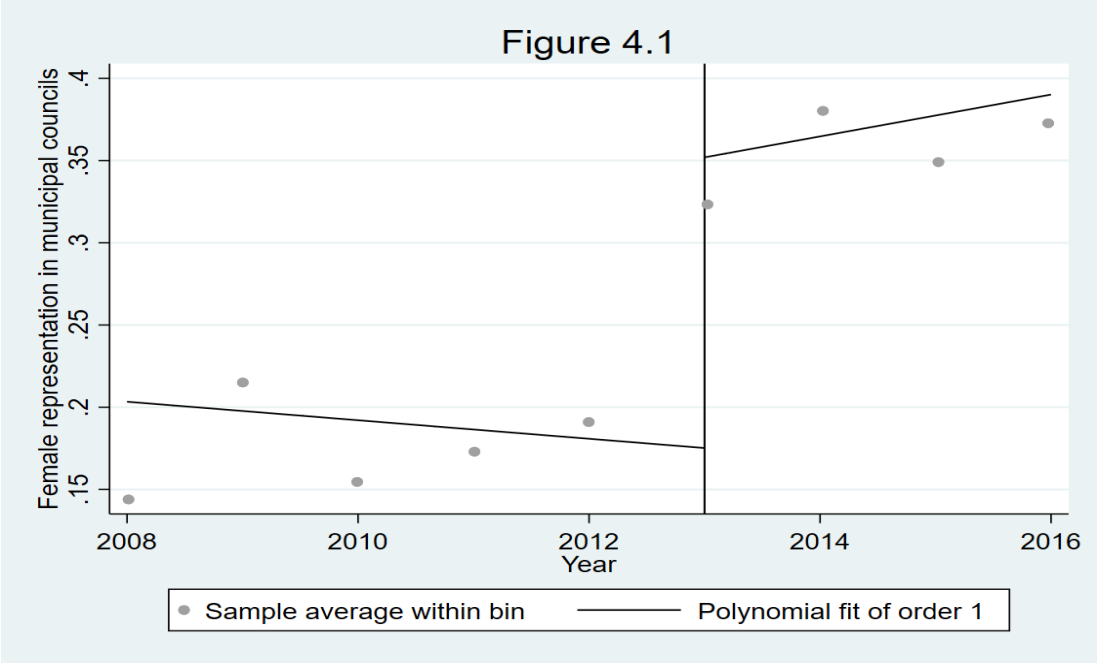


Figure 4.1 denotes the quota of women in municipal councils from the year 2010 to the year 2016. The cutoff is set when Law No. 215/2012 comes into force, in fact, after the introduction of this measure, the quota undergoes a considerable increase. In this graph, municipalities with more than 5,000 inhabitants are considered and special statute regions , except Sardinia, are eliminated.

Figure 4.2 Average scores in Italian in INVALSI tests

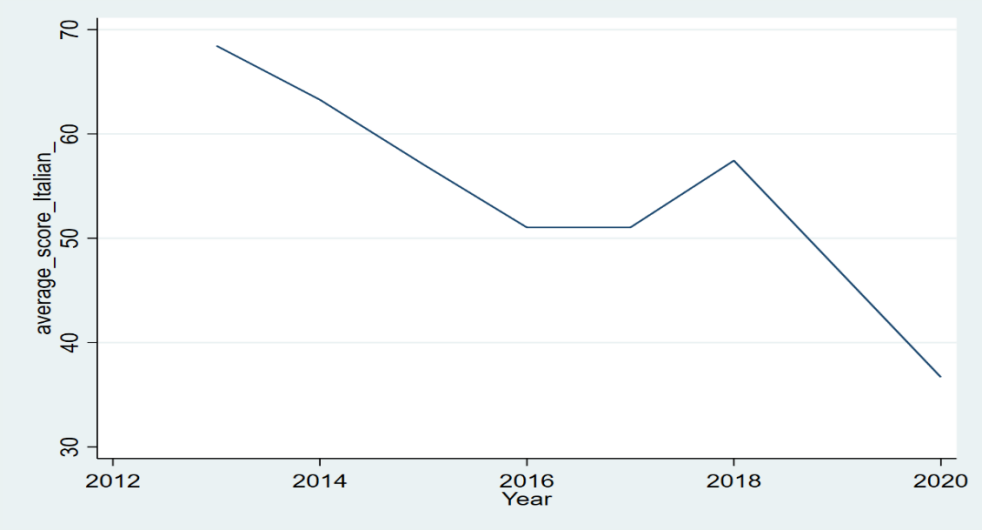
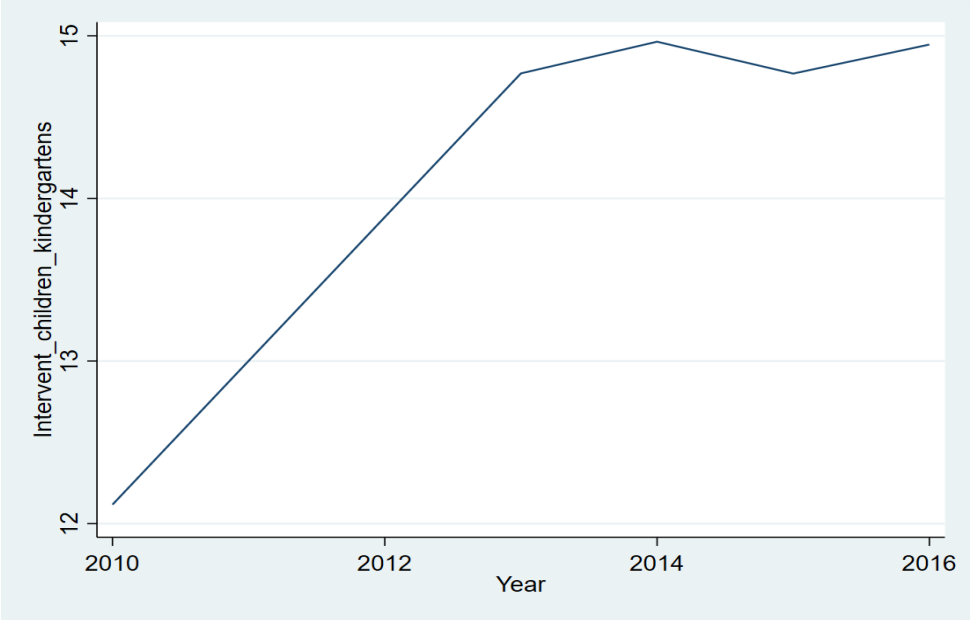


Figure 4.2 shows the annual average INVALSI test scores in Italian in the respective Italian municipalities. The performance of the students per year sees a decrease until the year 2016 and a beginning of an increase from 2018, but afterwards it starts to decrease again.

Figure 4.3. Logarithm of expenditure for mission 12, programme 01 (Interventions in favour of children and young people and kindergartens)

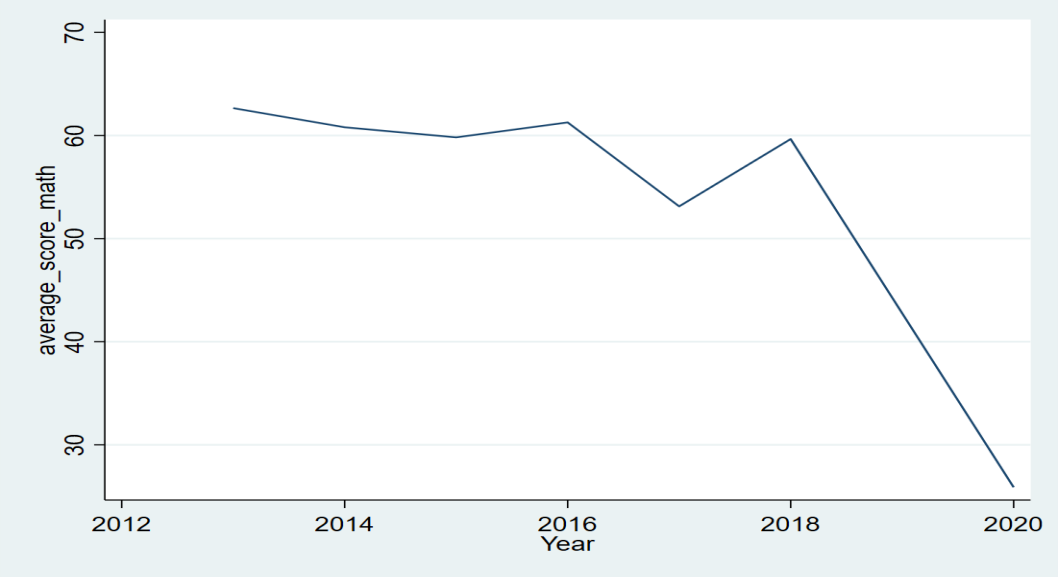


In Figure 4.3, expenditure on Interventions for Children and Interventions in favour of children and young people and kindergartens, shows an increasing trend, especially from 2013 onwards.

Figure 4.4 Logarithm of expenditure for mission 4 , programme 01 (Pre-school education)

In Figure 4.4, expenditure on Pre-School Education, shows an abrupt change in the trend, from decreasing to increasing.

Figure 4.5. Average scores in Math in INVALSI tests



In Figure 4.5, the average maths score tended to decrease until 2015; thereafter, a small rise occurred from 2015 onwards until it fell precipitously in the year 2017; in the year 2017 itself, the trend began to rise again.

The table below (Table 4.1) shows the average INVALSI scores in mathematics and in Italian from the year 2013 to the year 2020, the average of the rose quotas in the municipal councils from the year 2008 to the year 2016, the average of the expenditure for each municipality in pre-school education and in Interventions for children and minors and for kindergartens. The average score obtained in mathematics in the INVALSI tests is almost 60% compared to about 57% in Italian. The average per capita expenditure in mission 4, programme 01, is lower than the per capita expenditure in mission 12, programme 01. The average quota of women in the municipal council per municipality is 0.25.

Table 4.1. Average of INVALSI results in Italian and mathematics, average of per capita expenditure in Mission 4 and in Mission 12, average of gender quotas.

	Mean	***Standard deviation***	***Minimum value***	***Maximum value***	***Number of non-missing values***
Total normalized score - Mathematics	59.55	21.62	0	100	1,217,817
Total normalized score - Italian	57.38	24.45	0	100	1,256,026
Gender Quotas	0.25	0.11	0	.5	754,078
Per capita expenditure on pre-school education	23.11	26.07	0	136.2004	805,740
Per Capita Expenditure on interventions in favor of children and kindergartens	36.18	29.77	0	133.4897	805,740

Table 4.2 describes the variables used in the analysis and their respective description.

Table 4.2 lists the variables used

Variables	*Description*
Score_Math	*Total percentage score - Mathematics*
Nationality	*Origin of the student: in the dataset, it is identified with a dummy that takes the value 1 if the student is native, 0 otherwise.*
Regularity	*Regularity with regard to studies: in the dataset, it is identified with a dummy that takes the value 1 if the student is regular or anticipatory, 0 otherwise.*
Gender	*Identifies the gender of the student: in the dataset, it is identified with a dummy that takes the value 1 if the student is Male, 0 otherwise.*
Bachelor_Degree_Father	*Qualification, Bachelor's degree (father)*
High_School_Father (diploma)	*Qualification, High School (father)*

Middle_School_Father (licence)	*Qualification, Middle School (father)*
Bachelor_Degree_Mother	*Qualification, Bachelor's degree (Mother)*
Middle_School_mother (licence)	*Qualification, Middle School (Mother)*
High_School_mother (diploma)	*Qualification, High School (Motherr)*
Effectiveness of expenditure	*Interaction term (public expenditure according to the mission considered in the analysis multiplied by effectiveness)*
Gender_quotas	*The average quota of women in the municipal councils*
Change_in_gender_quotas	*Change in gender quotas (between the years 2013,2012 and 2011)*
Provinces	*Fixed effects per provinces*
Regions	*Fixed effects per Regions*
Year	*Time effects*
Municipalities_under_reform[9]	*Municipalities with a population of 5 or more inhabitans: in the dataset, it is identified with a dummy that takes the value 1 if the municipalities have a population of 5000 or more, 0 otherwise*
percap_expend_ educ	*Per capita expenditure on pre-school education*
Geographical area	*North West; North East; Centre; South; South and Islands*

[9] Special statute regions, not subject to Law 215/2012, are excluded from the analysis, with the exception of Sardinia.

Score_Italian	*Total percentage score - Italian*
percap_expend_children	*Per capita Expenditure on interventions in favor of children and kindergartens*
Effectiveness	*Dummy taking value 1 if the geographical area is north, 0 otherwise.*

Source: Data on the composition of municipal councils from administrative registers are provided by the Italian Ministry of the Interior. The 'Anagrafe degli amministratori locali e regionali' (AARL) collects digitised data on the members of municipal councils and mayors of each Italian municipality (from the year 2008 to the year 2016).

The analysis makes use of administrative data from the Italian Institute for the Evaluation of the Italian Educational System (henceforth INVALSI) on primary school students attending second grade in the school years 2013/2014 to 2020/2021 (in the year 2019/2020 no Invalsi tests are taken).

The data on expenditure in pre-school education (mission 4 programme 01) and on expenditure in Interventions for children and minors and for kindergartens (mission 12 programme 01) are provided by the AIDA PA database from the year 2010 to the year 2016 (expressed in thousands of euros).

1.5 Econometric framework

This session will discuss the econometric problems of the analysis, the methodology used and the models analysed.

1.5.1 Endogeneity problem

Before delving into the methodology and description of the model under analysis, it is fair to point out the econometric problems that some variables might present. The variables pre-school education expenditure and expenditure on childcare and day care services present endogeneity problems. For example, municipalities with higher employment rates, which are positively related to education levels, particularly among female workers, generate a higher demand for public day-care centres from policy makers. This is due to the fact that working parents are not able to take care of their children once the statutory holiday periods are over. Consequently, a reverse causality problem may arise due to a higher proportion of working people compared to the population, resulting in local spending on education. At the same time, higher local spending on education has a long-term effect on human capital, through the acquisition of higher individual skills, which does not discourage employment, particularly female employment, due to the balance between work and the cost of sending children to a private kindergarten. Furthermore, there is empirical evidence that municipalities with a more virtuous institutional environment are less likely to evade taxes. As a result, they have more revenue to finance public goods and services, including the creation of new kindergartens or primary schools, resulting in the hiring of new teachers and a decrease in the teacher/student ratio. Class size and the teacher/student ratio is, in fact, one of the variables that significantly influence the educational

attainment of students, i.e. one of the most widely used proxies for measuring the level of human capital. This also poses a reverse causality problem, in that municipalities with less evasion have more revenue to spend on education, thus creating a more virtuous and advanced institutional environment, which further discourages tax evasion, and so on. The other problem of endogeneity is found in the variable gender quota in municipal councils, as it might depend on socio-cultural reasons and gender stereotypes, especially in southern regions, where the share of women in these regions might be lower than in northern regions. To avoid bias in the estimation results, we will use the IV method and as an instrumental variable the exogenous change in the female share in the years 2013-2011, thus capturing the effects of the introduction of the 215/2012 reform. Since the exogenous instrument used refers to the introduction of a law, therefore, a particular moment in time is identified to capture its effects, other strategies to deal with endogeneity could have been considered, but some criteria were not met. However, the instrumental variables method was preferred.

1.5.2 Empirical Strategy

From the point of view of econometric modelling, a two-stage regression model is required for both the preliminary analysis, which examines the relationship between public expenditure on pre-school education and the total gender share, and for the main analysis, which examines the relationship between invalid results in Italian and mathematics (grade two) and local public expenditure on pre-school education. Robustness checks are performed on both analyses, but with a different expenditure category, mission 12 programme 01. For this purpose, Law No. 215/2012 is used as an exogenous variation, i.e. the variation in the share of women elected in the years 2013-2011 in the various municipal bodies as an exogenous instrument of public expenditure on pre-school education (and in the robustness checks for expenditure on childcare services and kindergartens) and total gender shares. To confirm the reliability of the results, the Durbin-Wu-Hausman test is performed; in addition, the Kleibergen-Paap rk test[10] for the rank of a matrix is implemented; finally, we perform the test for the presence of weak instruments, where the minimum eigenvalue statistic of Cragg and Donald (1993) and the null hypothesis of Stock and Yogo's (2005) test[11], i.e. that the set of instruments is weak, is reported.

[10] In econometrics, the requirement for identification is the rank condition, which states that a particular matrix must have the rank of an integer column. The Kleibergen-Paap rk statistic is a generalisation of Anderson's canonical correlation rank test to the case of a non-Kronecker covariance matrix. The ranktest implementation calculates rk statistics robust to various forms of heteroskedasticity, autocorrelation and clustering.

[11] The critical values for the relative bias of the 2SLS with two endogenous regressors are only available if there are at least four excluded instruments. With one endogenous regressor, critical values are only available if one has at least three excluded instruments.

1.5.3 Model

In this session we describe the three models considered in the analysis. In a preliminary step we estimate a model with public spending on pre-school education as the dependent variable (later the robustness check is run on the same model with spending on child care and kindergarten) on the total gender share, considering province and region fixed effects and time effects. In the second and third model Υ is the grade test score in math and italian for each student; EXP is the public expenditure for each municipality; ϒ and η are region and province fixed effect to account for any unobserved heterogeneity over time; X are several controls; μ an ν are random error terms. The instrumental variable is the change in the share of women elected to the various municipal bodies in the years 2013-2011, that it is exposed to exogenous changes due to the enactment of the reform.

$First\ model$

$EXP_m = \alpha_1 \cdot \widehat{Quotas}_m + \mathfrak{t} + \Upsilon_m + \eta_m + \pi \cdot X_m + \nu_m$ *(2) Second-Stage*

$Quotas_m = \alpha_1 \cdot \Delta Gender\_Quotas_{(2013\text{-}2011),m} + \mathfrak{t} + \Upsilon_m + \eta_m + \nu_m$ *(1) First-Stage*

Second model

$Y_{mathematics} = \beta \cdot \widehat{EXP}_{m,i} + \mathfrak{t} + \Upsilon_m + \eta_m + \pi \cdot X_{m,i} + \mu_{m.i}$ *(4) Second-Stage*

$EXP_i = \alpha_1 \cdot \Delta Gender\_Quotas(2013 - 2011), m + \mathfrak{t} + \Upsilon_m + \eta_m + \pi \cdot X_m + \nu_m$ *(3) First-Stage*

Third model

$Y_{italian} = \beta \cdot \widehat{EXP}_{m,i} + \mathfrak{t} + \Upsilon_m + \eta_m + \pi \cdot X_{m,i} + \mu_{m.i}$ *(6) Second-Stage*

$EXP_i = \alpha_1 \cdot \Delta Gender\_Quotas(2013 - 2011), m + \mathfrak{t} + \Upsilon_m + \eta_m + \pi \cdot X_m + \nu_m$ *(5) First-Stage*

1.6 Results

This section reports the results obtained in the analysis. As mentioned before, the instrumental variables methodology is used. We use the exogenous shock of reform no. 215/2012 that introduces double gender preference in municipalities with more than 5000 inhabitants to overcome the endogeneity problem of the variable spending on pre-school education (mission 4, programme 01). The choice of this variable is justified in the following way: by promoting greater involvement of women in politics, they can have an impact on the political process and on economic policy choices regarding the distribution of resources, such as public spending. The expenditure variable is endogenous, as it depends on several factors, e.g. a higher level of

public spending on education may be an endogenous characteristic of municipalities that are considered more 'virtuous', municipalities with higher employment rates are positively associated with the level of education, particularly among female workers, therefore, a reverse causality problem may arise due to a higher proportion of employees compared to the population, resulting in local spending on education. At the same time, higher local spending on education produces a long-run effect on human capital. In this regard, we exploit the exogenous shock of the reform as variation in the gender share in the year 2013-2011. The share of women for all years considered, could itself be endogenous due to the persistence of gender stereotypes in each municipality, for this reason we use the change in the years 2013-2011 of the reform as an instrumental variable for the share of women in the administration of each municipality and for the expenditure variable. Separate analyses are performed for this purpose: in the first step we regress the variable per capita expenditure, expressed on a logarithmic scale, on the share of women in each municipal council, the respective geographical areas, considering the population above 5000 inhabitants and excluding the special statute regions that are not subject to the reform, we control for the fixed effects per municipality and for the time effects year; in the second step we proceed to analyse the INVALSI result in grade two (mathematics) in relation to the variable spending on pre-school education, we include the student's regular or delayed enrolment, the student's origin, gender, father's and mother's educational qualification, mother's and father's occupation, fixed effects per municipality, per student and year time effects. Using the 2SLS estimator for both analyses and testing the reliability of this estimator, the tables below show the following estimates. In Table 6.3 we first run a simple OLS regression, but considering the endogeneity problems that characterise the proportion of women in municipal administrations for the reasons explained in the previous sections, we use the IV estimator. Table 6.4 shows the estimates of the first stage, where the variation in the years 2013-2011 of the gender share in municipal administrations explains the share of women in the years considered quite well, in fact it has a positive and statistically significant coefficient at 1%. Let us focus on the results of the second stage (table 6.5), which seem to be rather interesting. An increase of one percentage point in the share of women increases per capita expenditure on pre-school education by approximately 30.86 (in thousands of euros), (Svaleryd 2009). The Durbin-Wu-Hausman test (in the appendix) is performed, the null hypothesis is rejected at 5%, so the estimates returned by the 2SLS turn out to be reliable.

1.6.1 Primary analysis

Table 6.3 Linear regression

percapita_expend_educ	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Gender_quotas	32.9194	.3039	108.34	.0000	32.3239	33.515	***
Municipalities_under_reform	1.7418	1.0666	1.63	.1024	-.3486	3.8322	
Constant	4.1922	1.097	3.82	.0001	2.0421	6.3423	***

Mean dependent var	24.4383	SD dependent var	26.4441
R-squared	0.5458	Number of obs	661796
F-test	8283.3660	Prob > F	0.0000
Akaike crit. (AIC)	5690770.5696	Bayesian crit. (BIC)	5691876.6327

*** p<.01, ** p<.05, * p<.1*

Note: Province and Region fixed effects and time effects were included in each regression.

Table 6.4 Linear regression (First-stage regression)

Gender_quotas	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Change_in_gender_quotas	.0182	.0001	166.43	.0000	.0179	.0184	***
Municipalities_under_reform	-.0692	.004	-17.31	.0000	-.077	-.0613	***
Constant	.2338	.0041	57.00	.0000	.2258	.2419	***

Mean dependent var	0.2590	SD dependent var	0.1077
R-squared	0.6180	Number of obs	573077
F-test	10185.8918	Prob > F	0.0000
Akaike crit. (AIC)	-1478528.8666	Bayesian crit. (BIC)	-1477493.0592

*** p<.01, ** p<.05, * p<.1*

Note: Province and Region fixed effects and time effects were included in each regression.

Table 6.5 Instrumental variables 2SLS regression

percapita_expend_educ	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Gender_quotas	30.8603	1.5983	19.31	.0000	27.7277	33.9929	***
Municipalities_under_reform	1.7215	1.0754	1.60	.1094	-.3862	3.8293	
Constant	-10.4823	1.2822	-8.18	.0000	-12.9953	-7.9693	***

Mean dependent var	26.5332	SD dependent var	26.8642
R-squared	0.5608	Number of obs	571767
Chi-square	720531.1960	Prob > chi2	0.0000

*** p<.01, ** p<.05, * p<.1*

Note: Province and Region fixed effects and time effects were included in each regression.

1.6.2 Main analysis

We proceed to comment on the estimates obtained in the second analysis where the dependent variable is the INVALSI performance in mathematics (grade 2) and then on the INVALSI results in Italian grade 2. Here again, a simple OLS regression is performed, but to obviate the endogeneity problems of the variable spending on pre-school education, we perform the analysis with the IV estimator. In the first stage we regress the endogenous variable spending on pre-school education on all potentially exogenous variables, focus on the instrument variable, then on the total change in the gender share between the years 2013-2011; the coefficient turns out to be statistically significant and positive.

In the last step, we obtain that expenditure leads to an increase in Invalsi performance in mathematics, grade 2, of about 11% (Priyanka's 2022). The educational qualification of parents plays a key role in Invalsi performance, a higher educational qualification is associated with an increase in student performance. Origin has a positive and significant effect on the score, being a native student increases the score by about 5.98; being a male student increases the score by 2.58; finally being an early and regular student increases the score in mathematics by 2.55. The estimates show a gap between the northern and southern regions, i.e., the estimates show that public spending is more effective in the North, but a one euro increase in spending is more effective in the South. The endogeneity test is also performed in this analysis, and again the estimates returned by the 2SLS estimator are 5% reliable (see appendix); in addition, two further tests are implemented: the Kleibergen-Paap rk test, where the model turns out to be exactly identified (see appendix); and the test for weak instruments, where we reject the null hypothesis because the minimum eigenvalue statistic is higher than the threshold value. The null hypothesis can easily be rejected due to the very high value of the minimum eigenvalue. A high R-square indicates to us that the instruments are very strong in the first stage (see appendix).

Table 6.6 Linear regression

Score_Math	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Nationality	5.7068	.1257	45.38	.0000	5.4603	5.9532	***
Regularity	1.953	.5913	3.30	.0001	.794	3.1119	***
Gender	2.4413	.0624	39.14	.0000	2.319	2.5635	***
Bachelor_degree_Father	4.8623	.1609	30.21	.0000	4.5469	5.1777	***
High_School_Father (diploma)	2.2876	.1476	15.50	.0000	1.9984	2.5769	***
Middle_school_Father	-1.2813	.1513	-8.47	.0000	-1.5779	-.9847	***
Bachelor_degree-Mother_	5.641	.1692	33.34	.0000	5.3095	5.9726	***
High_School_Mother (diploma)	2.9433	.1589	18.53	.0000	2.632	3.2547	***
Middle_school_Mother	-1.7313	.1662	-10.42	.0000	-2.057	-1.4056	***
percapita_exp_educ	-.0074	.0027	-2.72	.0066	-.0128	-.0021	***
Municipalities_under_reform	1.7283	2.3157	0.75	.4554	-2.8103	6.2669	
Effectiveness_of_expenditure	.0513	.0604	0.85	.396	-.0671	.1697	
Effectiveness[12]	0	.	.	.	.	.	
Constant	46.6372	2.4268	19.22	. 0000	41.8808	51.3936	***

Mean dependent var	61.5957	SD dependent var	21.5072
R-squared	0.0795	Number of obs	438132
F-test	356.8928	Prob > F	0.0000
Akaike crit. (AIC)	3896000.0727	Bayesian crit. (BIC)	3897176.0322

**** p<.01, ** p<.05, * p<.1*

Note: Province and Region fixed effects and time effects were included in each regression.

Table 6.7 Linear regression **(**First- stage regression)

percapita_expend_educ	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Nationality	-3.1092	.0696	-44.64	.0000	-3.2457	-2.9727	***
Regularity	-4.6981	.3246	-14.47	.0000	-5.3343	-4.0619	***
Gender	.0003	.036	0.01	.9928	-.0702	.0708	
Bachelor_degree_Father	.9081	.0914	9.94	.0000	.729	1.0872	***
High_School_Father (diploma)	-.6699	.084	-7.98	.0000	-.8345	-.5054	***
Effectiveness_of_expenditure	16.7302	.022	758.76	.0000	16.687	16.7734	***
Effectiveness	-14.4729	.3241	-44.66	.0000	-15.1081	-13.8377	***
Middle_school_Father	-1.2127	.0864	-14.04	.0000	-1.382	-1.0434	***
Bachelor_degre	.4139	.0962	4.30	.0000	.2253	.6024	***

[12] Effectiveness omitted because of collinearity.

e-Mother_							
High_School_Mother (diploma)	-.8006	.0905	-8.85	.0000	-.9779	-.6233	***
Middle_school_Mother	-1.1145	.0951	-11.72	.0000	-1.301	-.9281	***
Change_in_gender_quotas	[redacted]	.0233	40.21	.0000	.8911	.9824	***
Municipalities_under_reform	.6501	1.2447	0.52	.6014	-1.7894	3.0897	
Constant	8.8558	1.3189	6.71	. .0000	6.2707	11.4408	***

Mean dependent var	26.6657	SD dependent var	26.7680
R-squared	0.8287	Number of obs	380139
F-test	18197.0144	Prob > F	0.0000
Akaike crit. (AIC)	2907593.5236	Bayesian crit. (BIC)	2908700.0494

*** p<.01, ** p<.05, * p<.1*

Note: Province and Region fixed effects and time effects were included in each regression.

Table 6.8 Instrumental variables 2SLS regression

Score_Math	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
percapita_expend_educ	.1096	.0461	2.37	.0176	.0191	.2	**
Nationality	5.9829	.1924	31.10	.0000	5.6059	6.3599	***
Regularity	2.5472	.6405	3.98	.0001	1.2918	3.8027	***
Gender	2.5776	.0667	38.63	.0000	2.4468	2.7083	***
Bachelor_degree_Father	4.9184	.1745	28.19	.0000	4.5764	5.2603	***
High_School_Father (diploma)	2.468	.159	15.52	.0000	2.1563	2.7796	***
Effectiveness_of_expenditure	-1.8923	.772	-2.45	.0142	-3.4054	-.3792	**
Effectiveness	2.8347	.8288	3.42	.0006	1.2102	4.4591	***
Middle_school_Father	-.9658	.17	-5.68	.0000	-1.299	-.6325	***
Bachelor_degree-Mother_	5.5891	.1795	31.14	.0000	5.2372	5.9409	***
High_School_Mother (diploma)	2.9868	.1719	17.38	.0000	2.65	3.3236	***
Middle_school_Mother	-1.6906	.1836	-9.21	.0000	-2.0504	-1.3308	***
Municipalities_under_reform	2.0012	2.3095	0.87	.3862	-2.5253	6.5277	
Constant	42.4342	2.4798	17.11	.0000	37.5739	47.2945	***

Mean dependent var	61.4188	SD dependent var	21.4100
R-squared	0.0776	Number of obs	380139
Chi-square	33552.4645	Prob > chi2	0.0000

*** p<.01, ** p<.05, * p<.1*

Note: Province and Region fixed effects and time effects were included in each regression.

We perform the same analysis on INVALSI performance in Italian grade two and get the same effects as in mathematics grade two. Expenditure on pre-school education instrumented by the change in the gender quotas in municipal bodies between the years 2013 and 2011 leads to an increase in students' performance in Italian. The endogeneity test shows that the estimates below are reliable (see appendix).

Table 6.9 Linear regression

Score_Italian	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Nationality	8.9512	.1369	65.38	.0000	8.6828	9.2196	***
Regularity	4.2056	.6534	6.44	.0000	2.9249	5.4863	***
Gender	-.8228	.0672	-12.24	.0000	-.9545	-.6911	***
Bachelor_degree_father	7.6833	.1658	46.33	.0000	7.3582	8.0083	***
High_School_Father (diploma)	3.8854	.1566	24.82	.0000	3.5786	4.1923	***
Effectiveness_of_expenditure	.069	.0656	1.05	.2928	-.0595	.1975	
effectiveness	3.7612	1.659	2.27	.0234	.5097	7.0127	**
Middle_school_father	-.6574	.1629	-4.04	.0001	-.9767	-.3381	***
Bachelor_Degree_Mother[13]	0	.	.	.	.	.	
High_School_mother (diploma)	-2.1573	.0845	-25.53	.0000	-2.323	-1.9917	***
Middle_school_mother	-6.7107	.1137	-59.02	.0000	-6.9335	-6.4878	***
percapita_expend_educ	-.0044	.003	-1.49	.136	-.0102	.0014	
Municipalities_under_reform	2.9003	2.5371	1.14	.253	-2.0724	7.873	
Constant	48.2664	3.0844	15.65	.0000	42.221	54.3117	***

Mean dependent var	59.9995	SD dependent var	24.1807
R-squared	0.1467	Number of obs	442282
F-test	723.8638	Prob > F	0.0000
Akaike crit. (AIC)	4003025.5379	Bayesian crit. (BIC)	4004191.5064

*** p<.01, ** p<.05, * p<.1*

Note: Province and Region fixed effects and time effects were included in each regression.

Table 6.10 Linear regression (First-stage regression)

percapita_expend_educ	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Nationality	-3.0345	.0694	-43.70	.0000	-3.1706	-2.8984	***
Regularity	-4.9547	.3306	-14.99	.0000	-5.6027	-4.3067	***
Gender	.0024	.0355	0.07	.9469	-.0672	.072	
Bachelor_degree_father	.9002	.0862	10.45	.0000	.7313	1.0691	***

[13]No observations for this variable.

High_School_Father (diploma)	-.6612	.0816	-8.10	.0000	-.8212	-.5013	***
Effectiveness_of_expenditure	16.8114	.0218	769.73	.0000	16.7686	16.8542	***
effectiveness	-14.7935	.3278	-45.13	.0000	-15.436	-14.151	***
Middle_school_father	-1.2059	.0853	-14.14	.0000	-1.373	-1.0388	***
Bachelor_degree_mother[14]	0	.	.	.	.	.	
High_School_mother (diploma)	-1.1252	.0442	-25.43	.0000	-1.2119	-1.0385	***
Middle_school_mother	-1.4027	.0603	-23.25	.0000	-1.521	-1.2845	***
Change_in_gender_quotas	[redacted]	.023	34.95	.0000	.7582	.8483	***
Municipalities_under_reform	.6136	1.249	0.49	.6232	-1.8344	3.0617	
Constant	9.3619	1.3239	7.07	.0000	6.7671	11.9568	***

Mean dependent var	26.6140	SD dependent var	26.7711
R-squared	0.8316	Number of obs	383269
F-test	18920.1949	Prob > F	0.0000
Akaike crit. (AIC)	2924995.9069	Bayesian crit. (BIC)	2926092.4126

**** p<.01, ** p<.05, * p<.1*

Note: Province and Region fixed effects and time effects were included in each regression.

Table 6.11 Instrumental variables 2SLS regression

Score_Italian	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
percapita_expend_educ	.2922	.0585	4.99	.0000	.1775	.4069	***
Nationality	9.7318	.2265	42.97	.0000	9.2879	10.1757	***
Regularity	5.5368	.7361	7.52	.0000	4.094	6.9796	***
Gender	-.8227	.0726	-11.33	.0000	-.965	-.6803	***
Bachelor_degree_father	7.5091	.1837	40.87	.0000	7.149	7.8691	***
High_School_Father (diploma)	4.1211	.1714	24.04	.0000	3.7851	4.4571	***
Effectiveness_of_expenditure	-4.9023	.9834	-4.98	.0000	-6.8297	-2.9748	***
effectiveness	3.7881	1.0014	3.78	.0002	1.8254	5.7508	***
Middle_school_father	-.1416	.1883	-0.75	.4521	-.5107	.2275	
Bachelor_degree_mother[15]	0	.	.	.	.	.	
High_School_Mother (diploma)	-1.9042	.1119	-17.02	.0000	-2.1235	-1.6849	***

[14] No observations for this variable.

[15] No observations for this variable.

Middle_school_father	-6.4549	.1476	-43.74	.0000	-6.7441	-6.1656	***
Municipalities_under_reform	3.0913	2.554	1.21	.2261	-1.9144	8.097	
Constant	31.3231	2.7586	11.35	.0000	25.9164	36.7298	***

Mean dependent var	59.9706	SD dependent var	24.1435
R-squared	0.1340	Number of obs	383269
Chi-square	67310.7065	Prob > chi2	0.0000

**** p<.01, ** p<.05, * p<.1*

Note: Province and Region fixed effects and time effects were included in each regression.

1.7 Robustness Checks

In this session, robustness checks are performed. To confirm the results obtained previously, we consider the results in Italian, grade 2, in relation to expenditure on mission 12, programme 01 (Interventions for children and kindergartens) and the INVALSI in mathematics, grade 2, in relation to expenditure on interventions for children and kindergartens. In each estimate, special statute regions are eliminated and a population above 5,000 is considered, precisely because the law is applied to municipalities with a population above this threshold. We obtain similar results in the different specifications, shown in the appendix.

1.8 Conclusion

The present study focused on the impact of local public spending, particularly spending in mission 4 and mission 12 of program 01, on the development of human capital as measured by the educational achievement of Italian and Mathematics elementary school pupils, particularly class 2, as assessed by INVALSI tests. Public spending policies exert an influence on children's education and human capital, which is why it was deemed appropriate to investigate this relationship . In order to overcome the problems of endogeneity of the expenditure variable, it was thought to exploit the exogenous variation in reform Number 215/2012 that highlights women's participation in local political bodies to assess their impact on local public spending by mission and how the latter affects the educational performance of Italian children. Gender quotas refer to policies aimed at increasing female representation in municipal councils to counter inequalities in municipal government. The reference legislation in this analysis, which takes gender quotas into account, is Law No. 215/2012, which took effect for all Italian municipalities over the 5,000 population threshold, except for those with special statutes regions, except Sardinia, as they were not subject to reform. First we investigate the relationship between the expenditure variable (in mission 4 and in mission 12, programme 01) and the quota of women in the municipal council in each municipality, controlling for population over 5,000 inhabitants; then we investigate the relationship between the results of the grade 2 INVALSI tests in Italian and in mathematics, controlling for parents' educational qualification, origin, gender and regular or deferred enrolment of the student. In addition, an interaction term consisting of pre-school education expenditure and

geographical area was included in the model to capture the effect of expenditure between North and South. For both analyses, fixed effects and time effects are taken into account and the instrumental variable methodology (or 2SLS) is used; the instrumental variable for both analyses is the change in the quota of women in the years 2013-2011, since the variable representing the quota of women in municipal councils could be endogenous due to gender stereotypes, but the expenditure variable is also characterized by the endogeneity problem, i.e. in municipalities where the employment rate of women is higher, there could be an increase in demand for childcare and early childhood education, as women are unable to provide full care for their children. As a result, this mechanism could lead to an upturn in public spending. Similarly, this mechanism may lead to an increase in public spending for some municipalities. Through various specifications, we find that the proportion of women leads to an increase in spending on pre-school education. In addition, we observe that the change in the percentage of women between 2011 and 2013 that serves as an instrument for spending, resulting in improved INVALSI performance in both mathematics and Italian. These results are also confirmed by robustness checks. The allocation of public resources for individual skill development plays a key role especially therefore, promoting greater involvement of women in politics could have an impact on the political process and economic policy choices related to resource allocation, such as public spending, bringing positive effects on children's education. The ability to enter the labor market is now contingent on a worker's multifaceted skill set, also known as higher human capital, which is a collection of individual skills that positively influence the trend of aggregate productivity or the mechanisms underlying the phenomenon of economic growth. This phenomenon translates into a growing need for higher education, correlated with the increase in expenditure per student, both in average and incremental terms. This work on the impact of public spending on education and the presence of a high number of women in municipal councils could be of significant academic value for the improvement of the system.

1.9 Appendix

Endogeneity test performed on the estimates in table 6.5.

```
Tests of endogeneity
H0: Variables are exogenous
Durbin (score) chi2(1)        =  5.79802  (p = 0.0160)
Wu-Hausman F(1,571674)        =  5.79713  (p = 0.0161)
```

Endogeneity test performed on the estimates in table 6.8.

```
Tests of endogeneity
H0: Variables are exogenous
Durbin (score) chi2(1)        =  6.80007  (p = 0.0091)
Wu-Hausman F(1,380036)        =  6.79834  (p = 0.0091)
```

Kleibergen-Paap rk test on the estimates in Table 6.8

```
Kleibergen-Paap robust LIML-based (Wald version) test of rank of matrix
  Test statistic robust to heteroskedasticity
Test of rank=  0  rk=  304.46  Chi-sq(  1) p-value=0.0000
```

```
Kleibergen-Paap robust LIML-based (LM version) test of rank of matrix
  Test statistic robust to heteroskedasticity
Test of rank=  0  rk=  324.80  Chi-sq(  1) p-value=0.0000
```

Tests for weak instruments on the estimates in Table 6.8

First-stage regression summary statistics

Variable	R-sq.	Adjusted R-sq.	Partial R-sq.	F(1,380037)	Prob > F
per_capita~p	0.8287	0.8286	0.0042	1616.88	0.0000

Minimum eigenvalue statistic = 1616.88

Critical Values # of endogenous regressors: 1
H0: Instruments are weak # of excluded instruments: 1

	5%	10%	20%	30%
2SLS relative bias	(not available)			

	10%	15%	20%	25%
2SLS size of nominal 5% Wald test	16.38	8.96	6.66	5.53
LIML size of nominal 5% Wald test	16.38	8.96	6.66	5.53

Endogeneity test performed on the estimates in table 6.11

Tests of endogeneity
H0: Variables are exogenous
Durbin (score) chi2(1) = 25.9842 (p = 0.0000)
Wu-Hausman F(1,383167) = 25.979 (p = 0.0000)

Robustness checks on the preliminary estimate with expenditure in mission 12, programme 01 and gender quotas.

Table A1 Linear regression (First-stage regression)

Gender_Quotas	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Municipalities_under_reform	-.0692	.004	-17.31	.0000	-.077	-.0613	***
Change_in_gender_quotas	.0182	.0001	166.43	.0000	.0179	.0184	***
Constant	.2338	.0041	57.00	.0000	.2258	.2419	***
Mean dependent var		0.2590	SD dependent var			0.1077	
R-squared		0.6180	Number of obs			573077	
F-test		10185.8918	Prob > F			0.0000	
Akaike crit. (AIC)		-1478528.8666	Bayesian crit. (BIC)			-1477493.0592	

*** p<.01, ** p<.05, * p<.1
Note: Province and Region fixed effects and time effects were included in each regression.

Table A2 Instrumental variables 2SLS regression

percap_expend_children	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Gender_Quotas	69.8517	1.4469	48.28	.0000	67.0158	72.6877	***
Municipalities_under_reform	37.0702	.9736	38.08	.0000	35.162	38.9784	***
Constant	11.5318	1.1608	9.93	.0000	9.2568	13.8068	***
Mean dependent var		40.0348	SD dependent var			28.1811	
R-squared		0.6729	Number of obs			571767	
Chi-square		1177442.6817	Prob > chi2			0.0000	

*** p<.01, ** p<.05, * p<.1
Note: Province and Region fixed effects and time effects were included in each regression.

Tests of endogeneity
H0: Variables are exogenous
Durbin (score) chi2(1) = 597.693 (p = 0.0000)
Wu-Hausman F(1,571674) = 598.221 (p = 0.0000)

Robustness checks on the main estimate: Invalsi in mathematics in relation to expenditure in mission 12, programme 01 .

Table A3 Linear regression (First- regression)

percap_expend_children	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Nationality	-3.149	.0807	-39.02	.0000	-3.3071	-2.9908	***
Regularity	-6.4818	.3768	-17.20	.0000	-7.2205	-5.7432	***
Gender	.0111	.0418	0.27	.7906	-.0709	.0931	
Bachelor_degree_Father	1.3029	.1063	12.25	.0000	1.0945	1.5113	***
High_school_Father (diploma)	-.867	.0978	-8.87	.0000	-1.0587	-.6753	***
Effectiveness_of_Expenditure	14.8124	.0374	395.90	.0000	14.7391	14.8857	***
Effectiveness	-89.8979	.3896	-230.74	.0000	-90.6615	-89.1343	***
Middle_School_Father	-1.6958	.1007	-16.85	.0000	-1.8931	-1.4985	***
Bachelor_degree_Mother	.491	.1119	4.39	.0000	.2716	.7104	***
High_school_Mother (diploma)	-1.1717	.1053	-11.13	.0000	-1.378	-.9653	***
Middle_School_Mother	-1.4853	.1108	-13.41	.0000	-1.7024	-1.2682	***
Change_in_gender_quotas	1.3716	.0279	49.15	.0000	1.3169	1.4263	***
Municipalities_under_reform	19.5211	1.4449	13.51	.0000	16.6891	22.3531	***
Constant	56.8973	1.531	37.16	.0000	53.8965	59.898	***

Mean dependent var	40.0609	SD dependent var	27.5351
R-squared	0.7819	Number of obs	378103
F-test	13413.9998	Prob > F	0.0000
Akaike crit. (AIC)	3004681.8469	Bayesian crit. (BIC)	3005787.8249

*** p<.01, ** p<.05, * p<.1*

Note: Province and Region fixed effects and time effects were included in each regression.

Table A4 Instrumental variables 2SLS regression

Score_Math	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
percap_expend_children	.1276	.0326	3.92	.0001	.0638	.1914	***
Nationality	6.0598	.1642	36.90	.0000	5.7379	6.3816	***
Regularity	2.8427	.639	4.45	.0000	1.5903	4.0951	***
Gender	2.5862	.067	38.62	.0000	2.455	2.7174	***
Bachelor_degree_Father	4.7808	.1752	27.29	.0000	4.4375	5.1242	***
High_school_Father (diploma)	2.4515	.1591	15.41	.0000	2.1397	2.7633	***

Effectiveness_of_Expenditure	-1.995	.4847	-4.12	.0000	-2.945	-1.045	***
Effectiveness	11.6229	2.6239	4.43	.0000	6.4801	16.7658	***
Middle_School_Father	-.8871	.1705	-5.20	.0000	-1.2212	-.553	***
Bachelor_degree_Mother	5.5618	.1798	30.93	.0000	5.2093	5.9142	***
High_school_Mother (diploma)	3.0189	.1727	17.48	.0000	2.6804	3.3574	***
Middle_School_	-1.6715	.1835	-9.11	.0000	-2.0312	-1.3119	***
Municipalities_under_reform	-.2753	2.3921	-0.12	.9084	-4.9637	4.4131	
Constant	35.5573	3.1509	11.28	.0000	29.3817	41.7329	***

Mean dependent var	61.4355	SD dependent var	21.4122
R-squared	0.0763	Number of obs	378103
Chi-square	33742.9931	Prob > chi2	0.0000

**** p<.01, ** p<.05, * p<.1*

Note: Province and Region fixed effects and time effects were included in each regression.

Tests of endogeneity
H0: Variables are exogenous
Durbin (score) chi2(1) = 16.184 (p = 0.0001)
Wu-Hausman F(1,378000) = 16.1803 (p = 0.0001)

Robustness checks on the main estimate: Invalsi in Italian in relation to expenditure in mission 12, programme 01 .

Table A5 Linear regression (First-stage regression)

per_capita_exp_12	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Nationality	-3.1327	.0809	-38.74	.0000	-3.2912	-2.9742	***
Regularity	-6.6144	.3853	-17.16	.0000	-7.3696	-5.8591	***
Gender	.015	.0415	0.36	.7178	-.0664	.0964	
Bachelor_degree_Father	1.3808	.1008	13.70	.0000	1.1833	1.5783	***
High_school_Father (diploma)	-.8043	.0955	-8.42	.0000	-.9914	-.6171	***
Effectiveness_of_Expenditure	14.9648	.0377	397.30	.0000	14.891	15.0386	***
Effectiveness	-90.7937	.3955	-229.59	.0000	-91.5688	-90.0186	***
Middle_School_Father	-1.6817	.0998	-16.85	.0000	-1.8773	-1.4861	***
Bachelor_degre	0	.	.	.	.	.	

e_Mother[16]							
High_school_Mother (diploma)	-1.566	.0516	-30.32	.0000	-1.6673	-1.4648	***
Middle_School_Mother	-1.843	.0706	-26.10	.0000	-1.9814	-1.7046	***
Change_in_gender_quotas	1.2363	.0276	44.79	.0000	1.1822	1.2904	***
Municipalities_under_reform	19.1664	1.4564	13.16	.0000	16.312	22.0208	***
Constant	57.989	1.5435	37.57	.0000	54.9638	61.0142	***

Mean dependent var	40.2023	SD dependent var	27.6271
R-squared	0.7851	Number of obs	380965
F-test	13913.8745	Prob > F	0.0000
Akaike crit. (AIC)	3024267.3533	Bayesian crit. (BIC)	3025363.2500

**** p<.01, ** p<.05, * p<.1*

Note: Province and Region fixed effects and time effects were included in each regression.

Table A6 Instrumental variables 2SLS regression

Score_Italian	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
percap_expend_children	.1969	.039	5.05	.0000	.1205	.2732	***
Nationality	9.4268	.1858	50.72	.0000	9.0625	9.7911	***
Regularity	5.4164	.7206	7.52	.0000	4.0041	6.8287	***
Gender	-.8298	.0725	-11.45	.0000	-.9718	-.6877	***
Bachelor_degree_Father	7.473	.1837	40.68	.0000	7.1129	7.8331	***
High_school_Father (diploma)	4.0475	.1696	23.86	.0000	3.715	4.38	***
Effectiveness_of_Expenditure	-3.1473	.5854	-5.38	.0000	-4.2948	-1.9999	***
Effectiveness	16.4426	3.1675	5.19	.0000	10.2343	22.6509	***
Middle_School_Father	-.1944	.1863	-1.04	.2966	-.5596	.1707	
Bachelor_degree_Mother[17]	0	.	.	.	.	.	
High_school_Mother (diploma)	-1.9386	.1088	-17.82	.0000	-2.1519	-1.7253	***
Middle_School_Mother	-6.5296	.1422	-45.92	.0000	-6.8083	-6.2509	***
Municipalities_under_reform	-.3332	2.643	-0.13	.8997	-5.5133	4.8469	
Constant	21.6697	3.6142	6.00	.0000	14.586	28.7534	***

Mean dependent var	59.9907	SD dependent var	24.1351
R-squared	0.1419	Number of obs	380965
Chi-square	67844.7201	Prob > chi2	0.0000

[16] No observations for this variable.

[17] No observations for this variable.

*** p<.01, ** p<.05, * p<.1

Note: Province and Region fixed effects and time effects were included in each regression.

Tests of endogeneity
H0: Variables are exogenous
Durbin (score) chi2(1) = 25.5988 (p = 0.0000)
Wu-Hausman F(1,380863) = 25.5937 (p = 0.0000)

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DID THE OPENING OF SCHOOL CONTRIBUTE TO THE SPREAD OF COVID-19?
EVIDENCE FROM ITALY

*Carmela Ciccarelli**

Abstract

The Covid-19 pandemic affected economic, health and educational systems around the world. Various measures have been taken to mitigate the spread of the virus, but the closure and subsequent opening of schools has caused enormous controversy. The main objective of the following paper is to analyse whether the opening of schools in Italy has contributed to the increase in infections. The data used are provided by the Istituto Superiore di Sanità at a daily level, where the unit of observation is the province; the dependent variable is the daily infection rate per province. The key variable is school opening and may be endogenous, since the increase in infection pushes regions to delay school opening. The methodology used is that of instrumental variables and the variable serving as instrument is the start of the past academic year. The opening dates were shifted by approximately ten days to take into account the incubation time and the time to perform the test. The results show that the opening of schools has a statistically significant and positive impact on the growth of infections.

JEL Codes: I10, I18, I20, I28

Keywords: Covid-19, Schooling, Growth rate of contagion, Italy

2.1 Introduction

Schools are of vital importance to a country. Closing schools was a difficult and dramatic decision. The aim of this empirical analysis is to understand what role the opening of schools has on the spread of Covid-19 infections, helping to improve the management of a possible pandemic, especially in hospital facilities, social and economic policies to be implemented. From the results of our study, it appears that the opening of schools in September 1.5 times greater on the course of the epidemic than when they are closed, but their closure has socio-economic consequences that should be taken into account, which should be mitigated with recovery plans by governments. The regression analysis is conducted on Italian provinces and the total population. The regression analysis is conducted on the Italian provinces and the overall population, the data used are provided on a daily basis and are panel type, where the unit of observation is the province, the key variable is the opening of schools and the dependent variable is the daily Covid-19 infection rate. The dataset contains 27820 observations, 107 provinces and a time period from 24 February 2020 to 9 November 2020. All opening dates of the 2020/2021 academic year were taken into account and to take into account the opening of schools, a dummy was constructed that takes the value 1 when schools start the academic year and 0 otherwise. The event of national, regional and local elections allowed the regions to postpone the start of the academic year in order to be able to better manage the increase in infections. In essence, the decision to postpone the opening of schools could make the school opening variable endogenous. It was considered appropriate to use an estimator that takes this endogeneity into account, so the methodology used is that of instrumental variables. The exogenous instrumental variable that mitigates the endogeneity problem is the school opening with reference to the academic year 2015/2016. The opening dates are shifted by ten days to account for incubation and the time required to perform the test and obtain the result. A regression was run first with the OLS estimator and then a regression with the two-stage IV estimator (2SLS).

The relevant literature claims that the opening of schools accelerated the transmissibility of the virus, showing homogeneity in the results. The analysis conducted on the available data yields a positive and significant coefficient at 5% of school opening on the growth of the Covid-19 infection rate.

Robustness checks were performed using the start of the school year in previous years as the instrumental variable and including the turnout for the national referendum on 20 and 21 September 2020 in the regression; the turnout for the referendum enters the model via an interaction term. The robustness analysis still shows positive and significant coefficients of the key variable on the spread of contagions from Covid-19; while the interaction term is not statistically significant, so the referendum turnout does not appear to explain the contagion rate.

The following paper is structured as follows: section 2 provides a review of the literature on the subject, but several papers on the effects of the pandemic on the economic system and population are highlighted; section

3 includes a description of the data used and the model; section 4 is entirely dedicated to the identification strategy adopted; section 5 focuses on the results of the analysis; finally, section 6 reports the robustness checks performed, section 7 discusses the policy implications and section 8 draws conclusions; section 9 contains the appendix and finally the paper concludes with section 10 containing bibliographical references.

2.2 Literature background

The globally widespread Covid-19 pandemic has hit the economic, health and educational systems of most countries hard. To mitigate the damage of this epidemic, several policy actions have been taken, but the one that has generated the most debate is the opening of schools. With the Prime Ministerial Decree of 4 March 2020, the government provided for the suspension of educational activities, facilitating smart working with the aim of containing the COVID-19 epidemic. In Italy, the more or less temporary closure of schools is ordered by the prefects, who are representatives of the government and the mayor. The Prefect closes the school for various reasons, such as in case of danger, health emergencies, safety, extraordinary maintenance and so on. If, on the other hand, there is a momentary or imminent danger to general safety, it is the Headmaster or the Institute's Security Officer who orders the immediate closure of the school or the suspension of lessons. It will however be his duty to inform the Prefect, the Mayor and the Provincial School Office of his decision, explaining the reasons for it[18]. The works shedding light on the potential impact of open schools on the spread of Covid-19 are varied and the results tend to be rather homogeneous, although they analyse different scenarios. Cases increased after mid-September in all countries, although some countries delayed the opening of schools. In this regard, the following paper focuses on the second wave of Covid-19 and the opening of schools, which occurred in September 2020 to coincide with national, regional and local elections, in order to understand whether or not the policies adopted, including the policy of closing schools, were effective; moreover, this could help governments better manage any outbreaks in the future. In this section, an attempt is made to understand the state of the art of the literature.

A few years ago, even before the Covid-19 pandemic, Adda (2015) wondered about the determinants of the spread of viruses. The article studies the economic determinants of the spread of viruses in time and space, in the short and long term. Using data on three viral diseases, which differ in various aspects such as incubation time or infectivity, the results shed light on the effectiveness of these measures for emerging diseases that share some of the same characteristics as those considered by the authors. In the event of school closures, Adda (2015) notes a decrease in the incidence of influenza of between 20% and 30%. The

[18] DECREE-LAW No. 111 of 6 August 2021
Paragraph 4, Article 1 of the decree-law provides in this regard that - until 31 December 2021 - for specific areas of the territory or for individual institutes, the Presidents of the Regions and Autonomous Provinces as well as the Mayors, "exclusively in red or orange zones and in circumstances of exceptional and extraordinary necessity due to outbreaks or to the extremely high risk of the spread of the SARS-CoV-2 virus or its variants in the school population in compliance with the principles of appropriateness and proportionality", may derogate from the general rule of paragraph 1, ordering the suspension of the performance of school and teaching activities in attendance.

effect is especially pronounced for children. For gastrointeritis, school closures still lead to a decrease, but by a smaller magnitude; for chicken pox they find a decrease in incidence of around 10%. Although closing schools for a period of 2 weeks would reduce the total annual incidence of certain diseases by up to 12% in all age groups, such measures represent an overall cost to society. The analysis shows that epidemics spread faster during economic booms. During booms, more people travel, increasing people-to-people contact and the spread of disease. Finally, the results show that warmer temperatures help contain outbreaks of familiar viruses responsible for influenza or gastroenteritis.

A scenario very similar to the work in question is that analysed by Amodio et al. (2021), who draw attention to the role of schooling in the spread of Covid-19 in Sicily during the pandemic. The authors combine a weekly panel of Covid-19 cases, using Italian microdata from Sicily, covering the period 1 August - 14 December. The exogenous variation used is the change in legislation by the regional government upon the occurrence of a national referendum, held on 20-21 September. Since some schools were used as polling stations, the opening date of the schools varied from the official scheduled opening date, generating a spatio-temporal granular heterogeneity that allowed him to identify the differential effect of school opening on the spread of Covid-19. The dependent variable is the geolocalised total of weekly Covid-19 cases in the census area obtained from the Istituto Superiore di Sanità (ISS). The key explanatory variable is the indicator of public school opening, which takes the value 0 before opening and 1 after the school opening date. This variable enters the model with a delay of two weeks to reflect the serial time of the infection and the delays in detecting the virus among the children. The decision to open the school is endogenous because it could be based on several reasons, including the percentage of Covid-19 cases in the area, internal organisational and administrative issues. The result suggests that the final increase in Covid-19 cases associated with schools may have been between 14.6 and 26.1% of the cumulative Covid-19 cases observed on 14 December.

Previous work has only focused on one region, Sicily, but several works, including the article by Massad et al. (2021) to estimate the impact of reopening schools during the COVID-19 outbreak in Brazil, considered three cities in the state of São Paulo, of approximately equal size: the city of Santos (433 656 inhabitants), Bauru (379 297 inhabitants) and Franca (355 901 inhabitants). The estimated model is a modified version of the classic SEIR model and considers the total population involved divided into: susceptible individuals; once infected, the susceptible move to the exposed state; infected individuals; individuals in state A may have died of natural causes. A birth rate equal to the natural mortality of the population is assumed, without taking into account disease-induced mortality. The dynamics of the model are described by differential equations and the age range taken into account in this study is 0 to 9 years. The authors assume a very conservative level of

transmissibility of infection in children of 10% of adults, which is consistent with the fact that children are less likely to develop severe COVID-19 disease than adults. They calculated the estimated number of actively infected children by assuming that children between the ages of 0 and 9 years represent 2.5% of the reported cases. The authors simulated the reopening of schools on 16 September for a period of 30 days, where day 0 is the start date of the simulations. The results obtained on days 10, 20 and 30 are as follows: the number of asymptomatic cases ranges from a minimum of 9 (lower confidence interval to day 10 in Bauru) to a maximum of 168 (upper confidence interval to day 30 in Santos); the number of symptomatic cases ranges from a minimum of 7 (lower confidence interval to day 10 in Franca) to a maximum of 32 (upper confidence interval to day 30 in Bauru); but more worrying is the number of secondary cases caused by infected children among their teachers, school staff and housemates, ranging from a minimum of 2 (confidence interval below day 10 in Santos) to a maximum of 85 (confidence interval above day 30 in Franca).

On the other hand, there are also those who argue that the opening of the school did not cause a spread of contagions, but that different variables, such as mobility, temperatures, for example, should be considered. Various works that take these variables into account will be discussed below. The literature on the subject argues that cities with high pollution rates favour greater circulation of the virus than less polluted cities. With regard to climate, when temperatures are high, infections tend to decrease and vice versa. The article by Ingo E. Isphording et al. (2020) analyses the effect of the end of the summer school holidays on SARS-CoV-2 cases in Germany. Using appropriate estimates, they provide results on whether the end of the summer holidays and the reopening of schools, combined with strict hygiene measures in Germany, influenced the course of the COVID-19 pandemic. The estimates are based on the official daily case count per age group in all 401 German counties, so the dependent variable is the number of new confirmed cases of SARS-CoV-2 infections. They implemented an event study design in which changes in new confirmed cases are intuitively compared in the states that reopened after the summer break. The estimates focus on the phase of full re-opening of schools in all states after the summer break, which occurred from the beginning of August to mid-September 2020, with states that did not re-open schools serving as a control group. The analysis in this paper is based on a snapshot of data collected on 6 October 2020 and considers the observation window from 1 July to 5 October 2020, i.e., they consider a window of events of two weeks before and three weeks after the end of the summer holidays. Estimates show that three weeks after schools reopened, cases decreased by 0.55 cases per 100,000 (100K) inhabitants. The effect is concentrated among patients up to 34 years of age. In contrast, for the specifically vulnerable age group over 60, infection rates do not seem to be affected by the reopening of schools in the short term. When the authors estimate the equation separately for the different age groups, the effect is strongest in the youngest age group, that of 0-14 year old cases (where the end of the summer break is associated with a significant reduction in cases after 3 weeks for individuals up

to 14 years of age). The reductions for the older age groups are smaller and not significant. The concentration of effects in the youngest age group, which includes school-age children, and the gradual decrease in effect size with age confirm that the reduction in the number of cases at the end of the summer holidays is causally linked to the reopening of schools. In their analysis, Ingo E. Isphording makes an observation: schools reopened after the summer holidays in August and September, when weather conditions (warm temperatures and little precipitation) were favourable for outdoor activities and ventilation of classrooms. These conditions can be obstructed by colder temperatures and worse weather in the autumn, facilitating outbreaks in schools. Summer holidays are characterised by significantly different mobility patterns, less commuting and less use of public transport. To distinguish the effect of the reopening of schools from these coincidences as much as possible, the researchers test different measures of mobile phone mobility. They find no evidence of a positive effect of the end of the summer holidays on the number of confirmed cases. The results indicate a significant negative effect on the number of new cases. Intrastate mobility (both within and between counties in the same state) increases gradually before the end of the summer holidays and remains constant thereafter. Mobility related to activities of daily living (grocery and retail shopping, commuting and work) gradually increases before the end of the summer break and families with school-age children gradually return to their places of residence and resume daily activities.

The work of Perone (2020) also takes both pollution and climatic conditions into account, and focuses primarily on the reasons for the differences in case fatality rates (CFR) between the 20 Italian regions and 107 provinces at the time of the epidemic peak. In his analysis, the author takes into account health system metrics, environmental pollution, climatic conditions, demographic variables and three ad hoc indices representing health system saturation. The analysis showed that environmental, demographic and health factors played an important role in explaining the variability of the CFR. Specifically, the ageing population, air pollutant concentrations, relative humidity, prevalence of COVID-19 and saturation of critical and ordinary care beds were found to be positively correlated with the CFR. Whereas, overall health care efficiency (IPS), physician density and mean temperature were negatively associated with CFR.

Another paper confirming the increase in infections when schools reopen is Courtemanche et al. (2021) who examine the impact of school reopenings in Texas on the prevalence of COVID-19 using hand-collected information on teaching patterns and school district start dates, combined with weekly county-level data on confirmed COVID-19 cases and deaths. The authors find that the reopening of schools in Texas gradually but substantially increased the per capita number of new weekly COVID-19 cases and deaths. The 95% confidence intervals of the baseline regression imply that the reopening of schools in Texas led to at least 43,000 more COVID-19 cases and at least 800 more deaths after two months.

The literature has also analysed in-presence, hybrid and distance learning scenarios. This article by Chernozhukov et al. (2021) empirically examines how the opening of K-12 schools and colleges is associated with the spread of COVID-19 using county-level panel data in the United States. Using data on foot traffic and K-12 school opening schedules, the authors examine how the increase in school visits and the opening of schools with different teaching methods (in-person, hybrid and distance) correlates with the 2-week forward growth rate of confirmed COVID-19 cases. The analysis of shows that an increase in visits to K-12 schools and universities, with in-person learning modes, is associated with a subsequent increase in case growth rates. The number of cases for the 10-19 and 20-29 age groups increased sharply in mid-September, while few cases were reported for the other age groups. This sharp increase in cases in these two age groups is associated with an increase in visits to colleges/universities, bars and restaurants in late August and early September. Furthermore, it provides evidence that the opening of K-12 schools with online education is associated with a decrease in case growth, perhaps because the opening of distance schools induces more cautious behaviour.

We move towards the end of this literature review and cite a study by Stage et al. (2020) which analyses the effect of school closures and subsequent reopenings on COVID-19 virus transmission, considering Denmark, Norway, Sweden and Germany as case studies. In this article, the authors compare the growth rates of daily hospitalisations or confirmed cases according to different interventions, such as restricting school attendance, examinations for older students or partial re-entry of younger groups. This study separates countries with low and high community transmission, e.g. in countries where community transmission is generally low, in this case Sweden, Denmark or Norway, large-scale reopening of schools, control or suppression of the epidemic seem feasible. While reopening schools may help to increase the rate statistically significantly in countries such as Germany, where community transmission is relatively high. Sweden implemented partial school closures that affected students aged 16 and over. However, there is no evidence to indicate that this intervention affects the daily incidence. The reopening of schools to younger groups of students in Germany, Denmark and Norway did not lead to a significant increase in the growth rate. The return of all students (up to the age of 16 in Denmark) does not appear to have increased transmission in Denmark and Norway. However, the return of most students (especially older students) in Germany increased transmission among students, but not among staff. When precautionary measures are implemented to mitigate the spread of contagion, the authors conclude that closing schools contributes to a reduction in the growth rate of the disease approximately 7 days after implementation.

The Covid-19 pandemic raises other issues besides school closures. As already mentioned, it also affected the economy, negatively affecting productivity growth. Before the onset of the COVID-19 pandemic, productivity was stagnant, so it only exacerbated the collapse in productivity. Business growth had already slowed dramatically after the global financial crisis, with the world's largest companies growing at half the pace they

did before 2008. Moreover, increases in capital investment had outpaced revenue expansion, squeezing returns. Now, with the global economic slowdown due to the pandemic, rising inflation and geopolitical uncertainty, growth that produces profits and shareholder value may become even more elusive. According to research by the McKinsey Global Institute (2023), the potential exists to accelerate annual productivity growth by about one percentage point, which is more than double the pre-pandemic productivity growth rate. Moreover, the pandemic has pushed companies to become more efficient. Between 42 and 45 per cent of respondents in an executive survey reduced their operating expenses relative to turnover between December 2019 and December 2020. According to the October 2021 World Economic Outlook compiled by the International Monetary Fund (IMF), global economic growth fell to an annualised rate of around -3.2 per cent in 2020, with a recovery of 5.9 per cent and 4.9 per cent for 2022. The IMF also concluded that advanced economies will face continued economic challenges until 2022 due to supply shortages and that the outlook for low-income developing economies 'has darkened considerably' due to disparities in access to vaccines and differences in economic policy support. The pandemic-related recession is more global in nature than the one experienced during the 2009-2010 global financial crisis. In its recent forecasts, the IMF predicted that geographic regions of the global economy will recover at different speeds, reflecting differences in the pace of vaccination, the extent of policy support, and various structural conditions, such as the role of tourism in developing countries. In the early stages of the pandemic, European countries did not adopt a synchronised fiscal policy response similar to that developed during the 2008-09 global financial crisis. For the most part, EU members used a combination of national fiscal policies and ECB bond purchases to cope with the economic impact of the pandemic. Central banks in advanced economies acted to prevent a financial crisis by buying assets and providing liquidity at favourable rates. In contrast, central banks of emerging economies reacted less aggressively, partly reflecting the success of central banks in advanced economies in easing global financial pressures, which allowed emerging economies to focus their efforts on supporting domestic demand. Individual countries adopted quarantines and called for asset closures, travel and border restrictions, tax exemptions for businesses, extensions of certain payments, loan guarantees and subsidies for workers and businesses. The European Commission called for greater coordination among EU members in the development and implementation of monetary and fiscal policies to deal with the economic consequences of the pandemic virus. During the summer of 2020, European governments attempted a gradual reopening of businesses, generating a 12.4 % increase in Eurozone GDP in Q3 2020. According to first estimates, the EU's economic growth rate almost came to a standstill in the fourth quarter, with a 0.5 per cent decline due to the resumption of blocking measures. After several months of data pointing to the start of an economic recovery in the Eurozone, surveys of business activity in August 2020 indicated that the recovery slowed down due to an increase in new cases of COVID-19 after countries started to reintroduce quarantines and closures in various parts of the Eurozone, although most of the closures did not include schools or some manufacturing companies. Regarding comparisons with past crises, in Nuno Fernandes' report, the author

argues that comparisons with other global crises, such as the 2008 financial crisis, cannot be made. This time we were faced with a series of new challenges, which prevent simple comparisons with the past: it was a global pandemic, it did not focus on lower middle-income countries, interest rates were at historic lows, the world is much more integrated, the current crisis is generating spillover effects along supply chains and we have a simultaneous destruction of supply and demand. Focusing on the Italian economy, the work of Balduzzi et al. (2020) investigates the economic effects of the COVID-19 pandemic and the role played by credit constraints in the transmission mechanism using a novel survey of Italian firms' expectations and plans, conducted just before and after the outbreak (they collect this information between 24 March and 7 April 2020, two weeks after the implementation of the first closure policies). Enterprises in the areas most affected by the COVID-19 outbreak show a significantly different reaction in terms of expectations and plans. These enterprises are more pessimistic in terms of future sales and orders, expect to decrease investment and employment and increase prices more, compared to enterprises in the provinces with fewer deaths. Credit constraints amplify the effects of pandemic shocks on factor demand and sales. Credit-constrained firms also expect to charge higher prices than unconstrained firms. Companies that were subject to credit restrictions before the epidemic are significantly more pessimistic about their future sales. This is consistent with the fact that companies decrease employment and investment due to the financial frictions they face and, consequently, decrease production.

The literature emphasises students' learning after the pandemic. The prolonged closure of schools during the pandemic had negative effects on learning and also on students' desire to invest in themselves. The pandemic and the subsequent interruption of face-to-face teaching gave rise to the problem of learning loss[19]. As is well known, one of the measures taken by (almost) all countries in the world, in order to limit the spread of the virus, has been the closure of schools for longer or shorter periods. Countries such as Australia, Iceland and the United States have only closed schools in some territories. In others, however, school closures were differentiated according to grade: for example, in Sweden most primary and lower secondary schools remained open, while upper secondary schools switched from face-to-face to distance learning from mid-March 2020. Finally, in the main European countries, schools were closed altogether, although not for the same duration. In the period from March 2020 to March 2022, schools in Italy were completely closed for 13 weeks, exceeding the 7 and 10 weeks of France and Spain, but still shorter than Germany, where the closure lasted 14 weeks. The negative impact of Covid-19 on the Italian education system is of great concern. In the article by Bortolamai et al. (2022) it is argued that Italy was lagging behind other OECD countries even before the pandemic. The results of PISA 2018 (an international survey promoted by the OECD every three years to detect the competences of 15-year-old students in reading, mathematics and science) show that Italian students scored below the OECD average in both reading and science, while in mathematics the results are

[19] Loss of competence levels in students due to the interruption of learning paths for an extended period of time.

in line with it. The PISA results are not to be underestimated, as the authors point out, precisely because an average score of 50 points higher in the PISA ranking is estimated to be associated with a 0.87% increase in annual economic growth. This means that relatively small improvements in the skills of young people can have a major impact on the future well-being of the country, as the theory of endogenous growth suggests: greater human capital corresponds to greater productivity and thus growth for a country. In Italy, the latest Invalsi data for the year 2022 show a decline in student learning at all levels compared to pre-pandemic years. In particular, in the second year of primary school, around 30% of students do not reach the minimum level of competence in either Italian or mathematics. The same applies to students in the final year of secondary school. The negative results suggest a significant post-Covid learning loss, which is generally more pronounced for students attending institutions or high schools other than science. Furthermore, the data suggest that the learning loss among university students appears to have been less intense than among lower school students. Recently released American College Testing (ACT) and National Assessment for Educational Progress (NAEP) test scores recorded the largest drop in reading scores among 9-year-olds since 1990 and the first-ever drop in maths scores among the same group. These findings confirm how damaging COVID-19 school closures and the emergence of distance learning have been for K-12 students nationwide. The ACT, for example, noted in its official press release that "these declines have returned student achievement to levels last seen in the early 1990s. Feng et al. (2021) conduct an analysis of a sample of Chinese primary and secondary school students pre- and post-pandemic of Covid-19. They find that average subject scores were high in the first semester compared to the second semester (post-pandemic). Online teaching affected students' performance quite negatively, especially in children; moreover, it widened the urban-rural gap, which already existed before the pandemic. They also analysed the difference in performance between boys and girls, but the gap did not change before and after the pandemic, with girls dominating over boys. Online education, the authors conclude, is not effective in compulsory education, on a large scale and especially in the long term. The work of Azevedo et al. (2021) presents a simulation of the potential effect of COVID-19-related school closures on schooling and learning outcomes in 174 countries. The analysis finds that the overall level of schooling and learning will decrease substantially.

The COVID-19 pandemic not only had an impact on the educational and economic system or on student learning, but also psychological implications. School closures, combined with other measures restricting personal freedom, can affect the psychological well-being and mental health of the population. The rapid increase in fear and anxiety among people due to the uncertainty of the disease accompanied by essential but socially disruptive measures such as closures and quarantines, led to significant psychological and psychiatric disorders: depression, anxiety, panic disorders and behavioural disorders. Pathological dispositional factors include distance from family, loneliness, misinformation on social media, financial insecurity and stigmatisation. The author of the following article, Sood (2020), questioned whether or not the pandemic could lead to a mental health catastrophe. According to the author, the impact on the economy

has caused financial insecurity and stress in the population, with indirect consequences on health; another major concern was burnout among doctors and increased stress for health workers who had to be constantly on their toes with increasing patient loads, but also with new guidelines and policies; finally, the quarantine that has forced the world's population to stay indoors has developed anxiety related to claustrophobia and the inaccessibility to drugs has increased withdrawal syndromes in drug addicts and people who regularly abuse substances. A systematic review of the literature on the impact of school closures and lockdowns in 2020 in response to the covid-19 pandemic on the physical health and psychological well-being of young people, in the work of Minozzi et al. (2021) found that the prevalence of anxiety in adolescents ranged from 19% to 64% and depression from 22.3% to 43.7%. In children aged 5-12 years, the prevalence of anxiety ranged from 19% to 78% and depression from 6.3% to 22.6%. In pre-school children, some studies showed a worsening of behavioural disorders and emotional state while others showed no change.

2.3 Sample and data

This section will explain in detail the dataset taken into consideration and the variables used. The analysis is conducted on the Italian provinces, the Covid-19 pandemic data are provided by the Istituto Superiore di Sanità, which has monitored and is monitoring the infection situation in Italy. Balanced panel data is used and it covers a time period from February 24, 2020 to November 9, 2020 (with T equal to 260 days and N equal to 107, where T>N). But we will focus on the second period of the pandemic, from August onward. The dataset contains provincial and regional level variables and has 27820 observations. The variables used in the model (defined as relevant to the results) are contained in Table 3.1. The choice of control variables is derived from the literature reviewed, in particular the work of Amodio et al. (2021). Most of the works use data on mobility, population density, temperature and pollution. The control variables also included GDP, which could have a certain effect on the growth rate of contagions, i.e. a country with a high GDP could increase contagions assuming that there is more work and consequently more mobility.

Table 3.1. Variables used in the model

Variables	**Description**
Growth rate of contagion	The dependent variable is *the growth rate of Covid-19 infections,* generated by the variable new cases. *New cases per province*[20] : New cases that are added to the total cases and the total positive, always a positive number, not counting exits, cures and deaths (Data source: Superior Institute of Health);
StartSchool & StartSchool2	*StartSchool* is the dummy variable indicating the start of the school in the year 2020/2021; *StartSchool2* indicates the opening of the school in the year 2015/2016 and is the instrumental variable of the StartSchool variable. Startschool2 is also a dummy.
Retail-Recreational activities, Grocery Pharmacy, Parks, Stations, Workplace, Residential places.	*Retail and recreational activities, Grocery and Pharmacy activities, Parks, transit stations, workplaces, Residential Locations* : Mobility of people in Italian provinces, from February 24, 2020 by particular types of places (Data source: GOOGLE).
Mean-Min-temperatures and Mean-Max-temperatures.	*Average value year 2007-2016 Minimum temperatures, average value 2007-2016 maximum temperatures:* period 2007-2016 per province (values in degrees Celsius). (Source: Istat, meteo-climatic and hydrological data collection).
Pollution	*Summary indicator of pollution by provinces:* The summary indicator of air pollution of the capitals has been calculated taking into consideration both WHO and regulatory references: (Puei +Pomsi +Nuei +Olti)/Mi ×100. Where, considering the monitoring of all the active control units, i.e. with quality of the data collected complying with the regulations in force. (Source: Istat, Environmental data in cities).
ln Gdp	*Logarithm of Gross domestic product* – current prices 2019 by regions: GDP on the production side: This is the sum of added value at basic prices of resident production units, plus VAT, taxes on imports and taxes on products net of subsidies on products (Valuation: current prices, Data source: ISTAT);
Density	*Density* variable constructed from the following variables: Population by province, Surface area (sq. km), Number of municipalities*:* List of Italian provinces and metropolitan cities, ordered by number of inhabitants, with an indication of the number of municipalities (Data source: ISTAT);
Provinces	*Provinces:* provinces of Italian regions.

[20] Increment values, like the variable new cases, sometimes have negative values, but this is due to later corrections or deletions.

The dependent variable is the daily growth rate of Covid-19 infections, generated by the variable new cases, precisely because new cases are added to the total number of cases and the total number of positive cases. The explanatory variables are at provincial level, but the GDP variable is only provided at regional level (the natural logarithm of GDP was used in the regression). In the dataset there is the variable mobility per province, understood as mobility to workplaces, stations, pharmacies, supermarkets, parks and places of residence. From the variables resident population (year 2020) and surface area (number of inhabitants per square kilometre), the resident population density per province was calculated; somehow the population played a role in the spread of the infection.

2.3.1 School opening indicator

Public schools were supposed to start the 2020/2021 school year on 14 September, with the exception of public schools that were polling stations for the national referendum held on 20-21 September (year 2020) and for regional and local elections, which had the possibility of starting on 24 September 2020. Some school leaders delayed the opening to assess the final arrangements for the emergency situation, taking advantage of the local and national elections. Other school leaders, however, stuck to the original plan. In the dataset, a dummy called StartSchool is used to identify the start of school set at the regional level, which takes the value 1 at the beginning of the academic year and 0 when schools are actually closed. The opening dates considered are as follows: September 14, September 15, September 16, September 22 and September 24. The regions that postponed the opening of schools in the year 2020 are the following: Puglia, Calabria, Abruzzo, Basilicata, Campania and Sardegna (opening date September 22); while the others preferred to bring forward the opening: the Friuli Venezia Giulia region kicked off the academic year on 16 September 2020, Toscana on 15 September 2020 and Lombardia, Molise, Trentino Alto Adige, Valle D'Aosta, Emilia Romagna, Lazio, Liguria, Marche, Sicilia, Umbria , Veneto and Piemonte on 14 September 2020. The opening dates were shifted by 10 days to get an idea of the actual cases, considering about seven days for the incubation of the virus plus two or three days to carry out the molecular swab. The variable to identify the opening date of schools in 2020 could be endogenous, because the contagion could push the opening date of schools forward, but in addition to this motivation, the opening date of schools for some regions also depended on the issue of local and national elections in Italy, as mentioned above. For this reason, it was decided to use an instrumental variable. In this specific case, we used the opening of schools in the year (2015/2016), because most schools in that year started the academic year on 14 September (coincides with the opening date and day of the year 2020). In addition, the correlation with previous academic years was checked and a correlation of 0.965 was found for the year 2015-2016 (shown in Table 3.1), which is higher than for the other years. The correlation is very close to 1, a sign of little variability, but an attempt was made to make the most of it, precisely because some regions postpone the start of the academic year. Unfortunately, it is not possible to check whether the instrumental variable (StartSchool2) is uncorrelated with the error term. The instrumental variable is labelled

StartSchool2 which takes value 1 when schools have started the academic year and value 0 when schools are closed. In 2015, the regions that started the school year on 14 September were as follows: Lombardia, Liguria, Marche, Piemonte, Sicilia, Umbria, Valle D'Aosta, Friuli Venezia Giulia, Sardegna, Calabria, Abruzzo, Basilicata, Campania; on 15 September Emilia Romagna, Lazio, Tuscany; on 16 September Veneto and Puglia; on 10 September Trentino Alto Adige and on 9 September Molise.

Table 3.2. Matrix of correlations: year 2015-2016

Variables	(1)	(2)
(1) StartSchool	1.000	
(2) StartSchool2	0.965	1.000

2.3.2 Descriptive Statistics

The descriptive statistics below show the average daily infection rate per province before the opening of schools, after ten days from the first opening of schools (i.e. 14 September 2020) and finally with the full opening of schools from 24 September 2020 onwards. It is evident that the Covid-19 infection rate tends to increase on average by 11%, especially when schools are fully open.

Table 3.3: Average of new cases before the start of the academic year

Variable	Obs	Mean	Std. Dev.	Min	Max
Growth rate of contagion	3031	9.516	33.358	0	792

Table 3.4: Average of new cases ten days after first opening (on 14 September 2020)

Variable	Obs	Mean	Std. Dev.	Min	Max
Growth rate of contagion	2463	10.263	36.559	0	792

Table 3.5: Average number of new cases after ten days from the second opening (on 24 September 2020)

Variable	Obs	Mean	Std. Dev.	Min	Max
Growth rate of contagion	1926	10.959	40.412	0	792

The figures below represent the covid-19 infection rate for all those regions that set the school opening on 14 September 2020 and for all those regions that decided to postpone the start of the academic year to 24 September 2020. Figure 3.1 shows the growth rate of Covid-19 infection in regions that anticipated the start of the school year to 14 September 2020. The cutoff was set at 24 September 2020, exactly ten days after the first opening of schools, so that incubation and time to swab can be taken into account. One notices a change in the slope of the line, which becomes positive immediately after the cutoff.

Figure 3.1.

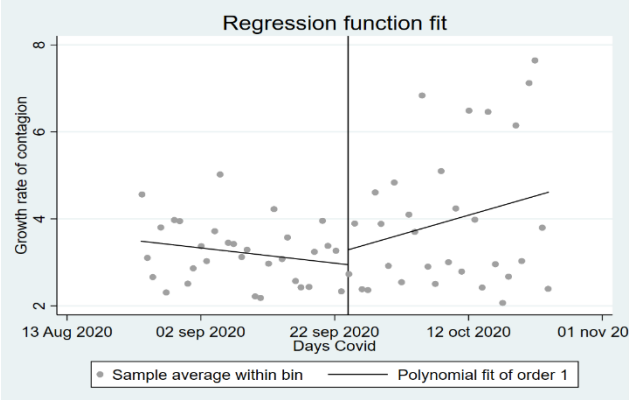


Figure 3.2

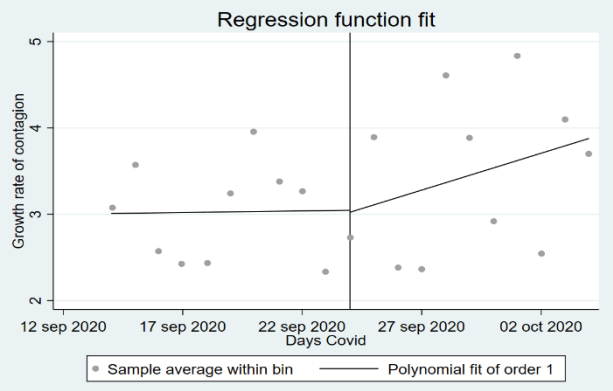


Figure 3.2 shows the contagion growth rate of regions that anticipated the start of the academic year (14 September 2020), but with a reduced bandwidth, closer to the cutoff. It turns out that the contagion rate increases ten days after the first opening.

Figure 3.3

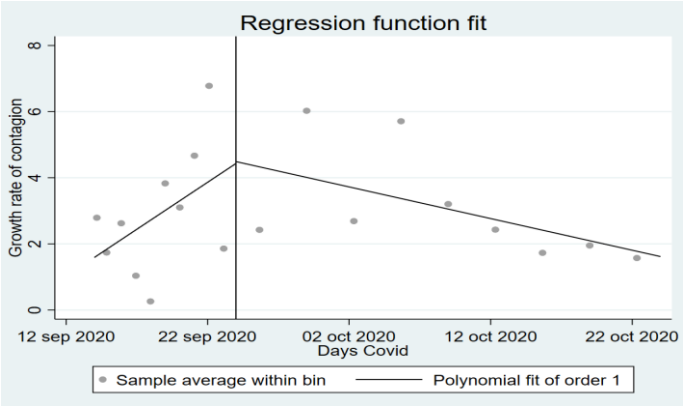


Figure 3.3 shows the growth rate of Covid-19 infection in the regions that postponed the start of the academic year. This graph is a falsification, as it is the increase in contagion that pushes regions to postpone the start of the academic year to 24 September 2020; moreover, there are few regions that postpone the academic

year to 24 September 2020, compared to all those that anticipate the school year. Figure 3.4 shows that, ten days after the full opening of schools, the contagion increases in regions that postpone the start of the school year, when the bandwidth is reduced and the cutoff is set at 4 October 2020 (ten days after full opening); the same applies to regions that anticipate the opening of the school year, i.e. an increasing contagion trend is expected, Figure 3.5.

Figure 3.4

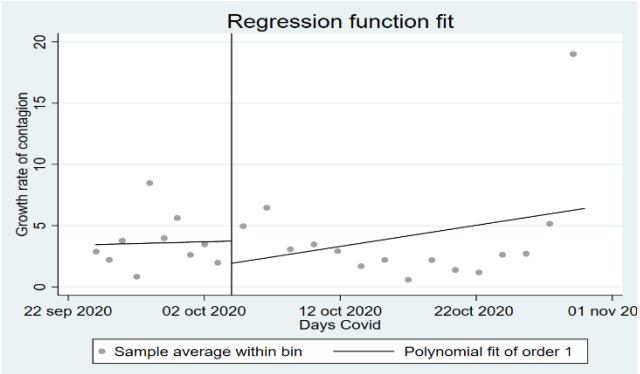
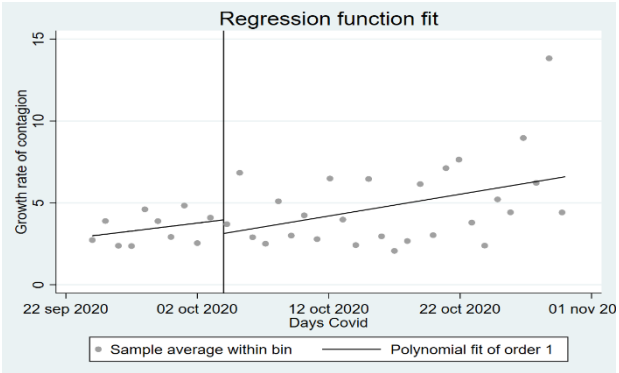


Figure 3.5



2.3.3 Model

In this session, the model used and the identification strategy of the analysis will be explained in detail. Let us consider the following model (for simplicity we use a matrix form):

$$Y_{i,t} = \beta X_{i,t} + \gamma t + \alpha_i + \delta S_{i,t} + \mu_{i,t}$$

where $Y_{i,t}$ denotes the growth rate of infections for province i at time t. The key variable is the dummy denoting the opening of schools $S_{i,t}$, which takes the value 0 when schools are closed and value 1 when regions open for the academic year. In addition, the model includes fixed effects, denoted α_i, capturing the common shocks of Covid-19 cases in all provinces, while $\mu_{i,t}$ is an error term that captures the remaining unobserved heterogeneity and t is time variation between provinces. X_(i,t)=(1,x_i2,...,x_ik) is a 1 × k (row) vector of explanatory variables (including a constant) and β = (β_1,β_2, ...,β_k) is a k × 1 (column) vector.

2.4 Empirical strategy

The empirical strategy adopted will be explained in detail in the following section. The regression analysis was conducted using the OLS estimator and the IV estimator (two-stage least squares method). However, as discussed above, it can be argued that the decision to open the school is endogenous, precisely because the decision of the school leaders could be based on several reasons. This implies that an ideal estimation should take this endogenous decision into account when modelling the school effect. Furthermore, since it is panel data, it would have been appropriate to use a panel methodology, but in the data set T>N; although the exact distributional results are valid for any N and T under the classical fixed effects assumptions, for example, the inference could be sensitive to violations of the assumption when N is small and T is large[21]. Considering the reasons just listed, estimator IV[22] was chosen. The instrumental variable chosen is the opening of the 2015-2016 school year, identified in the regression as Startschool2. The instrumental variable and the endogenous variable have a correlation index of 0.965. The method of the 2SLS or IV, can be explained in the following way:

$$y_1 = \beta_0 + \beta_1 y_2 + \beta_2 z_1 + \ldots + \beta_k z_{k-1} + u_1 \qquad (1)$$

where y_2 (i.e StartSchool), is assumed to be correlated with the error term u_1, thus, is the endogenous variable. The instrumental variable (z_k , i.e. Startschool2) does not appear in the model, but the key assumption is that z_k is uncorrelated with u_1 and it is also assumed that u_1 has an expected value of zero:

$$E(u_1) = 0,\ Cov(z_j, u_1) = 0,\ j = 1,\ldots.k. \qquad (2)$$

The 2SLS estimator is obtained in two stages: in the first stage, we regress the endogenous variable on all exogenous variables:

$$y_2 = \pi_0 + \pi_1 z_1 + \ldots + \pi_{k-1} z_{k-1} + \pi_k z_k + v_2, \qquad (3)$$

[21] Wooldridge, (2013) Introductory Econometrics A modern Approach, 5th edition.
[22] When we have one IV for each endogenous explanatory variable, we can call the estimation method IV or 2SLS. Wooldridge (2013) Introductory Econometrics A modern Approach, 5th edition.

obtain the fitted values of $\hat{y}_2$ and test the significance of the coefficient of the instrumental variable, thus, π_k must be non-zero:

$$\pi_k \neq 0 \qquad (4)$$

In this case, the variable startschool2 is significant, so it can be used in the model as an instrumental variable for the endogenous variable StartSchool. The second stage is an OLS regression and $\hat{y}_2$ obtained in the first stage is used instead of y_2.

Significance test of the instrumental variable StartSchool2

StartSchool2 = 0
F(1, 21929) =77131.21
Prob > F = 0.0000

In addition, the Durbin-Wu-Hausman endogeneity test is performed, which is used to determine whether the endogenous regressors in a simultaneous equation model are truly endogenous; in this case, the null hypothesis has been rejected, so the estimates returned by the two-stage IV estimator can be relied upon.

Test of endogeneity
H0: Variables are exogenous
Durbin (score) chi2(1) = 7.03375 (p = 0.0080)
Wu-Hausman F(1,21927) = 7.03087 (p = 0.0080)

2.5 Results

This section shows the results of the empirical analysis. Table 5.1 shows the output of a simple OLS regression, Table 5.2 shows the results obtained at the first stage and Table 5.3 contains the results obtained at the second stage. In Table 5.1, the startschool variable does not appear to be statistically significant, but as mentioned earlier, the results from a simple OLS regression may be biased because the endogeneity of startschool is not taken into account, i.e., the fact that the contagions push forward the school opening date. This can be explained by the instrumental variables method. The key variable Startschool is well explained by the instrumental variable Startschool2 in the first stage, in fact, it is significant at 1%. In the second stage Startschool shows a positive and statistically significant coefficient at 5%. This coefficient can be interpreted as follows: the opening of the school has a positive and statistically significant impact on the growth rate of infections, more precisely, infections grow more than twice as fast after the opening of the school.

Table. 5.1 Linear regression

Growth rate of contagion	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Retail-Recreational activities	-.041	.016	-2.60	.009	-.073	-.01	***
Grocery Pharmacy	.016	.012	1.34	.18	-.008	.04	
Parks	.005	.003	2.11	.035	0	.011	**
Stations	.027	.009	3.08	.002	.01	.044	***
Workplace	.015	.015	1.00	.316	-.015	.045	
Residential places	.237	.042	5.70	0	.155	.318	***
Pollution	.129	.009	14.06	0	.111	.147	***
Mean-Min-temperatures	.116	.046	2.50	.012	.025	.206	**
Mean-Max-temperatures	-.253	.075	-3.36	.001	-.401	-.106	***
ln Gdp	1.146	.178	6.45	0	.797	1.494	***
Density	.009	.0003781	23.61	0	.008	.01	***
T	.009	.003	2.76	.006	.003	.016	***
StartSchool	.679	.584	1.16	.245	-.466	1.824	
Provinces	-.018	.004	-4.21	0	-.026	-.009	***
Constant	-7.155	3.454	-2.07	.038	-13.926	-.385	**

Mean dependent var	3.691	SD dependent var	19.257
R-squared	0.078	Number of obs	21943
F-test	132.540	Prob > F	0.000
Akaike crit. (AIC)	190327.194	Bayesian crit. (BIC)	190447.137

**** p<.01, ** p<.05, * p<.1*

Table.5.2. Linear regression (First Stage)

StartSchool	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Provinces	-6.06e-08	.0000227	0.00	.998	0	0	
Retail-Recreational activities	-.0000801	.0000866	-0.93	.354	0	0	
Grocery-Pharmacy	.0000738	.000066	1.12	.262	0	0	
Parks	.0000484	.0000143	3.39	.001	0	0	***
Stations	-.0003251	.0000478	-6.79	0	0	0	***
Workplace	.0011331	.0000823	13.77	0	.001	.001	***
Residential places	.0025164	.0002266	11.11	0	.002	.003	***
Pollution	1.43e-06	.0000498	0.02	.98	0	0	
Mean-Min-temperatures	.0005149	.0002512	2.05	.04	0	.001	**

Mean-Max-temperatures	-.0018669	.0004102	-4.55	0	-.003	-.001	***
ln Gdp	.003262	.0009673	3.37	.001	.001	.005	***
Density	-8.51e-06	2.06e-06	-4.13	0	0	0	***
T	.0003344	.0000193	17.31	0	0	0	***
StartSchool2	[redacted]	.003246	277.73	0	.895	.908	***
Constant	-.0014037	.0188089	-0.07	.941	-.038	.035	

Mean dependent var	0.184	SD dependent var	0.387
R-squared	0.933	Number of obs	21944
F-test	21663.533	Prob > F	0.000
Akaike crit. (AIC)	-38488.215	Bayesian crit. (BIC)	-38368.272

**** p<.01, ** p<.05, * p<.1*

Table.5.3. Instrumental variables 2SLS regression (Second Stage)

Growth rate of contagion	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
StartSchool	[redacted]	.662	2.27	.023	.208	2.802	**
Provinces	-.018	.004	-4.23	0	-.026	-.01	***
Retail-Recreational activities	-.041	.016	-2.58	.01	-.072	-.01	***
Grocery-Pharmacy	.014	.012	1.18	.24	-.01	.038	
Parks	.006	.003	2.38	.017	.001	.011	**
Stations	.027	.009	3.07	.002	.01	.044	***
Workplace	.008	.015	0.51	.612	-.022	.038	
Residential places	.216	.042	5.10	0	.133	.298	***
Pollution	.129	.009	14.11	0	.111	.147	***
Mean-Min-temperatures	.114	.046	2.46	.014	.023	.204	**
Mean-Max-temperatures	-.257	.075	-3.41	.001	-.405	-.11	***
ln Gdp	1.149	.178	6.47	0	.801	1.498	***
Density	.009	.0004	23.66	0	.008	.01	***
T	.006	.004	1.51	.13	-.002	.013	
Constant	-6.785	3.456	-1.96	.05	-13.559	-.011	**

Mean dependent var	3.691	SD dependent var	19.257
R-squared	0.078	Number of obs	21943
Chi-square	1860.477	Prob > chi2	0.000

**** p<.01, ** p<.05, * p<.1*

Mobility is explained by the following variables: commercial and recreational activities have a negative impact on the growth rate of Covid-19 infection, thus as travel to recreational places and commercial activities increases, infection decreases by 0.041; whereas when mobility is explained by parks, transit stations and

residential locations it has a positive and significant impact on the growth rate of Covid-19 infection, respectively by 0. 0062%, 0.0269% and 0.22%; the maximum mean temperature shows a significant and negative coefficient, i.e., as the maximum mean temperature increases, the infection rate decreases by 0.26%; while as the minimum mean temperature increases, the infection rate increases by 11%, just as the pollution index increases the infections by 13% (results consistent with the cited literature, Adda, J. (2015), Perone, G. (2020) and Ingo, E.I., et al., (2020)); increasing GDP, measured in current prices, increases the growth rate of infections by 1.15%; population density has a positive and significant influence on the dependent variable of 0.009%.

2.6 Robustness checks

In this section, robustness checks are performed and the tables containing the results are presented in the appendix. The school openings of the following academic years 2016-2017, 2017-2018, 2018-2019, 2019-2020 were used as the instrumental variable of the StartSchool endogenous variable. The method used is that of instrumental variables, correlation is checked and the endogeneity test is performed. Robustness checks return consistent estimates in both the first and second stages. The IV estimator shows a positive and statistically significant 5% coefficient of the key variable StartSchool in the different specifications, furthermore, the magnitude of the Startschool coefficient is very close to the main results; the coefficients of the other explanatory variables also maintain a certain consistency in the estimates both in terms of significance, sign and magnitude of the coefficients. Subsequently, it was deemed appropriate to consider the event of the national elections of 20 and 21 September 2020; this event may have tended to affect the increase in the number of infections. An interaction term consisting of the referendum turnout by province and a temporal dummy[23] that takes the value 1 from 1 October 2020 and 0 before that date (again, the election date is shifted by about 10 days) is inserted into the basic model. Using the OLS estimator and the IV estimator, the results in Table A21 (see appendix) show that voter turnout did not have a significant impact on the growth of the infection, while the opening of schools is still statistically significant and positive at 5%, with a coefficient of 1.55. Therefore, it would appear that only the opening of schools had an impact on the growth of Covid infection19.

[23] In the model, the time dummy is identified with Time; the interaction term is labelled time_Referendum turnout.

2.7 Policy Implications

While school closures have slowed the surge in Covid-19 infections, they have also had a huge impact on children's and adolescents' learning, but also on their mental health and other aspects of their lives. Globally, the disruption of education has meant that millions of children have significantly lost the academic learning they would have gained had they been in the classroom (Feng et al., 2021; Azevedo et al. , 2021). The Covid-19 pandemic not only claimed more than five million lives, but also pushed the global economy into a severe recession as a result of blocking measures imposed by national governments to limit the spread of the virus(Balduzzi et al. 2020). Several sectors were affected: many companies went out of business and supply chains were disrupted. There was a reduction in the production of some goods due to the lack of raw materials, an increase in the prices of final goods, but also an increase in oil and energy, subsequently aggravated by the Russia-Ukraine conflict. The labour market has also shrunk, i.e. the overall employment rate relative to the population has fallen dramatically. One of the problems that governments will have to tackle in the future, apart from the loss of learning in children and young people, is the increase in inequality caused by the economic crisis as a result of the pandemic, through extraordinary fiscal and monetary policy measures, although in response to the pandemic crisis, the National Recovery and Resilience Plan, the EUR 750 billion package, is in place for six years.

2.8 Conclusion

The opening of schools since the beginning of the Covid-19 pandemic has been the subject of much debate in many European countries. On the one hand, it has been argued that it was schools that acted as a vehicle for the transmission of the virus, while others have argued that the proper use of masks and, thus, appropriate antigenic measures would certainly have mitigated the spread of the virus. Different scenarios were analysed, with most of the literature claiming that the opening of the school contributed to the transmission of the virus. The main purpose of this research was precisely to understand whether the opening of schools had indeed contributed to the spread of the virus, taking into account many factors that could have influenced the growth of infections (as found in the literature) such as mobility, level of pollution, temperatures. The regression analysis was carried out using the OLS estimator and the IV estimator. The instrumental variables method was used because of the endogeneity that could characterise the variable SchoolStart, as this decision could have depended on the course of the epidemic and the local and national elections that took place in September 2020, of which many schools were polling stations. As an instrument for the endogenous variable, the StartSchool variable is used, i.e. the opening of schools in the year 2015/2016. From the analysis conducted, there appears to be a positive and significant impact of the StartSchool variable on the dependent variable. Robustness checks are then carried out, using the past openness of the school as an instrumental

variable. These confirm the results obtained in the main estimation. Finally, an attempt is made to understand whether the Covid-19 contagion rate can be altered by national, regional and local elections, and thus can be considered a confounding factor, or whether the high contagion rate is simply due to the opening of schools. An interaction term, generated by the referendum turnout and the time dummy, is included in the model. The result does not return the significance of the interaction term, and therefore, of the turnout on the Covid-19 contagion rate. Over the months, we have seen how the virus has mutated, becoming less aggressive but spreading faster, so the increase in infections could also be influenced by these characteristics found in the new Coronavirus variants. Although the analysis does not take into account the new forms of the virus, it is worth understanding and evaluating what policy actions to take during an epidemic and its consequences. Although the results show robustness, the research has some critical aspects, for example: the analysis is not conducted on the school-age population, but on the population as a whole; furthermore, some data do not refer to the year 2020, e.g. the average temperature per province refers to the year 2016-2017 and the air pollution index to the year 2018-2019; as mentioned above, the variable new cases sometimes has negative values, but this is due to later corrections or deletions. Conclusions can therefore be drawn that are not entirely specific, but in general fairly consistent with the rest of the literature.

2.9 Appendix

Robustness check results for the year 2016-2017:

Table A7 Linear regression (First Stage)

StartSchool	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Provinces	-.0000277	.0000254	-1.09	.276	0	0	
Retail-Recreational activities	-.000221	.0000967	-2.28	.022	0	0	**
Grocery-Pharmacy	.0001654	.0000738	2.24	.025	0	0	**
Parks	.0000605	.000016	3.78	0	0	0	***
Stations	-.0003701	.0000535	-6.92	0	0	0	***
Workplace	.0015466	.0000918	16.85	0	.001	.002	***
Residential places	.0033062	.0002532	13.06	0	.003	.004	***
Pollution	-.0001029	.0000557	-1.85	.065	0	0	*
Mean-Min-temperatures	.0005593	.0002807	1.99	.046	0	.001	**
Mean-Max-temperatures	-.0013043	.0004582	-2.85	.004	-.002	0	***
ln Gdp	.0013041	.0010806	1.21	.227	-.001	.003	
Density	-6.88e-06	2.30e-06	-2.99	.003	0	0	***
T	.0004468	.0000217	20.57	0	0	0	***
StartSchool2	.8714728	.0036364	239.65	0	.864	.879	***
Constant	-.0073925	.0210175	-0.35	.725	-.049	.034	

Mean dependent var	0.184	SD dependent var	0.387
R-squared	0.916	Number of obs	21944
F-test	17044.444	Prob > F	0.000
Akaike crit. (AIC)	-33623.281	Bayesian crit. (BIC)	-33503.337

**** p<.01, ** p<.05, * p<.1*

Significance test of the instrumental variable StartSchool2

StartSchool2 = 0
F(1, 21929) =57433.84
Prob > F = 0.0000

table A8 Instrumental variables 2SLS regression (Second Stage)

Growth rate of contagion	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Startschool	1.43	.686	2.08	.037	.085	2.775	**
Provinces	-.018	.004	-4.23	0	-.026	-.009	***
Retail-	-.041	.016	-2.58	.01	-.072	-.01	***

Recreational activities							
Grocery-Pharmacy	.014	.012	1.19	.234	-.009	.038	
Parks	.006	.003	2.35	.019	.001	.011	**
Stations	.027	.009	3.07	.002	.01	.044	***
Workplace	.008	.015	0.55	.584	-.022	.039	
Residential places	.217	.043	5.11	0	.134	.301	***
Pollution	.129	.009	14.10	0	.111	.147	***
Mean-Min-temperatures	.114	.046	2.46	.014	.023	.204	**
Mean-Max-temperatures	-.257	.075	-3.41	.001	-.404	-.109	***
ln Gdp	1.149	.178	6.47	0	.801	1.497	***
Density	.009	.0004	23.65	0	.008	.01	***
T	.006	.004	1.57	.117	-.002	.013	
Constant	-6.818	3.457	-1.97	.049	-13.594	-.042	**

Mean dependent var	3.691	SD dependent var	19.257
R-squared	0.078	Number of obs	21943
Chi-square	1859.676	Prob > chi2	0.000

**** p<.01, ** p<.05, * p<.1*

Test of endogeneity
H0: Variables are exogenous
Durbin (score) chi2(1) = 4.33442 (p = 0.0373)
Wu-Hausman F(1,21927) = 4.33212 (p = 0.0374)

Table A9 Matrix of correlations: year 2016-2017

Variables	(1)	(2)
(1) StartSchool	1.000	
(2) StartSchool2	0.955	1.000

Robustness check results for the year 2017-2018:

Table A10 Linear regression (First Stage)

StartSchool	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Provinces	-.0000237	.0000259	-0.91	.361	0	0	

Retail-Recreational activities	-.0002462	.0000986	-2.50	.013	0	0	**
Grocery-Pharmacy	.0001815	.0000752	2.41	.016	0	0	**
Parks	.0000608	.0000163	3.73	0	0	0	***
Stations	-.0003712	.0000545	-6.81	0	0	0	***
Workplace	.0016771	.0000935	17.94	0	.001	.002	***
Residential places	.0035856	.000258	13.90	0	.003	.004	***
Pollution	-.0000851	.0000568	-1.50	.134	0	0	
Mean-Min-temperatures	.00074291	.0002862	2.60	.009	0	.001	***
Mean-Max-temperatures	-.0011351	.0004672	-2.43	.015	-.002	0	**
ln Gdp	.0018695	.0011019	1.70	.09	0	.004	*
Density	-7.86e-06	2.34e-06	-3.36	.001	0	0	***
T	.0004753	.0000222	21.45	0	0	.001	***
StartSchool2	.8641884	.0037053	233.23	0	.857	.871	***
Constant	-.0220031	.0214272	-1.03	.304	-.064	.02	

Mean dependent var	0.184	SD dependent var	0.387
R-squared	0.912	Number of obs	21944
F-test	16332.425	Prob > F	0.000
Akaike crit. (AIC)	-32767.257	Bayesian crit. (BIC)	-32647.313

**** p<.01, ** p<.05, * p<.1*

Significance test of the instrumental variable StartSchool2

StartSchool2 = 0
F(1, 21929) =54397.54
Prob > F = 0.0000

Table A11 Instrumental variables 2SLS regression (Second Stage)

Growth rate of contagion	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
StartSchool	1.461	.692	2.11	.035	.106	2.817	**
Provinces	-.018	.004	-4.23	0	-.026	-.009	***
Retail-Recreational activities	-.041	.016	-2.58	.01	-.072	-.01	***
Grocery Pharmacy	.014	.012	1.18	.237	-.009	.038	
Parks	.006	.003	2.36	.018	.001	.011	**
Stations	.027	.009	3.07	.002	.01	.044	***
Workplace	.008	.016	0.53	.597	-.022	.039	
Residential places	.217	.043	5.09	0	.133	.3	***

Pollution	.129	.009	14.10	0	.111	.147	***
Mean-Min-temperatures	.114	.046	2.46	.014	.023	.204	**
Mean-Max-temperatures	-.257	.075	-3.41	.001	-.405	-.109	***
ln Gdp	1.149	.178	6.47	0	.801	1.498	***
Density	.009	.0004	23.66	0	.008	.01	***
t	.006	.004	1.52	.128	-.002	.013	
Constant	-6.804	3.457	-1.97	.049	-13.581	-.028	**

Mean dependent var	3.691	SD dependent var	19.257
R-squared	0.078	Number of obs	21943
Chi-square	1859.786	Prob > chi2	0.000

**** p<.01, ** p<.05, * p<.1*

Test of endogeneity
H0: Variables are exogenous
Durbin (score) chi2(1) = 4.45056 (p = 0.0349)
Wu-Hausman F(1,21927) = 4.44821 (p = 0.0349)

Table A12 Matrix of correlations : year 2017-2018

Variables	(1)	(2)
(1) StartSchool	1.000	
(2) StartSchool2	0.953	1.000

Robustness check results for the year 2018-2019:

Table A13 Linear regression (First Stage)

StartSchool	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Provinces	-.0000348	.0000282	-1.23	.217	0	0	
Retail-Recreational activities	-.0002417	.0001072	-2.25	.024	0	0	**
Grocery-Pharmacy	.0003447	.0000817	4.22	0	0	.001	***
Parks	-.0000326	.0000177	-1.84	.065	0	0	*
Stations	-.0002194	.0000592	-3.71	0	0	0	***
Workplace	.0019569	.0001015	19.27	0	.002	.002	***
Residential places	.0047785	.0002797	17.09	0	.004	.005	***
Pollution	-.0001536	.0000617	-2.49	.013	0	0	**
Mean-Min-	.0011768	.0003109	3.78	0	.001	.002	***

temperatures							
Mean-Max-temperatures	-.0003912	.0005074	-0.77	.441	-.001	.001	
Ln Gdp	.0020387	.0011972	1.70	.089	0	.004	*
Density	-.0000103	2.54e-06	-4.05	0	0	0	***
t	.0007199	.0000237	30.35	0	.001	.001	***
StartSchool2	.8224883	.0039788	206.72	0	.815	.83	***
Constant	-.0612245	.0232706	-2.63	.009	-.107	-.016	***

Mean dependent var	0.184	SD dependent var	0.387
R-squared	0.897	Number of obs	21944
F-test	13596.792	Prob > F	0.000
Akaike crit. (AIC)	-29127.524	Bayesian crit. (BIC)	-29007.581

**** p<.01, ** p<.05, * p<.1*

Significance test of the instrumental variable StartSchool2

StartSchool2 = 0
F(1, 21929) =42731.86
Prob > F = 0.0000

Table A14 Instrumental variables 2SLS regression (Second Stage)

Growth rate of contagion	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
StartSchool	1.473	.718	2.05	.04	.066	2.881	**
Provinces	-.018	.004	-4.23	0	-.026	-.009	***
Retail-Recreational activities	-.041	.016	-2.58	.01	-.072	-.01	***
Grocery-Pharmacy	.014	.012	1.18	.238	-.009	.038	
Parks	.006	.003	2.36	.018	.001	.011	**
Stations	.027	.009	3.07	.002	.01	.044	***
Workplace	.008	.016	0.52	.604	-.022	.039	
Residential places	.216	.043	5.05	0	.132	.3	***
Pollution	.129	.009	14.10	0	.111	.147	***
Mean-Min-temperatures	.114	.046	2.46	.014	.023	.204	**
Mean-Max-temperatures	-.257	.075	-3.41	.001	-.405	-.109	***
ln Gdp	1.149	.178	6.47	0	.801	1.498	***
Density	.009	.0004	23.65	0	.008	.01	***
t	.006	.004	1.47	.142	-.002	.014	
Constant	-6.799	3.458	-1.97	.049	-13.577	-.02	**

Mean dependent var	3.691	SD dependent var	19.257
R-squared	0.078	Number of obs	21943
Chi-square	1859.525	Prob > chi2	0.000

**** p<.01, ** p<.05, * p<.1*

Test of endogeneity
H0: Variables are exogenous
Durbin (score) chi2(1) = 3.60501 (p = 0.0576)
Wu-Hausman F(1,21927) = 3.60297 (p = 0.0577)

Table A15 Matrix of correlations

Variables	(1)	(2)
(1) StartSchool	1.000	
(2) StartSchool2	0.944	1.000

Robustness check results for the year 2019-2020:

Table A16 Linear regression (First Stage)

StartSchool	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Provinces	-.0000329	.000028	-1.18	.24	0	0	
Retail-Recreational activities	-.0002165	.0001066	-2.03	.042	0	0	**
Grocery-Pharmacy	.0003078	.0000812	3.79	0	0	0	***
Parks	-8.57e-06	.0000176	-0.49	.626	0	0	
Stations	-.0002904	.0000589	-4.93	0	0	0	***
Workplace	.0019858	.0001009	19.68	0	.002	.002	***
Residential places	.0047609	.000278	17.13	0	.004	.005	***
Pollution	-.0001329	.0000613	-2.17	.03	0	0	**
Mean-Min-temperatures	.0009409	.0003091	3.04	.002	0	.002	***
Mean-Max-temperatures	-.000894	.0005046	-1.77	.076	-.002	0	*
ln Gdp	-.0010029	.00119	-0.84	.399	-.003	.001	
Density	-8.86e-06	2.53e-06	-3.50	0	0	0	***
t	.0006781	.0000237	28.61	0	.001	.001	***
StartSchool2	.8268895	.0039654	208.52	0	.819	.835	***
Constant	-.0084638	.023158	-0.37	.715	-.054	.037	

Mean dependent var	0.184	SD dependent var	0.387
R-squared	0.898	Number of obs	21944
F-test	13772.821	Prob > F	0.000
Akaike crit. (AIC)	-29380.806	Bayesian crit. (BIC)	-29260.862

**** p<.01, ** p<.05, * p<.1*

Significance test of the instrumental variable StartSchool2

(1) StartSchool2 = 0
F(1, 21929) =43482.51
Prob > F = 0.0000

Table A17 Instrumental variables 2SLS regression (Second Stage)

Growth rate of contagion	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
StartSchool	1.459	.716	2.04	.042	.056	2.863	**
Provinces	-.018	.004	-4.23	0	-.026	-.009	***
Retail-Recreational activities	-.041	.016	-2.58	.01	-.072	-.01	***
Grocery-Pharmacy	.014	.012	1.18	.237	-.009	.038	
Parks	.006	.003	2.35	.019	.001	.011	**
Stations	.027	.009	3.07	.002	.01	.044	***
Workplace	.008	.016	0.53	.598	-.022	.039	
Residential places	.217	.043	5.06	0	.133	.301	***
Pollution	.129	.009	14.10	0	.111	.147	***
Mean-Min-temperatures	.114	.046	2.46	.014	.023	.204	**
Mean-Max-temperatures	-.257	.075	-3.41	.001	-.405	-.109	***
ln Gdp	1.149	.178	6.47	0	.801	1.498	***
Density20	.009	.0004	23.65	0	.008	.01	***
t	.006	.004	1.49	.137	-.002	.014	
Constant	-6.805	3.458	-1.97	.049	-13.583	-.027	**

Mean dependent var	3.691	SD dependent var	19.257
R-squared	0.078	Number of obs	21943
Chi-square	1859.475	Prob > chi2	0.000

**** p<.01, ** p<.05, * p<.1*

Test of endogeneity
H0: Variables are exogenous
Durbin (score) chi2(1) = 3.54008 (p = 0.0599)
Wu-Hausman F(1,21927) = 3.53807 (p = 0.0600)

Table A18 Matrix of correlations

Variables	(1)	(2)
(1) StartSchool	1.000	
(2) StartSchool2	0.945	1.000

Robustness check results including referendum turnout:

Table A19 Linear regression

Growth rate of contagion	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Retail-Recreational activities	-.04	.016	-2.49	.013	-.071	-.008	**
Grocery-Pharmacy	.015	.012	1.25	.211	-.009	.039	
Parks	.006	.003	2.22	.026	.001	.011	**
Stations	.026	.009	2.93	.003	.009	.043	***
Workplace	.017	.015	1.10	.27	-.013	.047	
Residential places	.242	.042	5.78	0	.16	.325	***
Pollution	.13	.009	14.10	0	.112	.148	***
Mean-Min-temperatures	.117	.046	2.51	.012	.025	.208	**
Mean-Max-temperatures	-.247	.076	-3.26	.001	-.396	-.099	***
ln Gdp	1.164	.179	6.51	0	.814	1.515	***
Density	.009	0	23.38	0	.008	.01	***
t	.009	.003	2.73	.006	.003	.016	***
Provinces	-.018	.004	-4.35	0	-.027	-.01	***
time_Referendum turnout	-.008	.048	-0.16	.872	-.102	.087	
StartSchool	.705	.592	1.19	.234	-.455	1.864	
Constant	-7.554	3.476	-2.17	.03	-14.366	-.741	**

Mean dependent var	3.709	SD dependent var	19.352
R-squared	0.078	Number of obs	21702
F-test	122.748	Prob > F	0.000
Akaike crit. (AIC)	188448.117	Bayesian crit. (BIC)	188575.880

**** p<.01, ** p<.05, * p<.1*

Table A20 Linear regression (First Stage)

StartSchool	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Provinces	1.52e-06	.0000229	0.07	.944	0	0	
Retail-Recreational activities	-.0000901	.0000872	-1.04	.301	0	0	

Grocery-Pharmacy	.0000781	.0000665	1.18	.239	0	0	
Parks	.0000504	.0000144	3.50	0	0	0	***
Stations	-.0003288	.0000482	-6.82	0	0	0	***
Workplace	.0011457	.0000831	13.79	0	.001	.001	***
Residential places	.0025281	.0002284	11.07	0	.002	.003	***
Pollution	-2.10e-06	.0000501	-0.05	.963	0	0	
Mean-Min-temperatures	.0005114	.0002525	2.02	.043	0	.001	**
Mean-Max-temperatures	-.0018811	.0004117	-4.57	0	-.003	-.001	***
ln Gdp	.003192	.0009714	3.28	.001	.001	.005	***
Density	-8.39e-06	2.06e-06	-4.06	0	0	0	***
t	.0003354	.0000195	17.21	0	0	0	***
StartSchool2	.9007389	.0032848	274.24	0	.894	.907	***
time_Referendum turnout	.0000248	.0002615	0.10	.924	0	.001	
Constant	-.0003681	.0188929	-0.02	.988	-.037	.037	

Mean dependent var	0.184	SD dependent var	0.387
R-squared	0.932	Number of obs	21703
F-test	19857.878	Prob > F	0.000
Akaike crit. (AIC)	-37934.035	Bayesian crit. (BIC)	-37806.272

**** p<.01, ** p<.05, * p<.1*

Significance test of the instrumental variable StartSchool2

(1) StartSchool2 = 0
F(1, 21687) =75208.55
Prob > F = 0.0000

Table A21 Instrumental variables 2SLS regression (Second Stage)

Growth rate of contagion	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
StartSchool	1.545	.671	2.30	.021	.23	2.861	**
Provinces	-.018	.004	-4.38	0	-.027	-.01	***
Retail-Recreational activities	-.04	.016	-2.46	.014	-.071	-.008	**
Grocery-Pharmacy	.013	.012	1.09	.277	-.011	.037	
Parks	.007	.003	2.50	.012	.001	.012	**
Stations	.026	.009	2.91	.004	.008	.043	***
Workplace	.009	.016	0.60	.546	-.021	.04	
Residential places	.221	.043	5.18	0	.137	.305	***
Pollution	.13	.009	14.14	0	.112	.148	***
Mean-Min-temperatures	.115	.046	2.47	.013	.024	.206	**

Mean-Max-temperatures	-.251	.076	-3.32	.001	-.4	-.103	***
ln Gdp	1.168	.179	6.53	0	.818	1.518	***
Density	.009	.0004	23.43	0	.008	.01	***
t	.006	.004	1.49	.137	-.002	.013	
time_Referendum turnout	-.013	.048	-0.26	.795	-.107	.082	
Constant	-7.175	3.478	-2.06	.039	-13.991	-.359	**

Mean dependent var	3.709	SD dependent var	19.352
R-squared	0.078	Number of obs	21702
Chi-square	1846.291	Prob > chi2	0.000

**** p<.01, ** p<.05, * p<.1*

Test of endogeneity
H0: Variables are exogenous
Durbin (score) chi2(1) = 7.00569 (p = 0.0081)
Wu-Hausman F(1,21685) = 7.00246 (p = 0.0081)

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The role of bullying on the academic performance among early, regular and older students

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Abstract

Bullying within educational institutions not only affects the psychological and social well-being of its victims, but also hampers their academic performance. Bullying, a highly damaging form of aggression, is widespread in educational institutions around the world. Current research shows that, in addition to the physical harm inflicted, bullying can cause a drop in educational achievement. Consequently, this problem has attracted our attention among pre-adolescent students. Let us look at the data provided by the INVALSI institute regarding scores in mathematics and Italian, as well as questionnaires from the 2013-2014 school year, class five, primary school. We relate the scores obtained in mathematics and Italian to incidents of bullying, identified through the administration of the questionnaires to the students. We classify students into two cohorts: early, regular and older students born in the first four months of the year, and a second cohort consisting exclusively of regular and older students born in the second four months of the year. The presence of early learners in a class implies that bullying is more likely in the first cohort than in the second. We use the instrumental variables method to mitigate endogeneity issues in the analysis and find that students in the first cohort who are bullied tend to show significantly lower academic performance than the second cohort.

JEL: I20, H52, I21; I28; J24
Keywords: bullying, primary school, INVALSI tests

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3.1 Introduction

The issue of bullying is gaining more attention, particularly within the context of schools. Within the literature, numerous studies exist that examine this phenomenon and its effects on the well-being of students. However, there are fewer studies that investigate how bullying impacts academic performance. The latter studies indicate that individuals who experience episodes of bullying tend to have lower academic performance on average. Nonetheless, the majority of studies focus solely on the age group of 14-19, and in Italy specifically, research on bullying across all age groups is scarce. In Italy and other parts of the world, incidents of bullying appear to be on the rise among children and adolescents. The nature of bullying varies, ranging from simple and seemingly harmless teasing to outright insults and even physical violence. These actions undeniably have serious consequences, especially during this vulnerable stage of life and for children who are particularly sensitive. In order to combat and prevent bullying, it is essential to have a better understanding of this phenomenon in terms of its prevalence, main causes, and short-term and long-term effects on the students who experience it. The data collected by INVALSI (Italian National Institute for the Evaluation of the Educational System of Instruction and Training)[24] enables us to thoroughly analyse some key aspects. Specifically, personal questionnaires administered to students in the 5th and 10th grades (the final year of primary school and the second year of upper secondary school, respectively) during the academic years 2013-2014 and 2014/2015 included a set of eight questions regarding the frequency of both active and passive acts of bullying (i.e., acts perpetrated or suffered). In our work, we turn our attention to students who have been bullied, identified through the questionnaire, mentioned earlier, submitted to fifth grade students in the 2013-2014 school year; in addition to the questionnaire, we use data on their school performance in mathematics and Italian for the year 2013-2014. In order to overcome the problem of the endogeneity of the bullying variable, we make use of the legislation[25] regulating early enrolment in compulsory schooling in Italy to create two groups of early and regular students in one group and regular and older students in the other.

[24] The National Institute for the Evaluation of the Education and Training System, better known by the acronym INVALSI, is a research institute with legal personality under public law. The Institute has the task of preparing and carrying out periodic and systematic checks on the learning outcomes of Italian students (the INVALSI national tests).

The classes that take the INVALSI tests are:

-classes II and V of Primary School (grades 2 and 5)

-classes III of the Middle School (grade 8)

-classes II and V of the High School, (grades 10 and 13)

All students take an Italian and a Mathematics test; those in grades 5, 8 and 13 also take an English test, divided into Reading and Listening.

[25] Law No. 53 of 2003, the formalisation of which was then entrusted to Legislative Decree No. 59 of 2004: basically, it is the Moratti Law that introduced the concept of 'early schooling' and established that enrolment in the first class of primary school can be made for all children who are five and a half years old and who will turn six no later than 30 April of the same school year in which they apply to enrol.

Implementing efficient measures and strategies to combat bullying plays a pivotal role in the prevention or mitigation of bullying incidents, as well as the enhancement of students' academic achievements. The potential advantages of preventing bullying are substantial, encompassing both educational outcomes and the promotion of equal opportunities, given the propensity for bullying to impact students hailing from low socioeconomic backgrounds and those with immigrant backgrounds. While the arrangement of students in smaller classes may contribute to a reduction in bullying, which is more prevalent in larger class settings, it remains imperative to establish a school atmosphere that unequivocally condemns bullying, fostering an environment where all students feel secure and esteemed. The literature has demonstrated that the consequences of bullying and victimization can be notably severe and troublesome for young individuals. It has been established that individuals who engage in bullying during their school years are more prone to develop antisocial behaviors, such as violence, in adulthood (Ttofi et al., 2012). Moreover, they are also more likely to engage in delinquency (Farrington et al., 2012; Ttofi et al., 2011b). On the other hand, victims of bullying may experience a range of psychosomatic issues, including feelings of loneliness, withdrawal, and social avoidance (Espelage & Holt, 2001). Additionally, they may also develop anxiety and depression (Cerutti et al., 2005). The international literature has identified a higher likelihood of bullying in classrooms where there is a greater proportion of male students (Saarento et al., 2011). Likewise, there is an increased risk of victimization in such classrooms (Khoury-Kassabri et al., 2004). In general, a gender composition that favors boys may contribute to the creation of a more hostile school environment (Khoury-Kassabri et al., 2004). This environment not only entails a higher prevalence of bullies but also a greater number of male students who must defend themselves. This article is structured as follows: introduction, literature, data and descriptive statistics, identification strategy, model, results, conclusion, appendix and references.

3.2 Literature

Among the literature reviewed, the phenomenon of bullying in primary and secondary schools is studied. The results support the idea that bullying has a negative impact on school performance in the short and medium term. The study conducted by Demuro et al. (2020) examines the description of the characteristics of students who experience bullying and the examination of the potential effects on their short- and medium-term school performance. Preliminary results suggest that male students, foreigners, and those from lower and middle socioeconomic backgrounds are more likely to be victims of bullying. Moreover, it appears that victims of bullying generally score lower on standardized tests not only in the school year in which the bullying occurs, but also three years later, with a correlation between the severity of the incidents and the extent of decline. Oliveira et al. (2017) analyze bullying on the academic performance of sixth-grade students in public schools in Recife, Brazil. The researchers use data from a survey conducted by the Joaquim Nabuco Foundation in 2013 to investigate this relationship. The results of the study indicate that bullying has a negative effect on students' math performance, as those who reported being bullied achieve lower math scores than their non-

bullied counterparts. In addition, the study emphasizes the importance of social-emotional skills in reducing the likelihood of being bullied. Students who exhibit higher levels of conscientiousness and emotional stability tend to have better grades, while those who are more emotionally unstable tend to have lower grades. Additionally, the study reveals that students who have been bullied in the past perform approximately 4.34 points lower in mathematics compared to those who have not experienced bullying. França et al. (2021) also examined the influence of various forms of bullying (physical, psychological, and indirect) on students' academic performance in Brazil. The results indicated that physical bullying, such as physical aggression or destruction of objects, exerted a negative influence on the academic performance of Brazilian students, particularly in the areas of mathematics, reading, and science. Surprisingly, psychological bullying, which includes spreading gossip and teasing, produced positive effects on students' grades. In contrast, threats had a negative impact on grades in all subjects. In addition, indirect bullying, which involves experiences of exclusion from peers, showed no statistically significant influence on students' grades. Finally, it was observed that students with reading deficiencies were more susceptible to bullying, which could explain the greater disparities in grades observed between the treatment and control groups in the reading domain. Cavicchiolo et al. (2019), in this article, emphasize the importance of considering the influence that classroom characteristics have on individuals residing in these environments to understand the phenomenon of bullying and victimization. Using a multilevel analysis, they examine the impact of classroom characteristics, such as the number of students, percentage of male students, presence of immigrant students, average level of socioeconomic background, and average level of early learning, on bullying and victimization. Researchers control for school type to isolate the effects of these classroom characteristics. Analyses are based on a nationally representative sample of second-year secondary school students (N=25573) used by the National Institute for the Evaluation of the Education and Training System (INVALSI) for its 2015 Learning Survey. The results show the significant influence of classroom characteristics, with the percentage of males in the class and the average level of initial learning emerging as the most influential factors. The presence of immigrant students has a relatively small effect, while class size appears to be crucial in relation to victimization. Notably, socioeconomic composition does not seem to have a significant bearing. Ballatore et al. (2020) examines the impact of a student's position within the age distribution at the school level, commonly referred to as age class, on the probability of experiencing bullying at school. The study utilizes data from Italian students who were enrolled in fifth and sixth grade during three distinct school years, utilizing three waves of the SNV survey, which covers the school years 2009-10, 2010-11, and 2011-12, with a specific focus on fifth and sixth grade students. The data is collected through the Student Questionnaire, which contains information regarding victimization. To analyze the data, the researchers employ an empirical strategy that incorporates school-by-cohort fixed effects and an instrumental variables strategy based on the discontinuity in the likelihood of enrolling in a particular school year. This instrumental variables strategy is based on the end-of-year cut-off rule for enrollment. The end-of-year cut-off rule refers to a specific date, namely December 31st,

which serves as the natural cut-off date for enrolling students into the first grade of school. The children who are born in the early months of the year have the opportunity to enroll earlier, thus allowing for certain exceptions to the cut-off rule. The findings of the study indicate that age rank significantly influences the likelihood of being a victim of bullying at school. Specifically, an increase of one decile in age rank results in a decrease in the probability of being a victim by 1.3 percentage points, when compared to a baseline probability of approximately 22% for fifth-graders and 14% for sixth-graders. Moreover, the effect of age rank is found to be more pronounced when analyzed within groups defined by observable characteristics, such as gender and socio-economic status. Notably, boys are identified as a particularly vulnerable group, experiencing higher age rank effects in comparison to girls. Ponzo (2013) focuses specifically on the determinants and effects of being a victim of school bullying on the academic performance of Italian fourth and eighth grade students. The study combines two different datasets: the Progress in International Reading Literacy Study (PIRLS) conducted in 2006 and the Trends in International Mathematics and Science Study (TIMSS) conducted in 2007. This involves computing the propensity score, which is the probability of being a victim of bullying given pre-treatment control variables. Three methods of propensity score matching are implemented: nearest neighbor matching, radius or Caliper methods, and Kernel matching. These methods are used to compare treated and untreated individuals with the same propensity score in the common support region and estimate the average treatment effect. The nonparametric propensity score matching approach is adopted to address selection bias and identify an appropriate counterfactual for the treated group of students. The results suggest that being a victim of school bullying has a significant negative effect on student performance in both reading comprehension and mathematics and science tests at the fourth and eighth-grade levels. The adverse effect of bullying on educational achievement is larger at age 13 than at age 9. Specifically, the OLS estimations show that being a victim of bullying at school has a statistically significant negative impact on reading comprehension achievement, with a decrease of 16.33 points, which is significantly different from zero at the 1 percent level. The integration of immigrant children is of vital importance within the school system. Italy, as a nation, has witnessed a rapid surge in the enrolment of immigrant children in schools. Fedeli et al. (2023) conduct a comprehensive analysis that not only assesses students' academic abilities, but also considers their general well-being and social integration. Furthermore, the study explores the combined impact of two key factors related to the presence of immigrants in the classroom: the percentage of immigrant students and the level of ethnolinguistic diversity. To this end, the researchers design a conditional framework that aims to randomly expose students to varying proportions of immigrant and ethnolinguistic diversity. The data used in this study come from the National Institute for the Evaluation of the Italian School System and include the entire student population enrolled in fifth grades in the 2014-15 school year. The results indicate that the presence of immigrants and ethnolinguistic diversity is a risk factor. The results indicate that the presence of immigrants and the resulting ethnolinguistic diversity have minimal, relatively independent negative effects with a linear relationship. Furthermore, the impact is

mainly observed among first-generation students, while it has a limited influence on subsequent generations. The article by Farina et al. (2022), focuses on the shift from kindergarten to primary school and its impact on the social status and emotional competence of children involved in bullying. The authors investigate how interpersonal factors (e.g., social status indicators) and personal factors (e.g., empathy and emotional understanding) influence the assumption of roles in bullying incidents from a longitudinal perspective. These variables were assessed during the final year of kindergarten (t1) and the initial year of primary school (T2) for a group of 41 children. The findings suggest that social status indicators, such as social preference and social impact, significantly influence the assumption of roles in bullying incidents during the transition from kindergarten to primary school. Prosocial behaviors demonstrated greater stability, while social preference exhibited a positive effect on prosocial roles and a negative effect on hostile roles. The results of this study emphasize the significance of social preference in influencing the roles that individuals assume in instances of bullying. Being well-regarded by peers can serve as a safeguard against aggressive behavior and facilitate the display of prosocial actions. Conversely, experiencing low levels of social preference and influence can heighten the likelihood of becoming a victim.

3.3 *Data*

To perform the analysis, we use INVALSI data provided by the National Institute for the Evaluation of the Education and Training System. Invalsi tests are conducted on an annual basis in order to establish a historical record of students' abilities. These tests are intended for all students attending primary school II and V, secondary school III first grade and secondary school II and V second grade. Alongside the INVALSI tests, there is a questionnaire that collects contextual data to assess the added value produced by an educational institution and the underlying causes of its students' success or failure, taking into account the socio-economic-cultural context. With the help of the information obtained from this questionnaire, we are able to estimate the correlation between bullying and the scores obtained by fifth grade students in mathematics and Italian in the year 2013. Questions concerning bullying are only administered in the following academic years: 2013-2014 and 2014-2015 and these questions aim to distinguish between victims of bullying and those who engage in repetitive aggressive behaviour towards the most vulnerable. Our main focus is on the bullied students identified through the questionnaire administered in the 2013-2014 school year in fifth grade and their respective scores in mathematics and Italian. To identify these victims, we rely on students' answers to the following four questions: 1) Have you been teased by other students? 2) Have you been insulted by other students? 3) Have you been isolated or excluded by other students? 4) Have you been physically assaulted by other students? Each of these questions offers four potential answers: never, occasionally, weekly and daily. We construct a binary variable to identify bullied students, which will take the value 1 if they have been bullied at least once and 0 otherwise. We included the following variables as covariates in the

regression models: gender, migration background (Italian, first-generation foreigner, second-generation foreigner), geographical area of residence, socioeconomic background (socioeconomic status indicator, called ESCS), parents' educational qualification, kindergarten and nursery school attendance, age, place of birth and time code of the student. Students who are bullied may have different characteristics or circumstances that influence their academic performance, therefore, it is difficult to isolate the true causal effect of bullying, which is why it is considered an endogenous variable. To overcome the problem of endogeneity, we consider the regulations governing first enrolment and compulsory schooling in Italy, namely, Law No. 53 of 2003, the formalisation of which was then entrusted to Legislative Decree No. 59 of 2004. The beginning of the Italian academic year takes place in September. In a specific year, denoted as "t," students who are six years old or will reach that age by December 31 are required to begin school in September. However, according to the law, students who will turn six years old by April 30 of the following year, "t + 1," are also permitted to enroll. Nonetheless, this alternative remains discretionary, and it is evident that the decision to enroll early for these students is closely associated with their potentially unobservable characteristics. Consequently, each class consists not only of regular students, but also of those who were enrolled early, as well as students who turned six years old between January 1 and April 30 of year "t," whose parents chose not to enroll them in advance during year "t-1" (Ordine et al., 2018). We exclude students born from September onwards, so that we have one group of students born in the first four months of year 't', 't-1', t-2' and 't+1' and a second group of students born from May until August in year 't', 't-1' and t-2'. Thus, within each class, there are three distinct groups of students: group (i) comprises students born between January and April of year 't + 1', group (ii) comprises those born between May and August of year 't', 't-1' and 't-2', and group (iii) comprises students born between January and April of year 't', 't-1' and 't-2'. Combining groups (i) and (iii) yields a group of students consisting of regular, older and early learners born in the first four months of year 't', 't-1' t-2' and year t+1[26]; while in group (ii) we will have students born in the second four months of the year, so we exclude early learners. The framework that characterises this analysis results in classes in which fifth grade students are aged between:

- 113 months and 116 months at the start of the academic year [27](those who turn six years old until April of year 't + 1')

-121 months and 128 months (regular) at the beginning of the academic year (those turning six in year 't');

-133 months and 140 months (older) at the beginning of the academic year (those turning six in year 't-1');

-145 months and 152 months (older) at the beginning of the academic year (those turning six in year 't-2').

[26] The reference year of birth for regular students is the year 2003, for older students it is the year 2002 and 2001, and for early learners it is the year 2004

[27] In our case, we are referring to the 2013-2014 academic year, grade 5, which started in September, then, after transforming the age into months, we calculate the age based on the start of the school year.

In order to examine the impact of bullying among these groups, we use a dummy (Enrollment) as an instrumental variable, which will take value 1 for groups (i) and (iii), and value 0 for group (ii) which consists exclusively of students born from May to August in year 't', 't-1' and 't-2'. We exclude students born from September onwards, so that we have one group of students born in the first four months of year 't', 't-1', t-2' and 't+1' and a second group of students born from May to August in year 't', 't-1' and 't-2'.

3.3.1 Descriptive Statistics

In this particular section, we present the average frequency of responses on Bullying provided by students, as registered in the INVALSI questionnaire during the academic year 2013-2014 (Table 3.1). The answers to the following questions are extracted from the questionnaire: Q10_E - During this year, how often at school: - have you been teased by other students? Q10_F - During this year, how often at school: - have you been insulted by other students? Q10_G - During this year, how often at school: - have you been isolated or excluded by other students? Q10_H - During this year, how often at school: - have you been beaten up by other students? Additionally, we provide a comprehensive table depicting the variables employed in our analysis (Table 3.2). Furthermore, we present in figures 3.2 and 3.3 the average scores in mathematics and Italian for the academic year 2013-2014 (grade 5) and in figure 3.4 the propensity to be bullied.

Table 3.1 Bullying, Grade 5, Year 2013-2014

	Mean	Standard deviation
Have you been teased by other students?=Never	0.29	0.45
Have you been teased by other students?=Sometimes	0.56	0.50
Have you been teased by other students?=Every week	0.08	0.27
Have you been teased by other students?=Every day	0.08	0.26
Have you been insulted by other students?=Never	0.48	0.50
Have you been insulted by other students?=Sometimes	0.41	0.49
Have you been insulted by other students?=Every week	0.06	0.23
Have you been insulted by other students?=Every day	0.05	0.22
Have you been isolated or excluded by other students?=Never	0.55	0.50
Have you been isolated or excluded by other students?=Sometimes	0.37	0.48
Have you been isolated or excluded by other students?=Every week	0.04	0.21
Have you been isolated or excluded by other students?=Every day	0.04	0.19
Have you been beaten up by other students?=Never	0.81	0.39
Have you been beaten up by other students?=Sometimes	0.15	0.36
Have you been beaten up by other students?=Every week	0.02	0.13
Have you been beaten up by other students?=Every day	0.01	0.12

Table 3.1 shows the frequency of responses (on average) to the questions identifying bullying. As we can see, the answer relating to a higher frequency of occurrence of bullying has a very low average compared to when bullying occurs occasionally or not at all.

Table 3.2 shows the variables that we used in the analysis.

VARIABLES	DESCRIPTION
SCORE_MATH	Percentage score obtained in mathematics in INVALSI tests
BULLYING	It is a binary variable that takes the value 1 if they have been bullied at least once and 0 otherwise.
ENROLLMENT	Is the instrumental variable, also binary, which takes the value 1 for all early and late students born respectively in the first four months of year t, t-1, t-2 and year t+1 (January, February, March, April), and 0 for regular and graduate students born in year t, t-1, t-2 but in the following four months (May, June, July and August);
AGE	The age of the student is represented in months as follows: 108 months corresponds to 9 years; 120 months corresponds to 10 years; 132 months corresponds to 11 years; and 144 months corresponds to 12 years.
ESCS	The social, economic and cultural status of the families of the students participating in the INVALSI Tests
EDUCATION_MOTHER	The educational qualification (Mother): 1. Elementary license. 2. Medium license. 3. Three-year professional qualification. 4. High school diploma. 5. Any other qualification that is higher than a diploma, such as an I.S.E.F. qualification, an Academy of Fine Arts qualification, or a Conservatory qualification. 6. Degree or a higher degree, such as a Research Doctorate
EDUCATION_FATHER	The educational qualification (Father): 1. Elementary license. 2. Medium license. 3. Three-year professional qualification. 4. High school diploma. 5. Any other qualification that is higher than a diploma, such as an I.S.E.F. qualification, an Academy of Fine Arts qualification, or a Conservatory qualification. 6. Degree or a higher degree, such as a Research Doctorate

CITIZENSHIP	1.Native; 2.First-generation Foreigner; 3.Second-generation Foreigner
KINDERGARTEN_ATTENDANCE	1.Yes; 2. No
GENDER	Student's gender: 1.Male; 2.Female
GEOGRAPHICAL AREA	1.North; 2.Center; 3.South
NURSERY_ATTENDANCE	1.Yes; 2. No
BIRTHPLACE	Student's place of birth: 1= Italy (or Republic of San Marino); 2= European Union; 3= Non-EU European country; 4= Other
STUDENT_TIMETABLE	Student Timetable Code 1=24 hours; 2=27 hours; 3=28 to 30 hours; 4=31 to 39 hours; 5=40 hours

Figure 3.2 shows the average score in mathematics in the academic year 2013-2014, grade 5, and on the x-axis is the age in months. The score seems to be high for those who are 108 months old, i.e. the anticipatory group, then gradually the score decreases as age increases, which seems to have a logic. In Figure 3.3, the score decreases dramatically for students born in the second quarter of year t as age increases, so these are regular or older students.

Figure 3.2. Maths scores (Academic Year 2013-2014, Grade 5)

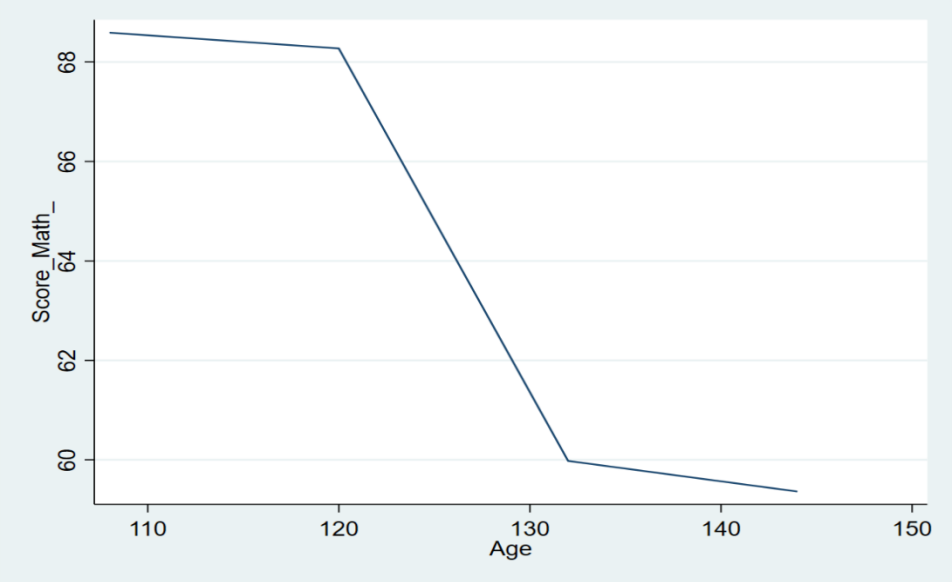


Figure 3.3. Italian scores (Academic Year 2013-2014, Grade 5)

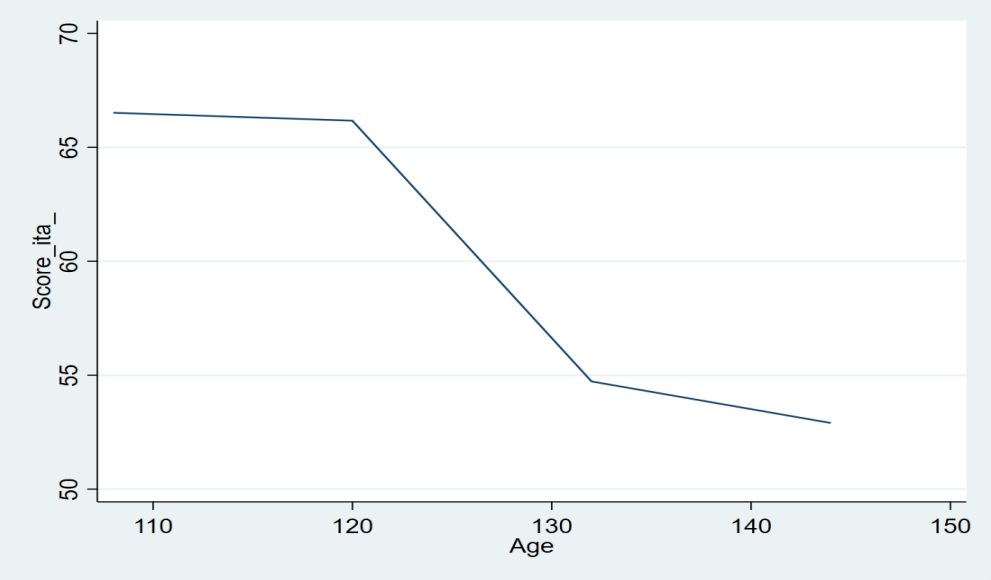
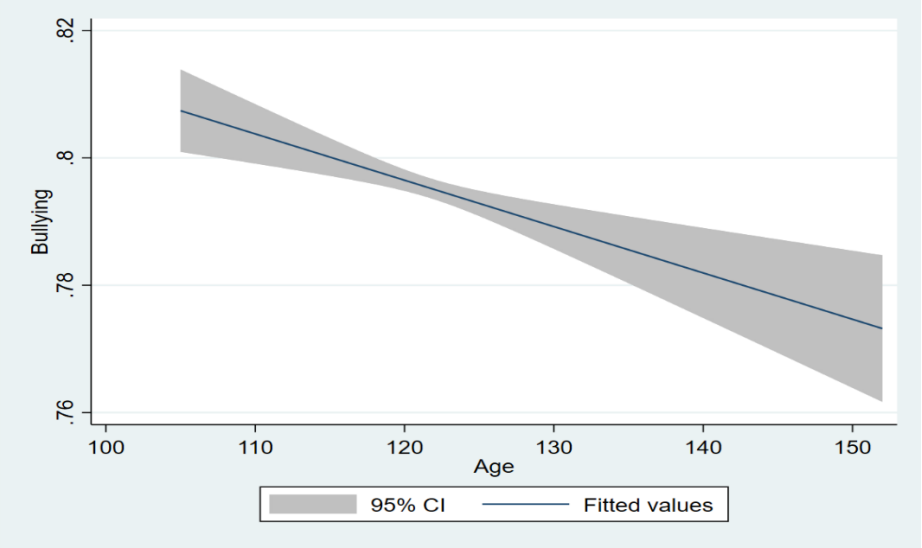


Figure 3.4. Propensity to be bullied.



The propensity to be bullied is statistically higher for those who are early learners, while it decreases with increasing age (Ballatore et al., 2020).

3.4 Identification Strategy

The key variable (bullying) may be endogenous because bullied students may have different characteristics or circumstances that influence their school performance, so it is difficult to isolate the true causal effect. Children who enter school early may be exposed to bullying because they are younger than the class, but better children may also be bullied by less good ones (reverse causality). In this regard, we thought of using the instrumental variables method to solve the endogeneity problem of the key variable Bullying. Considering the reform introduced in Italy, namely Law no. 53 of 2003, the formalisation of which was then entrusted to Legislative Decree no. 59 of 2004, which allows students born in year t+1 up to 30 April to enter primary school early, we create a first group consisting only of early and regular students born in the first quarter of year t, t-1, t-2 and t+1; a second group consisting only of regular and late students born in the second quarter of year t, t-1, t-2, as explained in section 3.3. The instrumental variable that allows us to capture the effect of bullying is called Enrolment and will take the value 1 for the first group, 0 for the second group. The instrument is considered to be effective because it does not determine the school result as in each class there are both early and late learners; the two groups are comparable in terms of performance.

3.5 Model

In this section, we will discuss the composition of the model through which the analysis was executed. The dataset employed is a cross-section, in which the dependent variable (Score_Math) represents the percentage score attained in mathematics during the academic year 2013-2014 for each student; X denotes a set of control variables including the age of each student in months, the social, economic and cultural status of the families of the students participating in the INVALSI Tests (ESCS), the educational qualification of both parents, the geographical area (North, Center, South), the citizenship of each student, student's place of birth, student timetable code, the attendance of kindergarten and nursery. Bullying It is a binary variable that takes the value 1 if they have been bullied at least once and 0 otherwise. Enrollment is the instrumental variable, also binary, which takes the value 1 for all early, regular and late students born respectively in the first four months of year t, t-1, t-2 and year t+1 (January, February, March, April), and 0 for regular and late students born in year t, t-1 and t-2, but in the following four months (May, June, July and August); ε represents the error term. The analysis is conducted using a 2SLS approach, where equation number 1 represents the second stage (structural equation), and equation number 2 represents the first stage (equation in reduced form), where we regress the endogenous variable onto potential exogenous variables.

$$Score\_Math_i = \boldsymbol{\beta X} + \boldsymbol{\delta Bullying_i} + \boldsymbol{\varepsilon_i} \qquad \textbf{(1) Second stage}$$

$$Bullying_i = \boldsymbol{\beta X} + \boldsymbol{\delta Enrollment_i} + \boldsymbol{\varepsilon_i} \qquad \textbf{(2) First stage}$$

3.6 Results

In this section, we will discuss the results returned by the OLS estimator in the first column and the results of the 2sls estimator, second and third columns (table 6.3).

Table 6.3 Results when the dependent variable is the mathematics score

	OLS Score_Math	1st Stage (IV) bullying	2nd Stage(IV) Score_Math
bullying	-1.9109***		-0.9610***
	(0.0952)		(21.9078)
120.Age	2.2454***	-0.0313***	-0.7056
	(0.1342)	(0.0034)	(0.6304)
132.Age	-0.9213**	-0.0524***	-5.8524***
	(0.3803)	(0.0095)	(1.3884)

144.Age	-0.8871	-0.0777**	-8.2082**
	(1.1927)	(0.0310)	(3.5284)
ESCS	1.5701***	-0.0189***	-0.2087
	(0.0643)	(0.0016)	(0.4451)
Female	-1.9458***	-0.0165***	-3.4955***
	(0.0771)	(0.0019)	(0.4087)
Foreigner 1st Generation	-0.7234*	-0.0202*	-2.1859*
	(0.3756)	(0.0105)	(1.1950)
Foreigner 2nd Generation	-3.4599***	0.0107**	-2.3593***
	(0.1481)	(0.0043)	(0.5036)
Centre	-0.3660***	-0.0180***	-2.0673***
	(0.0935)	(0.0028)	(0.4829)
South	1.1658***	-0.0429***	-2.9170**
	(0.0757)	(0.0024)	(0.9443)
Middle school (Father)	2.1999***	-0.0050	1.8176**
	(0.1954)	(0.0058)	(0.6224)
Three-year professional qualification (Father)	3.0545***	-0.0046	2.7423***
	(0.2186)	(0.0065)	(0.6901)
High school diploma (Father)	4.5910***	-0.0030	4.3094***
	(0.2065)	(0.0062)	(0.6497)
Other qualification above diploma (Father)	4.3418***	-0.0053	3.6918***
	(0.3185)	(0.0097)	(1.0075)

University degree or higher (Father)	5.5699***	0.0059	6.0481***
	(0.2341)	(0.0070)	(0.7454)
Middle school (Father)			
Middle school (Mother)	1.9218***	0.0093	2.9059***
	(0.2096)	(0.0064)	(0.6958)
Three-year professional qualification (Mother)	2.5586***	0.0112	3.6862***
	(0.2344)	(0.0071)	(0.7767)
High school diploma (Mother)	4.5054***	0.0052	5.1184***
	(0.2203)	(0.0067)	(0.7076)
Other qualification above diploma (Mother)	4.6977***	0.0183**	6.5287***
	(0.2942)	(0.0089)	(1.0016)
University degree or higher (Mother)	6.2973***	0.0171**	8.0715***
	(0.2460)	(0.0075)	(0.8645)
European Union	-0.6647*	0.0630***	4.5080**
	(0.3816)	(0.0106)	(1.7759)
European Country Non-EU	-3.8604***	0.0405***	-0.9442
	(0.4369)	(0.0121)	(1.5389)
Other	-5.2853***	0.0265**	-3.4524**
	(0.3849)	(0.0110)	(1.2720)

27 hours Student_Timetable	-0.2320 (0.5543)	-0.0235 (0.0171)	-2.6404 (1.8337)
28 to 30 hours Student_Timetable	-0.7292 (0.5539)	-0.0104 (0.0171)	-1.9036 (1.7743)
31 to 39 hours Student_Timetable	-0.6052 (0.5547)	0.0294* (0.0171)	2.0270 (1.8780)
nursery_attendance	0.0450 (0.0698)	-0.0276*** (0.0021)	-2.4115*** (0.6411)
kindergarten_attendance	-2.3965*** (0.1438)	-0.0022 (0.0045)	-2.6123*** (0.4629)
enrollment		-0.0099*** (0.0021)	
_cons	63.4670*** (0.6196)	0.8671*** (0.0191)	143.9793*** (18.8530)
N	175,169	175,169	175,169

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.001$

We do not dwell much on the results obtained through simple linear regression, as they are biased. As mentioned earlier, the model has mathematics score as the dependent variable (grade 5, academic year 2013-2014), includes a number of controls, mostly categorical control variables, among the regressors is the key variable bullying which suffers from endogeneity problems. In the first column, bullying has a negative and statistically significant coefficient at 1%. To account for the endogeneity problem, we used an estimator that can provide more accurate estimates, namely the 2SLS. In the first stage we regress our endogenous variable on all potentially exogenous variables, including the instrumental variable for bullying, called Enrollment. The latter is a dummy that takes the value 1 for early and late students born in the first four months of year t,t-1,t-2 and year t+1, 0 for students born in the second four months of year t,t-1 and t-2, thus only regular and older students are included. In the first stage, the instrumental variable seems to explain the dependent variable bullying well, with a negative and statistically significant coefficient at 1%. Let us move on to the final

results: early and regular or older students born in the first four months of year t, t-1, t-2 and t+1, who were bullied (at least once), see their maths scores drop by about 0.96 compared to those who have never been exposed to bullying. The other control variables, such as age, explain, for example, that students who are 144 months and 132 months old see their maths scores decrease compared to early learners by 8 points and 6 points, respectively, with a significance of 5% and 1%; the female gender scored about 3.5 points lower in maths compared to males; being a foreign student lowers the score in mathematics by about 2 points compared to natives; the education of the father and mother has a positive influence on the score compared to parents with a primary school licence; those who did not attend nursery or kindergarten have a lower score than those who did; students living in the centre and south performed about two points lower in mathematics than students in the north; Non-Italian students who, however, belong to an EU country perform about four times as well as Italian students; while students from countries whose category is called others, score lower than Italian students. Finally, in the appendix we report Durbin-Wu-Hausman test to see whether the estimates returned by the 2sls estimator are reliable. In our case we reject the null hypothesis so we can place confidence in the estimates just shown (see appendix).

Referring to the model below and using the estimator 2sls, when the dependent variable becomes the score obtained in Italian, the results are similar to the previous ones (Table 6.4):

$$Score\_Ita_i = \boldsymbol{\beta X} + \boldsymbol{\delta Bullying_i} + \boldsymbol{\varepsilon_i} \qquad \textbf{(1) Second stage}$$

$$Bullying_i = \boldsymbol{\beta X} + \boldsymbol{\delta Enrollment_i} + \boldsymbol{\varepsilon_i} \qquad \textbf{(2) First stage}$$

The coefficient of the key variable bullying retains almost the same magnitude as before. Being bullied for those born in the first four months of the year (group of early, regular and older students), decreases their score in Italian by approximately 0.97 compared to those not exposed to bullying and were born in the second four months of the year t, t-1 and t-2; the significance remains unchanged. The rest of the control variables maintain some consistency with the results shown above, except for the gender variable, this time it is girls who perform better in Italian than boys. Again, the estimates obtained are reliable, as we reject the null hypothesis of the Durbin-Wu-Hausman test (see appendix).

Table 6.4 Results obtained when the dependent variable is the italian score

	(1) Score_Ita	(2) bullying	(3) Score_Ita
bullying	-1.8950***		-0,9697***
	(0.0940)		(22.7314)
120.Age	2.7868***	-0.0310***	-0.1570
	(0.1326)	(0.0034)	(0.6461)
132.Age	-1.9029***	-0.0538***	-7.0177***
	(0.3793)	(0.0096)	(1.4564)
144.Age	-2.0200*	-0.0919**	-10.7617**
	(1.2174)	(0.0329)	(3.9572)
ESCS	1.7477***	-0.0188***	-0.0355
	(0.0635)	(0.0016)	(0.4578)
Female	2.8169***	-0.0166***	1.2346**
	(0.0762)	(0.0020)	(0.4260)
Foreigner 1st Generation	-3.2919***	-0.0225**	-5.4338***
	(0.4483)	(0.0106)	(1.2376)
Foreigner 2nd Generation	-5.1191***	0.0103**	-4.1417***
	(0.1800)	(0.0043)	(0.5129)
enrollment		-0.0097***	
		(0.0021)	
Centre	0.2258**	-0.0182***	-1.5037**
	(0.1125)	(0.0029)	(0.5014)
South	1.4333***	-0.0425***	-2.6050**
	(0.0929)	(0.0024)	(0.9704)
Middle school (Father)	2.4349***	-0.0056	1.9052**
	(0.2381)	(0.0059)	(0.6424)

Three-year professional qualification (Father)	3.4058*** (0.2656)	-0.0055 (0.0066)	2.8835*** (0.7105)
High school diploma (Father)	5.1043*** (0.2511)	-0.0044 (0.0063)	4.6856*** (0.6707)
Other qualification above diploma (Father)	4.8278*** (0.3862)	-0.0065 (0.0098)	4.2083*** (1.0283)
University degree or higher (Father)	6.4006*** (0.2841)	0.0047 (0.0071)	6.8500*** (0.7586)
Middle school (Mother)	2.2597*** (0.2553)	0.0079 (0.0065)	3.0102*** (0.7078)
Three-year professional qualification (Mother)	2.9510*** (0.2846)	0.0104 (0.0072)	3.9415*** (0.7924)
High school diploma (Mother)	5.3231*** (0.2679)	0.0039 (0.0068)	5.6948*** (0.7228)

Other qualification above diploma (Mother)	5.5180*** (0.3563)	0.0173* (0.0090)	7.1613*** (1.0184)
University degree or higher (Mother)	7.3471*** (0.2990)	0.0158** (0.0076)	8.8530*** (0.8750)
European Union	-0.9242** (0.4529)	0.0664*** (0.0107)	5.3857** (1.8790)
European Country Non-EU	-5.6094*** (0.5176)	0.0426*** (0.0122)	-1.5617 (1.6002)
Other	-6.1337*** (0.4622)	0.0265** (0.0111)	-3.6168** (1.3107)
27 hours Student_Timetable	-0.8442 (0.6683)	-0.0232 (0.0172)	-3.0461 (1.8511)
28 to 30 hours Student_Timetable	-1.2011* (0.6678)	-0.0102 (0.0172)	-2.1683 (1.7890)
31 to 39 hours Student_Timetable	-1.4588** (0.6689)	0.0294* (0.0172)	1.3382 (1.8998)
nursery_attendance	0.2445** (0.0839)	-0.0278*** (0.0021)	-2.4017*** (0.6702)

kindergarten_attendance	-2.2956***	-0.0034	-2.6205***
	(0.1745)	(0.0045)	(0.4761)
_cons	56.8339***	0.8688***	139.4368***
	(0.7519)	(0.0192)	(19.6021)
N	172,068	172,068	172,068

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.001$

3.7 Conclusion

Bullying within educational institutions not only impacts the emotional and social well-being of its victims, but also hinders their scholastic achievements. Bullying, a form of violence that is significantly detrimental, is prevalent in educational institutions globally. Existing research reveals that, apart from the physical harm inflicted, bullying can induce a decline in one's self-assurance, self-worth, and academic performance. Consequently, this matter necessitates our continual attention and introspection. Due to the significance of the subject matter, we undertook this analysis utilizing the surveys that were administered during the INVALSI tests in the 2013-2014 academic year for grade 5. By merging the responses provided by the students to the questionnaires with the dataset encompassing the scores achieved in Italian and mathematics, we constructed a unified dataset. The key variable known as bullying might exhibit endogeneity due to the fact that students who experience bullying may possess distinct characteristics or circumstances that have an impact on their academic performance. Consequently, it becomes challenging to isolate the genuine causal effect. In the context of the reform implemented in Italy, specifically Law No. 53 of 2003, which was subsequently formalized by Legislative Decree No. 59 of 2004, the admission of students into primary school at an early age is permitted for those born in year t+1 until 30 April. To investigate this, we establish a first group consisting solely of early and regular students born in the initial four months of year t, t-1, t-2, and t+1. Additionally, a second group is comprised exclusively of regular and late students born in the subsequent four months of year t, t-1, t-2. The instrumental variable employed to capture the impact of bullying is denoted as Bullying, and it assumes a value of 1 for the first group and 0 for the second group. Employing a 2SLS approach, the analysis reveals that early and regular or older students born in the initial four months of year t, t-1, t-2, and t+1, who have experienced bullying (at least once), witness a decline in their mathematics and Italian scores that is approximately 0.96 and 0.97 compared to those who have never been subjected to this phenomenon. Educational interventions have the potential to play a pivotal role in addressing both traditional and cyberbullying, for example, promoting a proactive attitude and soft skills related to the management and control of social-emotional skills in the development of an evolving personality. According to data from the

Health Behaviour Surveillance of School-Age Children - HBSC Italy 2022[28], harassing behaviors at school are more common in younger children and girls. This work aims to show how this phenomenon should be considered a serious public health problem.

[28] The results of the HBSC 2022 data collection were presented at the Istituto Superiore di Sanità (ISS) on Feb. 8, 2023 at the national conference "Adolescent Health: Data from the Health Behaviour in School-aged Children surveillance - HBSC Italy 2022," in the presence of the regional and corporate contact persons who coordinated the activities at the local level and in the presence of some of the most important Scientific Societies, Federations and Professional Associations that have been involved in the health of boys and girls for years.

3.8 Appendix

Durbin-Wu-Hausman test on the estimates obtained in Table 3.6

```
Tests of endogeneity

H0: Variables are exogenous
Robust score chi2(1)          =  123.955  (p = 0.0000)
Robust regression F(1,175139)   =  124.032  (p = 0.0000)
```

Durbin-Wu-Hausman test on the estimates obtained in Table 4.6

```
Tests of endogeneity
H0: Variables are exogenous
Robust score chi2(1)          =  123.166  (p = 0.0000)
Robust regression F(1,172038)   =  123.247  (p = 0.0000)
```

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Conclusions

The dissertation focuses its attention on three subjects that are of considerable importance: school performance in relation to public spending and the presence of the female gender in political bodies, in the third chapter it introduces the phenomenon of bullying and school performance, and in the second chapter it focuses on school reopening during the pandemic. The results are based on empirical analyses, using the 2sls estimator we correct for endogeneity problems in some variables.

The priority given to education is bound to be an even more decisive factor in a country's development. Therefore, investment in the education system, from the early years of life to the higher grades of education, is central. A better allocation of expenditure could have positive effects on the academic performance of students, which is why it was thought to investigate this relationship by raising another issue, namely, gender quotas in municipal administrations. The under-representation of women in politics can be attributed to the various obstacles in the long career path typical of this sector. Women may not be interested in running for office because of time constraints due to childcare, or because of the lack of external family and/or financial support. We think that somehow a greater presence of women would allow a better allocation of expenditure between chapters, as they are closer to issues such as education and childcare, which could have positive effects on academic performance. This thesis is borne out by the results: in particular, the increase in public expenditure, which is instrumented by the introduction of double preference in municipalities with over 5000 inhabitants, has a favourable impact on school results in Italian and mathematics. Education is a strategic lever for the labour market, and effective and efficient investments in education, childcare extension and training are a prerequisite for improving the quality and inclusiveness of education systems and crucial aspects in shaping the society of the future.

Therefore, the presence of schools holds a significant level of importance within a nation. The decision to close schools during the pandemic was undoubtedly challenging and momentous, made with full awareness of the detrimental effects it would impose upon the already fragile Italian educational system. The closure of schools due to the pandemic has had a profound impact on the educational progress of children and adolescents, as well as their mental well-being and various other aspects of their lives. On a global scale, the interruption of education has resulted in a substantial loss of academic knowledge for millions of children who would have otherwise acquired it through in-person classroom instruction. The purpose of the second chapter was to ascertain the role that reopening schools played in the transmission of Covid-19 infections. it aimed to determine whether this decision was justified and whether it could be implemented again in the event of another pandemic. The

analysis was conducted using data from various Italian provinces, with information on the Covid-19 pandemic sourced from the Higher Institute of Health. The dependent variable in this study was the daily growth rate of Covid-19 infections. The findings of the analysis revealed that the presence of schools has an impact on the progression of the epidemic that is 1.5 times greater than when schools are closed. Nonetheless, it is crucial to consider the socio-economic consequences that arise from the closure of schools. In this regard the final chapter, we delved into the topic of bullying, examining it in depth.

The occurrence of bullying is an urgent matter that necessitates intervention within the educational institution. In the preceding chapter, we have illustrated the significance of combating this phenomenon. Not only does it cause physical and psychological harm to the child or adolescent, but it also has the potential to impede academic performance and exacerbate personality disorders. The utilization of INVALSI data and an appropriate methodology has revealed that the presence of bullying has a detrimental impact on academic achievement, particularly when there are students who begin grade 5 in Italian and mathematics at an early age. The role of the psychologist is considered indispensable within the school environment in order to identify difficulties early on that contribute to the development of psychological syndromes. Additionally, it is imperative to implement a program aimed at preventing bullying by assessing the distress experienced by young individuals and identifying individual, familial, and environmental risk factors that may give rise to violent behaviour. The introduction of school psychologists could significantly contribute to nurturing the potential and resources of children during their crucial developmental phase.